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Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations

Análisis del rendimiento y las reacciones de las extremidades inferiores de los atletas de pencak silat durante la competición: un enfoque contextual de las situaciones competitivas

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Abstract

Pencak silat performance relies heavily on explosive lower limb actions and rapid reactions during combat. However, limited empirical evidence exists on how these physical components influence actual match performance in *pencak silat* athletes. This study aims to analyse the relationship between lower limb components and athlete reaction time with match performance in *pencak silat*. The research employed a quantitative correlational method with a multiple linear regression analysis approach involving 24 *pencak silat* athletes who had competed at the provincial level. The measured components included leg strength, leg power (vertical jump), 20-metre sprint speed, and whole-body reaction time (visual and audio). Match performance was assessed through video analysis based on the number of successful punches, kicks, and takedowns. The results showed that the regression model for predicting the number of punches approached but did not reach statistical significance ($p = 0.069$; $R^2 = 0.41$, indicating a moderate-to-strong relationship). Within this model, significant partial contributions were found from leg strength ($p = 0.047$), visual reaction ($p = 0.005$), and audio reaction ($p = 0.021$). However, the regression models for the number of kicks ($p = 0.421$; $R^2 = 0.225$) and takedowns ($p = 0.336$; $R^2 = 0.254$) were not statistically significant. These findings indicate that leg strength and visual reaction play a crucial role in punch performance, while kicks and takedowns may be influenced more by technical and coordination factors.

Keywords: *Pencak silat*, lower limb, punch, reaction time, performance.

Resumen

El rendimiento en el *pencak silat* depende en gran medida de la explosividad de las extremidades inferiores y de la rapidez de reacción durante el combate. Sin embargo, existen pocas pruebas empíricas sobre cómo estos componentes físicos influyen en el rendimiento real de los atletas de *pencak silat* durante los combates. El objetivo de este estudio es analizar la relación entre los componentes de las extremidades inferiores y el tiempo de reacción de los atletas con el rendimiento en los combates de *pencak silat*. La investigación empleó un método correlacional cuantitativo en el que participaron 24 atletas de *pencak silat* que habían competido a nivel provincial. Los componentes medidos incluyeron la fuerza de las piernas, la potencia de las piernas (salto vertical), la velocidad en un sprint de 20 metros y el tiempo de reacción de todo el cuerpo (visual y auditivo). El rendimiento en los combates se evaluó mediante el análisis de vídeos basándose en el número de puñetazos, patadas y derribos exitosos. Los resultados mostraron que el modelo de regresión entre el rendimiento de las extremidades inferiores y el número de puñetazos era casi significativo ($p = 0,069$; $R^2 = 0,41$), con contribuciones parciales significativas de la fuerza de las piernas ($p = 0,047$), la reacción visual ($p = 0,005$) y la reacción auditiva ($p = 0,021$). Sin embargo, los modelos de regresión para el número de patadas ($p = 0,421$; $R^2 = 0,225$) y derribos ($p = 0,336$; $R^2 = 0,254$) no fueron estadísticamente significativos. Estos hallazgos indican que la fuerza de las piernas y la reacción visual desempeñan un papel crucial en el rendimiento de los puñetazos, mientras que las patadas y los derribos pueden verse más influenciados por factores técnicos y de coordinación.

Palabras clave: *Pencak silat*, extremidades inferiores, puñetazos, tiempo de reacción, rendimiento.



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Introduction

Physical factors—such as muscle strength, explosive power, stamina, and flexibility—are the main foundations for achieving high performance in combat sports (including *pencak silat*). The main attacks in combat sports are performed explosively and repetitively in the form of punches, kicks, knee strikes, and elbow strikes (Barley et al., 2019) to quickly bypass the opponent's defense and overcome their protective reactions (Liu et al., 2021). The attack must be sufficiently strong and meet the assessment criteria to be recorded as a valid decision in the assessment (Beattie & Ruddock, 2022). To produce explosive and repetitive movements, the physical ability of athletes plays a crucial role in the success of their performance in competitions.

Optimal performance in combat sports is largely determined by the integration of various physical components, including strength, explosive power, endurance, reaction speed, agility, flexibility, as well as core balance and stability. Strength and power, particularly in the lower extremities, are essential for generating explosive movements such as punches, kicks, and repeated takedowns, highlighting the benefits of strength and plyometric training in enhancing the technical performance of combat athletes (Cid-Calfucura et al., 2023). Aerobic and anaerobic endurance are also crucial for maintaining intensity during consecutive rounds (Vasconcelos et al., 2020). Additionally, other studies highlight the importance of functional training that includes speed, coordination, balance, and flexibility for quick technical responses and movement adaptation in combat (Ruddock et al., 2021). These findings reinforce the conclusion that all these physical aspects are interconnected and collectively determine performance success in combat sports.

The performance of athletes in combat sports is highly dependent on two main physical components, namely lower limb strength/ power and reaction time. Lower limb muscle strength enables the development of great force and energy transfer through the kinetic chain towards attacks such as punches or kicks, while reaction speed ensures a timely response to stimuli or opponents' movements. A study correlating maximum lower limb strength and punch speed showed strong correlations ($r = 0.66\text{--}0.80$) in both static and dynamic techniques in karate athletes (Quinzi et al., 2022). Lower limb strength is important for supporting reactions; lower limb muscle fatigue has been shown to slow

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athletes' reactions and significantly reduce kicking power (Sant'Ana et al., 2017). This is supported by other research explaining that lower extremity fatigue significantly slows reaction time for punches and kicks, demonstrating the relationship between lower body strength and explosive response in strengthening and striking techniques (Rodrigues et al., 2023). Meanwhile, research in the field of taekwondo compared elite and novice athletes and found that elite athletes had faster reaction times and movement times when performing roundhouse kicks, as well as more efficient neuromuscular programming (Ervilha et al., 2020). Furthermore, biomechanically, it has been proven that low lower extremity strength and flexibility, as well as poor biomechanical coordination, reduce kicking velocity and impact force, meaning that the fundamental role of lower body strength and control is important in maintaining the performance of combat athletes (Corcoran et al., 2024; Vagner et al., 2023).

However, most of these studies were conducted in laboratory or simulated conditions, rather than in the context of dynamic and high-pressure real-life competitions. Therefore, there is still a research gap that needs to be addressed, namely how lower limb strength and reaction speed contribute to actual performance in competition. To date, leg muscle strength is one of the determining factors in the effectiveness of kicks in *pencak silat* athletes (Ihsan et al., 2022). This assumption is reasonable according to research that leg muscle strength and power significantly support the kicks of martial artists (Corcoran et al., 2024; Yuan et al., 2025), activation of the main lower extremity muscles (such as the rectus femoris, gluteus maximus, and biceps femoris) is directly related to the creation of effective kicking movements towards the target (Safiyna et al., 2025; Sun et al., 2023). However, all of this was conducted under laboratory test conditions, not under actual competition conditions. Therefore, further research is needed on the ability of the lower extremities to predict an athlete's performance during competition.

Methodology

Design

This study used a correlational quantitative design with an ex post facto approach to analyse the relationship between lower limb ability and athletes' reactions to performance during *pencak silat* competitions.

Participants



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The research subjects consisted of 24 *pencak silat* athletes, comprising 20 males and 4 females. The average age was 19.8 ± 1.7 years, with the youngest being 16 years old and the oldest being 20 years old. The average height was 162 ± 5.78 cm, with the tallest being 175 cm and the shortest being 151 cm. The average weight was 56.1 ± 11.55 kg, with the heaviest being 90.8 kg and the lightest being 39.1 kg. The average body mass index was 21.3 ± 3.46 , with the highest being 31.1 and the lowest 17.1. All participants were active athletes from one of the *pencak silat* schools in Gresik District, East Java Province, Indonesia, who had passed the district-level selection to participate at the provincial level. Ethical approval was granted by the ethics committee (No.: 33A/C1/G/II/2025).

Data Collection

Data collection was conducted through a series of physical tests that have been proven valid and reliable in measuring the performance components of combat athletes. Leg muscle strength was measured using a Back and Leg Dynamometer (kg), which has high validity ($r > 0.913$) and strong inter-rater reliability ($ICC = 0.855$) (Romero-Franco et al., 2019). Leg power is measured through the Vertical Jump Test using the Jump MD device. This test has been validated to measure lower extremity explosiveness in combat sports athletes, with high reliability ($ICC = 0.93$) (Markovic et al., 2004). Whole Body Reaction Time (WBRT) is measured using a reaction timer based on visual and audio stimuli, where athletes are asked to perform a full motor response to the stimulus. This measurement is considered valid and reliable (Fukuda et al., 2025). The 20-metre sprint speed is measured using a digital stopwatch with a static start procedure. This test has good validity as an indicator of accelerative speed in combat sports and high reliability ($ICC = 0.91$) (Haugen et al., 2012). Meanwhile, data collection was carried out directly based on the number of valid punches, kicks, and takedowns which was decided by three nationally certified pencak silat referees. The IPSI competition protocol was used because the competition performance data was collected in the context of the Provincial Championship Selection. The video analysis is used for consideration performance during competition. Scoring is done independently, and the results are averaged to increase data objectivity (Franchini et al., 2005).

Data Analysis



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The data were analysed using multiple linear regression tests to determine the effect of strength, explosive power, and reaction on competition performance (number of punches, kicks, and falls). The analysis was conducted using SPSS version 25 software, with a significance level of 0.05 (Hair et al., 2014). Assumptions of normality and multicollinearity (through VIF) were tested to ensure the validity of the regression model with an acceptance level of <5.

Results

This study involved 24 *pencak silat* athletes who participated in provincial-level championships. The results of the descriptive statistical analysis can be seen in the following table.

Table 1. Descriptive statistics of lower extremity ability and athlete performance during competition

Measurement Aspect	N	Min	Max	Mean	SD	Skewness	Kurtosis
Leg strength	24	41.5	163.5	88.3	35.6	0.723	-0.317
Leg explosive power	24	30	68	49.37	10.6	-0.360	-0.735
Visual reaction	24	0.279	0.453	0.335	0.044	0.868	0.633
Audio Reaction	24	0.284	0.599	0.367	0.070	0.917	0.459
Speed	24	3.090	5.310	3.820	0.518	0.066	0.355
Strike	24	0	10	2.750	2.400	0.474	0.217
Kick	24	0	9	3.080	2.083	0.201	0.443
Fall	24	0	5	2.120	1.227	0.821	0.844

Based on the results of descriptive analysis, leg strength had a mean value of 88.3 with a standard deviation (SD) of 35.6, ranging from a minimum value of 41.5 to a maximum value of 163.5. These data show a slightly right-skewed distribution (skewness = 0.723) with a kurtosis of -0.317, indicating a distribution that is relatively close to normal. Explosive power had a mean of 49.37 and a standard deviation of 10.6, with a skewness of -0.360 and a kurtosis of -0.735. These values point to a slightly left-skewed distribution, but still within reasonable limits to be considered normal. In terms of visual reaction, the mean value is 0.335 seconds and SD 0.044, with skewness 0.868 and kurtosis 0.633, indicating a slightly right skewed and slightly leptokurtic distribution (having a sharper peak than a normal distribution). Similarly, audio reactions showed an average of 0.367 seconds, SD 0.070, with skewness 0.917 and kurtosis 0.459, also showing a



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distribution pattern similar to visual reactions. For speed, the average value recorded was 3.820 seconds, with an SD of 0.518, skewness of 0.066, and kurtosis of 0.355. The very small skewness value indicates that the distribution is almost symmetrical, approaching the normal distributions. Furthermore, aspects of the match results such as the number of hits, kicks, and falls showed average values of 2.750, 3.080, and 2.120, respectively. All three show a slightly right-skewed data distribution with skewness ranging from 0.201 to 0.821 and kurtosis between 0.217 and 0.844, which is still within the normal limits.

An analysis of the lower limb performance of *pencak silat* athletes during competition was conducted using regression tests between the variables of leg strength, leg explosive power, visual reaction, audio reaction, and speed against the athletes' performance during competition in the form of the number of punches, kicks, and falls. The results of the regression analysis of the lower limb performance of *pencak silat* athletes on the number of punches performed during competition can be seen in the following table.

Table 2. Relationship between lower limb ability and the number of punches performed by athletes during competition

Lower Extremity of Athletes	B	Beta	t	Sig	Collinearity Statistics (VIF)
Leg strength	0.030	0.439	2.128	0.047	1.298
Explosive power	-0.062	-0.274	-0.944	0.358	2.578
Visual reaction	67.847	1.243	3.219	0.005	4.554
Audio Reaction	-29.517	-0.862	-2.539	0.021	3.518
Speed	-2.577	-0.556	-1.720	0.103	3.187
R = 0.64, R-squared = 0.41, F = 2.503, p = 0.069					

Table 2 presents the results of regression analysis evaluating the relationship between several lower extremity variables of athletes (leg strength, explosive power, visual reaction, audio reaction, and speed) and the number of strokes made by athletes during competition. Based on the regression results, the coefficient of determination (R^2) value obtained was 0.41, indicating that 41% of the variation in the number of strokes could be explained by the five variables collectively. However, the overall significance value of the regression model ($F = 2.503$, $p = 0.069$) is slightly above the significance threshold of 0.05, so this model is not significant overall (Hair et al., 2014).

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Partially, there are three variables that show a significant effect on the number of strokes. First, leg strength has a significant positive effect ($B = 0.030$; $t = 2.128$; $p = 0.047$), indicating that the greater the leg strength, the more strokes the athlete performs. Second, visual reaction has a very significant and positive effect ($B = 67.847$; $t = 3.219$; $p = 0.005$), indicating that the ability to respond to visual stimuli contributes greatly to an athlete's striking performance. Third, audio reaction has a significant negative effect ($B = -29.517$; $t = -2.539$; $p = 0.021$), which means that the faster the reaction to audio stimuli, the fewer the number of punches. This can be interpreted as the incompatibility of audio stimuli in the context of punching performance. Meanwhile, explosive power ($p = 0.358$) and speed ($p = 0.103$) did not show a statistically significant effect on the number of strokes ($p > 0.05$), so neither was strong enough to be used as a single predictor in this model.

Next, to evaluate the potential multicollinearity between independent variables, the Variance Inflation Factor (VIF) value was used. All VIF values in the model were below the general tolerance limit of 10, with the highest value in visual reaction ($VIF = 4.554$), indicating no serious multicollinearity issues. Therefore, although the model as a whole is not significant, several individual predictors show a meaningful influence on athlete performance in the context of the number of kicks.

Table 3. Relationship between lower extremity ability and the number of kicks by athletes during competition

Lower Extremity Athletes	B	Beta	t	Sig	Collinearity Statistics (VIF)
Leg strength	0.016	0.277	1.173	0.256	1.298
explosive power	0.030	0.155	0.464	0.648	2.578
Visual reaction	25.823	0.545	1.232	0.234	4.554
Audio Reaction	-16.581	-0.558	-1.434	0.169	3.518
Speed	-0.629	-0.156	-0.422	0.678	3.187

$R = 0.475$, $R \text{ Square} = 0.225$, $F = 1.047$, $p = 0.421$

Table 3 shows the results of regression analysis to examine the relationship between several lower limb variables of athletes—namely leg strength, explosive power, visual reaction, audio reaction, and speed—and the number of kicks made by athletes during competition. Simultaneously, this model produced a correlation coefficient (R)



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value of 0.475 and a coefficient of determination (R^2) of 0.225. This means that only 22.5% of the variation in the number of kicks can be explained by these five variables together. However, the value of $F = 1.047$ with $p = 0.421$ indicates that the regression model is not statistically significant overall, as the p-value is well above the significance threshold of 0.05. This means that the combination of the five variables does not make a meaningful contribution to predicting the number of kicks an athlete makes.

Individually, none of the independent variables had a significance value (Sig.) below 0.05, which means that none of the variables had a significant partial effect on the number of kicks. For example, leg strength ($p = 0.256$), visual reaction ($p = 0.234$), and audio reaction ($p = 0.169$) show low and insignificant t-values. Even speed has the highest significance value ($p = 0.678$), so its contribution to the dependent variable is very weak. However, the regression coefficient (B) value for visual reaction is relatively large (25.823), indicating a potential positive relationship, but it is not statistically strong enough to be concluded as significant.

In terms of collinearity statistics (VIF), all variables were below the critical threshold of 10, and most were below 5—indicating no serious multicollinearity between independent variables. The highest VIF value was recorded for visual reaction (4.554), but it was still within the tolerance limit. Overall, the regression model in Table 3 shows that there is no significant relationship between lower limb components and the number of kicks made by athletes during competition, either simultaneously or partially. This indicates that factors other than the variables tested may be more dominant in influencing athletes' kicking performance.



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Table 4. Relationship between lower extremity ability and the number of falls during competition

Lower Extremity of Athletes	B	Beta	t	Sig.	Collinearity Statistics (VIF)
Leg strength	0.005	0.149	0.644	0.528	1.298
explosive power	-0.041	-0.355	-1.088	0.291	2.578
Visual reaction	-19.17	-0.687	-1.582	0.131	4.554
Audio Reaction	8.234	0.47	1.232	0.234	3.518
Speed	-0.356	-0.15	-0.413	0.684	3.187
R = 0.504, R Square = 0.254, F = 1.229, p = 0.336					

Table 4 presents the results of regression analysis between the lower extremity variables of athletes—namely leg strength, explosive power, visual reaction, audio reaction, and speed—and the number of falls during competition. The analysis results show a correlation coefficient (R) value of 0.504 and a coefficient of determination (R^2) of 0.254. This indicates that approximately 25.4% of the variation in the number of falls can be explained by the five independent variables simultaneously, while the rest is explained by other factors outside this model. However, the value of $F = 1.229$ with $p = 0.336$ indicates that the model is not significant overall ($p > 0.05$), so statistically this regression model is unable to explain a meaningful relationship between the independent variables and the number of falls by athletes.

Individually, all variables in this model also did not show a significant effect on the number of falls. The significance values (Sig.) for each variable are all greater than 0.05. For example, leg strength ($p = 0.528$), explosive power ($p = 0.291$), and speed ($p = 0.684$) indicate that the effect of each variable on athlete falls is not statistically significant. Visual reaction has the highest negative Beta value (-0.687), indicating a negative relationship, but it is still not significant ($p = 0.131$). Similarly, audio reaction ($p = 0.234$) shows a positive relationship but is not strong enough to be considered significant.

Regarding collinearity statistics, all VIF values are within acceptable tolerance limits (<10), with the highest value found in visual reaction ($VIF = 4.554$). This indicates that there are no serious multicollinearity issues in this regression model, so that the



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interdependence between independent variables is still within reasonable and acceptable limits.

Thus, it can be concluded that the regression model linking lower extremity variables to the number of athlete falls does not show a significant relationship either simultaneously or partially, and it is likely that there are other more dominant factors influencing athlete falls during competition.

Discussion

Based on the results of the regression analysis presented above, it can be seen that the relationship between the lower extremity variables of athletes and their performance during competition—in the form of the number of punches, kicks, and falls—shows varying results. In the relationship between the athlete's lower extremities and punches (Table 2), the regression model approached significance ($p = 0.069$) and was able to explain 41% of the variation in the number of punches ($R^2 = 0.41$). There were two variables that were found to significantly affect the striking performance of *pencak silat* athletes, namely reaction speed (visual, $p = 0.005$, and audio, $p = 0.021$) and leg strength ($p = 0.047$). The faster the reaction (visual or audio), the higher the striking performance of *pencak silat* athletes. This finding reinforces the results of other studies in boxing, which show that reaction time and visual coordination ability are proven to be the main predictors of striking performance (Wu et al., 2024). In karate, elite groups have shorter reaction times, faster wrist acceleration times, and more efficient braking phases than sub-elite groups when performing Gyaku Tsuki punches (Goethel et al., 2023). In the context of competition, *pencak silat* athletes react quickly to their opponents' movements to gain scoring opportunities. Quick responses to opponents' movement stimuli observed through visual and auditory cues significantly influence decision-making for striking, thereby aiding in scoring points. This demonstrates that stimuli—both visual and auditory—have a tangible impact on motor response speed in combat sports (Greco et al., 2024).

The second variable that influences the strikes of *pencak silat* athletes is leg muscle strength. This finding reinforces previous findings that leg muscle strength is highly correlated with strike speed, both in static and dynamic conditions (Quinzi et al., 2022). Therefore, to improve striking performance, lower body strength training is necessary because lower extremity strength training can not only increase strength,

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muscle power, and flexibility but also specific performance such as striking (Cid-Calfucura et al., 2023). In boxing, strength training exercises such as squats and bench presses increase maximum strength and muscle power production, as well as enhance the impact and speed of punches (Hernandez-Martinez et al., 2024). These exercises are important because lower limb muscle fatigue significantly slows punch reaction time (10–11%) (Rodrigues et al., 2023). The discovery of these two aspects affecting the striking performance of *pencak silat* athletes supports the development of training programmes that combine muscle strength enhancement with visual perception exercises to produce faster and better-coordinated motor responses (Clark et al., 2020).

Meanwhile, the results on the relationship between athletes' lower extremities and the number of kicks (Table 3) show that the regression model between lower extremity variables and the number of kicks is not significant ($p = 0.421$), with a relatively low contribution ($R^2 = 0.225$). None of the independent variables had a significant partial effect. These results indicate that lower limb-related variables (such as leg muscle strength, explosive power, visual/audio reaction, and speed) do not directly predict the number of kicks in *pencak silat* athletes. This indicates that kicking ability is more influenced by other factors not represented in the regression model, such as movement technique, hip flexibility, balance, neuromuscular coordination, or fighting strategy (Borouhak et al., 2023; Cherepov et al., 2021; Gavagan & Sayers, 2017). It is generally accepted that lower limb muscle strength is important for kicking performance, but its effectiveness is highly dependent on how that strength is utilised in the context of biomechanics and technique (Corcoran et al., 2024; Yuan et al., 2025) and motor coordination (Xiao & He, 2024). Furthermore, kicks in match situations are influenced by tactical decisions such as choosing the moment to attack, the ability to read gaps in the opponent's defense, and adjustments to the direction and height of the kick (Corcoran et al., 2024; Rizqi et al., 2024). This technical and tactical complexity often dominates over the contribution of basic physical abilities; therefore, statistical models do not show significance even though physical variables play an important role theoretically.

A similar pattern was observed in the relationship between athletes' lower extremities and (Table 4), where the regression model for the number of falls was also insignificant ($p = 0.336$) and explained only 25.4% of the variance ($R^2 = 0.254$). None of



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the lower extremity variables showed a statistically significant effect. These findings are consistent with the literature showing that falls in athletes—especially in combat sports such as *pencak silat*—are influenced more by a combination of aspects such as static and dynamic balance (Corcoran et al., 2024; Fong et al., 2014), as well as fighting strategies involving techniques and posture (Valdés-Badilla et al., 2022) rather than simply lower extremity strength. These factors are more dominant in maintaining body posture when performing manoeuvres, unbalancing, or physical contact with opponents. Moreover, the success of performing takedowns is highly dependent on body mechanics such as mastery of the centre of mass, utilization of momentum, and the ability to off-balance opponents (Mapelli et al., 2014; Syaifullah & Lingsir Maghribi, 2023). These biomechanical elements cannot be represented through simple physical tests, for example, leg strength or explosive power. On the other hand, tactical decisions—such as choosing the right time to pull, push, or twist an opponent's body—as well as the use of leverage and positional control are often the main determining factors in takedowns (Alfiansyah et al., 2023; Mujahid & Subekti, 2021). This technical and tactical complexity explains why regression models are unable to significantly predict the number of falls, even though physical variables play a supporting role in stability and movement readiness.

This study is limited by its small sample size and the fact that it only involved athletes from one region, which may limit the generalisation of the findings to the wider population of *pencak silat* athletes. Performance variables were only measured based on the number of techniques (punches, kicks, throws) successfully performed, without considering the quality of the techniques or the tactical context of the match. Furthermore, this study did not control for other confounding factors that could influence performance, such as more granular technical variables (for example, speed, power, or accuracy) or the athletes' psychological conditions (such as, competitive motivation or anxiety levels).

The results of this study have important implications for *pencak silat* coaches and practitioners. Training programmes specifically designed to develop leg muscle strength, and sensory (particularly visual) reaction skills are needed to improve the effectiveness of athletes' strikes during competition. Furthermore, since kicking and falling performance are not significantly explained by lower extremity strength and reaction, technical aspects, flexibility, coordination, and competition strategy need to be integrated



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into training. Further research is recommended to examine the interaction between physical, technical, and psychological factors more comprehensively in the context of actual competition.

Conclusion

This study shows that leg strength and visual and audio reaction speed significantly affect the striking performance of *pencak silat* athletes during competition. Leg muscle strength supports the ability to deliver more effective strikes, while reaction speed to visual and audio stimuli plays an important role in decision-making during competition. Conversely, no significant influence was found from lower extremity strength and reaction speed on the number of kicks and falls. These findings imply that kicking and falling performance are likely to be influenced by other factors such as technique, balance, coordination, and competition strategy. Therefore, the implication of this study is *pencak silat* athlete training programmes should emphasise the development of leg strength and sensory response training to support striking performance, as well as incorporating technical and tactical components to improve kicking and falling skills.

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<https://doi.org/10.55040/wj8nn970>

References

- Alfiansyah, A., Karo, P., Rahayu, T., & Setyawati, H. (2023). Application of Biomechanical Analysis of Pencak Silat Techniques. *International Conference on Science, Education and Technology*, 1(2), 48–53. <https://proceeding.unnes.ac.id/ISET/article/download/2393/1879/6394>
- Barley, O. R., Chapman, D. W., Guppy, S. N., & Abbiss, C. R. (2019). Considerations when assessing endurance in combat sport athletes. *Frontiers in Physiology*, 10(MAR), 435497. <https://doi.org/10.3389/fphys.2019.00205>
- Beattie, K., & Ruddock, A. D. (2022). The Role of Strength on Punch Impact Force in Boxing. *Journal of Strength and Conditioning Research*, 36(10), 2957–2969. <https://doi.org/10.1519/JSC.0000000000004252>
- Boroushak, N., Rashedi, H., Batavani, M., & Ashena, H. (2023). Modulation of the Hip Range of Motion for Kick following Combination Exercise in Iranian Elite Male Taekwondo Players: Quasi-experimental Study. *Journal of Research in Rehabilitation Sciences*, 19(1), 169–179. <https://doi.org/10.48305/JRRS.2023.42112.1067>
- Cherepov, E. A., Eganov, A. V., Bakushin, A. A., Platunova, N. Y., & Sevostyanov, D. Y. (2021). Maintaining postural balance in martial arts athletes depending on coordination abilities. *Journal of Physical Education and Sport*, 21(6), 3427–3432. <https://doi.org/10.7752/JPES.2021.06464>
- Cid-Calfucura, I., Herrera-Valenzuela, T., Franchini, E., Falco, C., Alvial-Moscoso, J., Pardo-Tamayo, C., Zapata-Huenullán, C., Ojeda-Aravena, A., & Valdés-Badilla, P. (2023). Effects of Strength Training on Physical Fitness of Olympic Combat Sports Athletes: A Systematic Review. *International Journal of Environmental Research and Public Health*, 20(4), 3516. <https://doi.org/10.3390/IJERPH20043516>
- Clark, J., Betz, B., Borders, L., Kuehn-Himmler, A., Hasselfeld, K., & Divine, J. (2020). Vision Training and Reaction Training for Improving Performance and Reducing Injury Risk in Athletes. *Journal of Sports and Performance Vision*, 2(1), e8–e16. <https://doi.org/10.22374/jspv.v2i1.4>



Original article. Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations. Vol. 12, n. ° 3; p. 1-20, July 2026.

<https://doi.org/10.55040/wj8nn970>

- Corcoran, D., Climstein, M., Whitting, J., & Del Vecchio, L. (2024). Impact Force and Velocities for Kicking Strikes in Combat Sports: A Literature Review. *Sports*, 12(3), 74. <https://doi.org/10.3390/sports12030074>
- Ervilha, U. F., Fernandes, F. de M., Souza, C. C. de, & Hamill, J. (2020). Reaction time and muscle activation patterns in elite and novice athletes performing a taekwondo kick. *Sports Biomechanics*, 19(5), 665–677. <https://doi.org/10.1080/14763141.2018.1515244>,
- Fong, S. S. M., Ng, S. S. M., Liu, K. P. Y., Pang, M. Y. C., Lee, H. W., Chung, J. W. Y., Lam, P. L., & Guo, X. (2014). Musculoskeletal Strength, Balance Performance, and Self-Efficacy in Elderly Ving Tsun Chinese Martial Art Practitioners: Implications for Fall Prevention. *Evidence-Based Complementary and Alternative Medicine : ECAM*, 2014, 402314. <https://doi.org/10.1155/2014/402314>
- Franchini, E., Takito, M. Y., & Bertuzzi, R. C. de M. (2005). Morphological, physiological and technical variables in high-level college judoists. *Archives of Budo*, 1(1). <https://archbudo.com/view/abstract/id/10730>
- Fukuda, W., Yoshihisa, T., & Yamada, Y. (2025). Effects of muscle quantity, muscle quality, and phase angle on whole-body reaction time in 5164 adults aged 20–91 years. *European Journal of Applied Physiology*, 125(1), 167–173. <https://doi.org/10.1007/s00421-024-05591-3>
- Gavagan, C. J., & Sayers, M. G. L. (2017). A biomechanical analysis of the roundhouse kicking technique of expert practitioners: A comparison between the martial arts disciplines of Muay Thai, Karate, and Taekwondo. *PLoS ONE*, 12(8), e0182645. <https://doi.org/10.1371/JOURNAL.PONE.0182645>
- Goethel, M. F., Vilas-Boas, J. P., Machado, L., Ervilha, U. F., Moreira, P. V. S., Bendilatti, A. R., Hamill, J., Cardozo, A. C., & Gonçalves, M. (2023). Performance, Perceptual and Reaction Skills and Neuromuscular Control Indicators of High-Level Karate Athletes in the Execution of the Gyaku Tsuki Punch. *Biomechanics* 2023, Vol. 3, Pages 415-424, 3(3), 415–424. <https://doi.org/10.3390/BIOMECHANICS3030034>



Original article. Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations. Vol. 12, n. ° 3; p. 1-20, July 2026.

<https://doi.org/10.55040/wj8nn970>

- Greco, F., Quinzi, F., Chiodo, S., Cerulli, C., Tranchita, E., Bertollo, M., & Emerenziani, G. Pietro. (2024). The effects of pre-task music on choice visual reaction time in elite taekwondo athletes. *Journal of Science and Medicine in Sport*, 27(4), 276–280. <https://doi.org/10.1016/j.jsams.2024.01.002>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate Data Analysis* (7th ed.). Pearson Education Limited.
- Haugen, T. A., Tønnessen, E., & Seiler, S. (2012). Speed and countermovement-jump characteristics of elite female soccer players, 1995-2010. *International Journal of Sports Physiology and Performance*, 7(4), 340–349. <https://doi.org/10.1123/IJSP.7.4.340>,
- Hernandez-Martinez, J., Cid-Calfucura, I., Valdés-Badilla, P., Franchini, E., García-García, J. M., & Herrera-Valenzuela, T. (2024). Acute and Chronic Effects of Muscle Strength Training on Physical Fitness in Boxers: A Scoping Review. *Applied Sciences* 2024, Vol. 14, Page 9706, 14(21), 9706. <https://doi.org/10.3390/AP14219706>
- Ihsan, N., Hidayat, R., Damrah, Neldi, H., Sepriadi, & Muslimin. (2022). The Contribution of Leg Muscle Explosive Power, Agility, and Self-confidence on Sickel Kick Performance. *International Journal of Human Movement and Sports Sciences*, 10(4), 683–688. <https://doi.org/10.13189/SAJ.2022.100408>
- Liu, T. Te, Lin, Y. C., Tang, W. T., Hamill, J., & Chang, J. S. (2021). Lower-limb kinematic characteristics of Taekwondo kicks at different attack angles. *International Journal of Performance Analysis in Sport*, 21(4), 519–531. <https://doi.org/10.1080/24748668.2021.1924526>
- Mapelli, A., Zago, M., Fusini, L., Galante, D., Colombo, A., & Sforza, C. (2014). Validation of a protocol for the estimation of three-dimensional body center of mass kinematics in sport. *Gait & Posture*, 39(1), 460–465. <https://doi.org/10.1016/j.gaitpost.2013.08.025>
- Markovic, G., Dizdar, D., Jukic, I., & Cardinale, M. (2004). Reliability and factorial validity of squat and countermovement jump tests. *Journal of Strength and Conditioning Research*, 18(3), 551–555. <https://pubmed.ncbi.nlm.nih.gov/15320660/>



Original article. Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations. Vol. 12, n. ° 3; p. 1-20, July 2026.

<https://doi.org/10.55040/wj8nn970>

- Mujahid, H., & Subekti, N. (2021). Tactical Analysis of Pencak Silat Competitions in the Competing Category. *Journal Coaching Education Sports*, 2(2), 123–136.
<https://doi.org/10.31599/ssj17q61>
- Quinzi, F., Rosellini, G., & Sbriccoli, P. (2022). Lower Limb Maximal Power Predicts Punching Speed in Different Static and Dynamic Attacking Techniques in Karate. *Journal of Strength and Conditioning Research*, 36(5), 1353–1359.
<https://doi.org/10.1519/JSC.0000000000003653>,
- Rizqi, M., Trisnanto, A., & Alfarizi, M. R. (2024). Analysis of the Use of Dominant Techniques in Pencak Silat in the Competition Category After the New Regulations of 2023. *Proceedings of International Conference on Physical Education, Health, and Sports*, 4, 491–495.
<https://doi.org/10.15294/ICOPHS.V4I1.3543>
- Rodrigues, J. C. C., Penna, E. M., Machado, H. E. S., Sant'Ana, J., Diefenthaler, F., & Coswig, V. S. (2023). Effects of lower and upper body fatigue in striking response time of amateur karate athletes. *PeerJ*, 1. <https://doi.org/10.7717/PEERJ.14764>,
- Romero-Franco, N., Fernández-Domínguez, J. C., Montaña-Munuera, J. A., Romero-Franco, J., & Jiménez-Reyes, P. (2019). Validity and reliability of a low-cost dynamometer to assess maximal isometric strength of upper limb: Low cost dynamometry and isometric strength of upper limb. *Journal of Sports Sciences*, 37(15), 1787–1793. <https://doi.org/10.1080/02640414.2019.1594570>,
- Ruddock, A., James, L., French, D., Rogerson, D., Driller, M., & Hembrough, D. (2021). High-Intensity Conditioning for Combat Athletes: Practical Recommendations. *Applied Sciences* 2021, Vol. 11, Page 10658, 11(22), 10658.
<https://doi.org/10.3390/APP112210658>
- Safiyna, A., Anwari, N., Susanto, I. H., Firmansyah, A., & Mustar, Y. S. (2025). Relationship between body composition and limb muscle power of taekwondo athletes. *Sriwijaya Journal of Sport*, 4(2), 113–123.
<https://doi.org/10.55379/SJS.V4I2.30>
- Sant'Ana, J., Franchini, E., da Silva, V., & Diefenthaler, F. (2017). Effect of fatigue on reaction time, response time, performance time, and kick impact in taekwondo



Original article. Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations. Vol. 12, n. ° 3; p. 1-20, July 2026.

<https://doi.org/10.55040/wj8nn970>

roundhouse kick. Sports Biomechanics, 16(2), 201–209.

<https://doi.org/10.1080/14763141.2016.1217347>,

Sun, J., Wang, Y., & Dong, D. (2023). Lower limb electromyographic characteristics and implications of taekwondo roundhouse kick “hit” and “miss” actions. Frontiers in Bioengineering and Biotechnology, 11, 1258613.

<https://doi.org/10.3389/fbioe.2023.1258613>

Syaifulloh, R., & Lingsir Maghribi, I. (2023). Speed analysis of the Front Kicks technique in 2022 pencak silat world champion athletes: Kinematic analysis. Jurnal SPORTIF: Jurnal Penelitian Pembelajaran, 9(1), 146–159.

https://doi.org/10.29407/js_unpgri.v9i1.19983

Vagner, M., Cleather, D. J., Olah, V., Vacek, J., & Stastny, P. (2023). A Systematic Review of Dynamic Forces and Kinematic Indicators of Front and Roundhouse Kicks across Varied Conditions and Participant Experience. Sports, 11(8).

<https://doi.org/10.3390/SPORTS11080141>,

Valdés-Badilla, P., Ramirez-Campillo, R., Herrera-Valenzuela, T., Branco, B. H. M., Guzmán-Muñoz, E., Mendez-Rebolledo, G., Concha-Cisternas, Y., & Hernandez-Martínez, J. (2022). Effectiveness of Olympic Combat Sports on Balance, Fall Risk or Falls in Older Adults: A Systematic Review. Biology, 11(1), 74.

<https://doi.org/10.3390/BIOLOGY11010074>

Vasconcelos, B. B., Protzen, G. V., Galliano, L. M., Kirk, C., & Del Vecchio, F. B. (2020). Effects of High-Intensity Interval Training in Combat Sports: A Systematic Review with Meta-Analysis. Journal of Strength and Conditioning Research, 34(3), 888–900. <https://doi.org/10.1519/JSC.0000000000003255>,

Wu, R., Yang, Q., Cui, W., Gao, D., Luo, Y., & Wang, D. (2024). Relationship between visual ability assessment and punch performance in competition in male amateur boxers. Frontiers in Physiology, 15.

<https://doi.org/10.3389/FPHYS.2024.1429554>

Xiao, S., & He, J. (2024). Effect of blood flow restriction training on the explosive power of lower limbs in taekwondo athletes during kicking. Molecular & Cellular Biomechanics, 21(3), 148–148. <https://doi.org/10.62617/MCB148>



Original article. Analysis of lower limb performance and reactions of pencak silat athletes during competition: a contextual approach to competitive situations. Vol. 12, n. ° 3; p. 1-20, July 2026.

<https://doi.org/10.55040/wj8nn970>

Yuan, Q., Deng, N., & Soh, K. G. (2025). A meta-analysis of the effects of plyometric training on muscle strength and power in martial arts athletes. BMC Sports Science, Medicine and Rehabilitation, 17(1), 12. <https://doi.org/10.1186/S13102-025-01059-9>