

Research article

Dominant Factors of Wrist Flexibility and Height: Shooting Ability of Petanque Extracurricular Students at SMK Tekno-SA Surakarta

Alinnuha Nur Diansyah ¹, Agus Susworo ¹, Damrah ^{2*} and Fiky Zarya ²

Citation: Diansyah A. N., Susworo A., Damrah, Zarya F. - Dominant Factors of Wrist Flexibility and Height: Shooting Ability of Petanque Extracurricular Students at SMK Tekno-SA Surakarta

Balneo and PRM Research Journal
2026, 17(1): 993

Academic Editor(s):
Constantin Munteanu

Reviewer Officer:
Viorela Bembea

Production Officer:
Camil Filimon

Received: 11.11.2025
Published: 31.03.2026

Reviewers:
Corina Sporea
Alin Ciubotaru

Publisher's Note: Balneo and PRM Research Journal stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



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- 1 Department Physical Education and Recreation, Faculty of Sports Science, Yogyakarta State University, Indonesia
- 2 Department of Sports Science, Universitas Negeri Padang, Indonesia

* Correspondence: damrah@fik.unp.ac.id,

Abstract: The purpose is to analyze the influence of wrist flexibility and body height on the shooting ability of petanque extracurricular students at SMK Tekno-Sa Surakarta. The sampling technique in this research uses a non-probability technique, namely saturated sampling or often called total sampling. Data collection is carried out by tests and measurements. To obtain data from each variable related to this research using tests and measurements. Data analysis uses statistical analysis with correlation studies, multiple regression data analysis techniques using the SPSS version 2.0 application. The results of the research are as follows. First, from the partial test results of multiple regression analysis, it can be seen that the wrist flexibility variable shows that the value of sig. $0.031 < 0.05$ then the hypothesis is accepted. This means that the variable wrist flexibility influences shooting. The second partial test result of multiple regression analysis shows that the height variable shows that the sig value. $0.018 < 0.05$ then the hypothesis is accepted. This means that the height variable has effect on shooting. Third, the wrist flexibility variable and body height simultaneously influence the shooting variable by 82.4%. the data concluded that, partially, the wrist flexibility variable and the height variable had effect on petanque shooting ability. Simultaneously, the wrist flexibility and body height variables had an effect on the shooting ability variable in petanque extracurricular students at SMK Tekno-Sa Surakarta.

Keywords: Shooting, Petanque, Extracurricular

1. Introduction

Petanque is a relatively new sport in Indonesia, although it is already well known internationally (Effendi et al., 2024; Hafidz et al., 2024). Petanque is characterized by a requirement for accuracy during play. Petanque does not require the same level of physical fitness as other sports, so it can be played by children, adults, the elderly, and even people with special needs (Nurhasan et al., 2024; Nurhidayat et al., 2024).

The shooting movement technique is a shooting throw which aims to hit the opponent's iron ball or wooden ball to score a point (Pedersen et al., 2018). In contrast to pointing, shooting is done with only one throwing technique because the iron ball thrown must directly hit the opponent's iron ball or wooden ball. Therefore shooting in Petanque has its own number to compete in.

Extracurricular activities are activities carried out to develop certain aspects of what is found in the current curriculum, including those related to how the actual application of the knowledge learned by students is in accordance with the demands of their life needs and the surrounding environment (Delorme et al., 2024; Jupri et al., 2024; Wachsmann & Zacharie, 2017).

Physical education coaches and teachers often do not know which physical factors are most important for petanque performance, making it difficult to develop training programs or identify athlete talent (Arwandi et al., 2023; HB et al., 2023; Munir, Sumaryanti, Rismayanthi, Bafirman, et al., 2024; Munir, Sumaryanti, Rismayanthi, Nasrulloh, et al., 2024; Putra et al., 2023; Wijaya et al., 2024). So far, extracurricular petanque trainers have assumed that the physical requirements are similar to other target sports, such as handball, basketball, or golf. Therefore, this research aims to identify which factors, such as arm muscle strength and height, determine shooting ability in petanque.

Several studies have been conducted that link physical condition with petanque, including research conducted by concluding that body height, arm length, arm muscle strength, wrist flexibility, balance, eye-hand coordination determine shooting accuracy (Feschet, 2013b; Rizal et al., 2021; Ronzano, 2017). Height can contribute 89.3% to shooting accuracy, arm length 88.1%, arm muscle strength 56.9%, wrist flexibility 64.5%, balance 82.7%, and eye-hand coordination 77% [2,10]. Ultimately, an optimal distance from the competitor and good hand-eye coordination can both increase the accuracy of petanque shooting (Eichberg, 2012; Feschet, 2011; Nuryadin et al., 2023). These findings do not align with the theory that increasing arm extension directly increases the speed and distance of the ball, as indicated by the petanque rule stating the maximum throwing distance is 9 meters (Feschet, 2013a; Pelana et al., 2021).

Regarding factors in physiology in the journal Sport Area, This research aims to determine the physical and psychological elements that are dominant in the sport of petanque (Pratama et al., 2024; Santosa et al., 2024). This study examined the relationship between physical and psychological factors and petanque performance using a quantitative descriptive correlational design. The participants included UNESA petanque athletes, Lamongan petanque athletes, and coaches from across Indonesia, and data were analyzed using Partial Least Squares (PLS) analysis. Results indicated that among physical factors, wrist flexibility, balance, and aerobic capacity were dominant, while anxiety and self-confidence were the most influential psychological factors. When analyzed together, physiological, biomotor, and psychological factors explained 97.6% of the variance in performance and playing processes, suggesting that these factors collectively have a highly dominant influence on petanque performance.

In petanque, success in shooting at the target is influenced by hand-eye coordination (54.61%), wrist flexibility (49.28%), buttock flexibility (41.60%), and balance (44.22%). Together, hand-eye coordination, wrist flexibility, hip flexibility, and balance accounted for 82.5% of shooting performance in petanque (Matsuda et al., 2022; Phytanza et al., 2022). This research can be further developed by including additional factors and involving elite athletes.

So far there has been no research conducted on extracurricular students regarding what actual elements determine petanque ability. Some studies only track relationships, without looking at the actual variables that influence petanque sport achievement. The difficulties faced by students in learning variations and combinations of basic petanque techniques require a physical education teacher to have creativity in learning the material. The lack of supervision from a trainer and physical education teacher means that students only practice normally, that is, only guided by exercises according to what they know through direct observation at several events or via YouTube media. At first glance, of course there is still a lot that extracurricular students at SMK Tekno-Sa Surakarta don't know about the aspects involved, such as what techniques and training models are appropriate to improve their abilities so they can compete closely with athletes from other schools.

This research has a necessity, if you remember that this sport is a newly developing sport, no amount of research has been found regarding the physical factors that determine the performance of the sport of petanque. Therefore, researchers need

to investigate the effects of wrist flexibility and body height on the shooting ability of petanque extracurricular students at vocational school Tekno-Sa Surakarta.

2. Materials and Methods

This study employed a quantitative approach with a Confirmatory Factor Analysis (CFA) design to investigate the contribution of body height and wrist flexibility to petanque shooting performance. The population and sample consisted of all 56 petanque extracurricular students at Tekno-Sa Surakarta Vocational School, selected using a saturated (total) sampling technique. Throughout the research, control variables such as training media, petanque balls, and execution time were kept constant to ensure consistent measurement conditions.

Data collection was conducted through standardized tests and measurements for each research variable. Body height was measured using a stadiometer, wrist flexibility was assessed using the wrist flexibility test with a goniometer, and petanque shooting ability was measured using a shooting game test prepared in a dedicated skill-assessment post. All obtained data were then verified, tabulated, and subjected to a series of quality checks, including validity and reliability tests, followed by classical assumption testing, particularly the normality test, to determine the feasibility of further analysis.

The collected data were analyzed using multiple regression analysis with SPSS version 20 to determine the effect of wrist flexibility and body height on shooting performance. The research procedure began with coordination with the school principal and physical education teachers, followed by briefing the extracurricular students regarding the research activities. The implementation stage included preparing all required instruments, conducting height and flexibility measurements, and assessing shooting performance individually using the predetermined shooting test. All procedures were executed in a standardized manner to produce valid, reliable, and representative data.

3. Results

This research is about wrist flexibility, body height on the petanque shooting ability of extracurricular students at SMK Tekno-Sa Surakarta with the variables in the research as follows, namely: Wrist flexibility in extracurricular students at SMK Tekno-Sa Surakarta Body height of extracurricular students at SMK Tekno-Sa Surakarta,, Petanque shooting ability at extracurricular at SMK Tekno-Sa Surakarta

The details of the collected data are presented in Table 1 below:

Tabel 1. Value Distribution

	Wrist flexibility	Body height	Shooting
Mean	78,39	171,18	10,07
N.Max	131	181	15
N.Min	37	161	5
Total	4389,84	9586.08	563.92

Wrist flexibility is the ability to move a joint to its limit of motion. In the wrist flexibility data, the average data obtained was 78.39, with the child's highest score being 131 and the lowest score being 37. The total score was 4389.84 from the 56 children who took the test.

Body height is the distance from the top of the head to the soles of the feet, measured using a stadiometer. From the height test results, the average height appears to be 171.18 cm. The highest value is 181 cm and the shortest is 161 cm. The total value obtained was 9586.08 cm from 56 children.

Shooting in petanque is different from other sports. In petanque, shooting is performed to prevent the opponent from scoring maximum points. From the measurements taken, it was recorded that the average score was 10.07. With the largest score

being 15 and the smallest score being 5. The total score obtained was 563.92 from 56 children.

Table 2. Test Reliability Level

Test	Reliability	Information
Wrist flexibility	0,961	Very high reliability
Body height	1,00	Very high reliability
Shooting	0,945	Very high reliability

This normality test was carried out on the results of tests carried out by researchers as a prerequisite for data analysis, but for the sake of accuracy of calculations the SPSS 20.0 program was used. The results of the normality test for each variable are as follows:

Table 3. Tests of Normality

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	Df	Sig.
Wrist flexibility	.096	28	.200*	.975	28	.727
Body height	.178	28	.023	.965	28	.448
Shooting	.132	28	.200*	.969	28	.545
a. Lilliefors Significance Correction						
*. This is a lower bound of the true significance.						

In the results above of the Wrist flexibility, a significance value of $p = 0.086$ was obtained so that $p > \alpha$ (0.05). Thus the data is normally distributed. In the above results of the height test, a significance value of $p = 0.448$ was obtained so that $p > \alpha$ (0.05). Thus the data is normally distributed. In the results above of the shooting test, a significance value of $p = 0.545$ was obtained so that $p > \alpha$ (0.05). Thus the data is normally distributed.

Table 4. Regression Analysis Test

Coefficients ^a								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-20.713	6.741		-3.073	.005		
	Wrist flexibility	.026	.011	.241	2.296	.031	.380	2.629
	Body Height	.060	.045	.103	1.355	.018	.729	1.372

a. Dependent Variable: shooting

The table above provides information about the regression equation and whether or not the wrist flexibility and body height variables partially influence the shooting variable. For the wrist flexibility variable, the significance value was 0.031, which is less than 0.05, so the hypothesis is accepted. This means that wrist flexibility influences shooting ability. For the body height variable, the significance value was 0.018, which is also less than 0.05, indicating that body height affects shooting ability.

The F test in the multiple linear regression analysis was significant, indicating that all independent variables together have a significant effect on the dependent variable:

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.908 ^a	.824	.817	.99479
a. Predictors: (Constant), Body Height (x2), Wrist flexibility (x1)				

Based on the SPSS "Model Summary" output table above, it is known that the coefficient of determination or R Square value is 0.824. The R Square value of 0.824 comes from squaring the correlation coefficient value or "R", namely $0.908 \times 0.908 = 0.824$. The coefficient of determination (R Square) is 0.824 or equal to 82.4%. This value means that wrist flexibility and body height together account for 82.4% of the variation in petanque shooting ability, while the remaining 17.6% is explained by other variables not included in the study.

4. Discussion

Contribution of Wrist Flexibility to Shooting Ability

Wrist flexibility plays an important role in increasing the accuracy of shooting movements in petanque. Flexibility is the freedom of movement in the wrist muscle joints to make maximum movements. With freedom of movement on fast bosi release due to the formation of an angle between the wrist and fingers as well as consistency of movement at the waist, shoulders, shooting elbow, wrist and fingers. Besides that, good flexibility supports the ability to carry out movements with a wide range of motion and to control and smooth the movement of the ball, the energy required does not double in amount, so that the ball throw will be more directed and accurate.

It is proven from the results of the partial Multiple Regression Analysis test that the wrist flexibility variable shows that the sig. $0.031 < 0.05$ then the hypothesis is accepted. This means that the wrist flexibility variable influences shooting ability. This is the basis for wrist flexibility which plays an important role in improving shooting movements in petanque. This discussion is supported (Helmi et al., 2024; Svensson & Tekin, 2021) The results showed that the success of shooting shots on the iron was contributed by hand-eye coordination factors (54.61%), wrist flexibility (49.28%), trunk flexibility (41.60%) and balance (44.22%) provided contribution to shooting shots on the iron.

Contribution of Body Height to Shooting Ability

Body height is an important component in sports where height offers an advantage (Boucher et al., 2017; Bueno et al., 2018). In petanque, taller players may find it easier to see the opponent's bosi, as the aim of the game is to bring the bosi closer to the boka and to defend one's position by keeping the opponent's bosi far from the boka. However, the partial test results of multiple regression analysis showed that the body height variable had a significance value of 0.018, which is less than 0.05, so the hypothesis is accepted. This means that body height affects shooting ability.

This discussion is supported by research (Laguenny et al., 2002; Pedersen et al., 2022). This research uses a quantitative approach with correlational analysis and uses descriptive methods, because it describes how much each variable contributes. The data from 15 petanque athletes in East Java were processed using SPSS Windows Release 20. The overall contribution was 64.2%, with body height being the most significant variable at 45.1% (Feschet, 2016; Loser et al., 2011).

Contribution of Wrist Flexibility and Body Height to Petanque Shooting Ability

Although researchers assumed that petanque shooting ability is influenced by several factors, it was found that some of these factors do not actually have an effect. However, it is known that the coefficient of determination value is 0.824 or equal to 82.4%, which means that the variables of wrist flexibility and body height simultaneously influence the shooting variable by 82.4%.

Biomechanics of shooting in petanque

Analysis of pointing and shooting movements was performed using Kinovea technology, which combines video and computer analysis to measure the angle, speed, and height of the ball in petanque. Kinovea offers user-friendly options for analyzing movements, including slow-motion video playback. This technology helps collect data on movements such as back swing, swing, and release in petanque.

The petanque sport's back swing is the initial movement when pointing or shooting, namely moving the arm backwards across the body's axis. Release when pointing or shooting is the moment when the ball leaves the hand. When the ball is released at the right time it will affect the height and speed of the ball (Txi et al., 2023; Vorup et al., 2017).

Wrist Flexibility Training Program to Improve Petanque Shooting Ability

The ability to shoot in petanque is influenced by several things, one of which is wrist flexibility. Training wrist flexibility can improve petanque shooting ability. Hand flexibility or suppleness can be trained with several programs, including with the help of hand grips, wrist curls, and light exercises for the arms and hands.

5. Conclusions

Based on the findings of this study involving extracurricular students at SMK Tekno-Sa Surakarta, wrist flexibility and body height were found to be significantly associated with petanque shooting ability. The results indicate that students with greater wrist flexibility and taller body height tended to demonstrate better shooting performance. Furthermore, both variables together accounted for 82.4% of the variance in petanque shooting ability, suggesting a strong combined association within the context of this sample.

However, these findings should be interpreted as exploratory and associative rather than causal. Other unexamined factors may also contribute to shooting performance. Therefore, wrist flexibility and body height can be considered important associated factors in understanding and potentially supporting the development of petanque shooting skills among extracurricular students at SMK Tekno-Sa Surakarta. Further research is recommended to explore additional variables and confirm these relationships in broader populations.

Author Contributions: Conceptualization, A.N.D. and A.S.; methodology, B.B.; software, F.Z. and B.B.; validation, A.N.D. and A.S.; formal analysis, B.B.; investigation, F.Z.; resources, F.Z.; data curation, B.B.; writing—original draft preparation, A.N.D.; writing—review and editing, A.N.D. and A.S.; visualization, F.Z.; supervision, B.B.; project administration, F.Z.; funding acquisition, B.B. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest - The authors declare that there is no conflict of interest in this research.

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