COMPARISON OF STRIKING POWER WHEN PERFORMING A LOW KICK AND A HOOK PUNCH IN MARTIAL ARTS

Radoslav Penov, Silvia Ilieva-Sinigerova, Milen Chalakov, Ivo Kamenov
National Sports Academy "Vassil Levski", Sofia, Bulgaria

ABSTRACT
Introduction: This article presents a comparison of the striking power low kick and a hook punch in martial arts. To accomplish the survey, a modern tactile striking platform and a statistical analysis of the parameters of the punches performed by the participants. The results for striking power were recorded in the same way and under the same conditions for each participant. To verify the reliability of the recorded data, we applied appropriate statistical methods.
Aim and Objectives: This study aims to compare the striking power of elite athletes in kyokushin karate, kickboxing, kudo, and muay thai. Using modern statistical methods, we established the average typical level, the interrelationships between the indicators, and compared the results in the four studied combat sports. This will help draw practical conclusions about the differences in striking power between the two studied strikes—low kick and hook punch— in combat sports.
Methodology: The study was conducted for the period from September to December 2024 using a modern tactile striking platform, the PowerKube Combat Performance Center Pro, by means of which the striking power of low kicks and hook punches in kyokushin karate, kickboxing, kudo, and muay thai was recorded. Each athlete performed 10 maximum-power attempts for both strikes.
Results: The comparison of low-kick and hook techniques across the combat sports in the study reveals statistically significant differences in the applied human force, impact power, and kinetic energy among athletes from the four disciplines.
Conclusion: Overall, the results confirm that striking performance varies considerably between combat sports, depending on technique, training, and possibly equipment. These results provide valuable information for coaches and athletes on the differences in the impact power of the low kick and the hook punch across different combat sports.

ORCID
Radoslav Penov
https://orcid.org/0000-0002-3355-0725
Silvia Ilieva-Sinigerova
https://orcid.org/0000-0002-6585-7107
Milen Chalakov
https://orcid.org/0000-0003-0861-7040
Ivo Kamenov
https://orcid.org/0009-0007-8209-3579

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Keywords: *PowerKube, martial arts, low kick, hook, striking power*

INTRODUCTION

One of the main criteria for awarding the victory in combat sports is defeating the opponent by means of a strike delivered with the necessary power and speed to a vital point, at the precise moment, and from the correct distance. This is why combat sports demand the development of high levels of muscle power (Zerpa et al., 2013; Arakchiyski, 2002; Kautzner, N., Marques Junior, 2012). It is clear that power and its manifestation in striking techniques are extremely important in combat sports, as they can secure victory by rapidly reducing the opponent's capabilities and potentially bringing them to a halt. Therefore, competitors need to execute effective, powerful strikes to score a point (Muhamad, Haqiyah, 2018).

When analyzing various kicking strikes, an average striking power ranging from 122.6 to 9015 N (Newtons) was recorded. Among the techniques analyzed, the sidekick (yoko geri) produced the highest striking power – 9015 N, which is sufficient to cause injury, including a fracture (Corcoran, et al., 2024). The rear-hand punch of elite boxing competitors reaches up to 4800 N. The high striking powers generated by the rear hand relate to significantly higher peak joint torques when flexing and extending the elbow joint of the same limb (Akbaş et al., 2021).

Identifying the qualities of power in the most frequently performed strikes and punches is essential for developing better neuromuscular training methods (Loturco et al., 2016).

The quality of striking power and its manifestation in the striking technique are extremely important in martial arts, since they can grant victory by drastically reducing the opponent's capabilities or even bringing them to a complete halt. The results regard-

ing the striking power of the low kick and the hook punch were recorded in the same way for each participant. This ensures that the study was conducted under the same conditions for all the athletes. The input data on the striking power were measured using a specialized striking platform - PowerKube Combat Performance Center Pro. In order to prove the reliability of the recorded data, we applied the necessary methods of statistical analysis.

Aim and Objectives

This study aims to compare the striking power of elite athletes in - kyokushin karate, kickboxing, kudo, and muay thai. Using modern statistical methods, we established the average typical level, the interrelationships between the indicators, and compared the results in the four studied combat sports. This will help to draw practical conclusions about the differences in striking power provided by the two studied strikes - low kick and hook-punch, in combat sports.

METHODOLOGY

The study was conducted between September and December 2024 using a modern tactile striking platform, the PowerKube Combat Performance Center Pro (PowerKube, 2025), to record the power of low kicks and hook punches in kyokushin karate, kickboxing, kudo, and muay thai. The participants were categorized by sport, and all four groups included medalists from world and European championships, as well as multiple winners of professional bouts ranked in the top 10 of national championships. The athletes completed informed consent forms for participation in the scientific study, having been previously informed of the study's purpose and procedures.

We identified a specific difference in punch power across the selected combat sports. In kyokushin karate, punches are delivered at the body level and with bare hands, while in kickboxing, kudo, and muay thai, punches are delivered at the head level and boxing gloves are used, with the exception of kudo, where specific gloves are required for this sport.

The Powerkube Combat Performance Center Pro's unique technology and software make it suitable for measuring all combat sports strikes. An advantage of using this device is its precise measurement of impact power (watts), kinetic energy (joules), and the human force (franklin) through the power testing function. The human force unit, the Franklin (f), was developed to quantify the total destructive potential of human force. It is a combination of measured impact power and kinetic energy. (PowerKube 2025).

Thirty elite athletes took part in the study, with an average age of 23.83±7.15 years, height of 178.43±5.56 cm, and weight of 74.98±5.23 kg. Each athlete performed 10 maximum power strikes of each kind. The statistical analysis of the results was completed using Jamovi V.2.6.44 (The jamovi project, 2024), a program based on the statistical language R that offers a variety of statistical analyses (R Core Team, 2024). The data will be analyzed using descriptive statistics, a normal distribution test (Shapiro-Wilk), correlation analysis, One-way ANOVA (non-parametric Kruskal-Wallis), and the DSCF test, which is a non-parametric multiple comparison test used to identify which specific pairs of groups differ significantly.

RESULTS

The data from the variance analysis showed a deviation from the normal distribution for some of the studied indicators and groups. The fact that the combat sports studied had different numbers of participants was also taken into account, as this also influenced the normality of the distribution, especially in the division by technique execution. This necessitated the application of non-parametric methods for subsequent processing of the results, as well as analyzing the mean values rather than arithmetic averages.

Table 1. *Descriptive statistics of the studied variables*

							Shapiro-Wilk	
	N	***Mean***	**Median**	***SD***	**Minimum**	**Maximum**	**W**	***p***
Age	60	23.9	20.0	8.1	16.0	40.0	0.8	<.001
Height	60	178.4	178.0	5.6	160.0	190.0	0.9	<.001
Beight	60	74.9	74.0	5.3	65.0	85.0	0.9	0.013
Human Force	60	70672.4	68782.4	32167.3	21753.4	156883.3	0.9	0.061
Kinetic Energy	60	240.0	228.3	61.7	114.4	391.9	0.9	0.490
Impact Power	60	40184.0	40116.4	14726.4	15485.7	73831.9	0.9	0.169

Figures 1 and 2 compare the means of human force, kinetic energy, and impact power for the low kick strike across the sports of kyokushin karate, kickboxing, kudo, and muay thai.

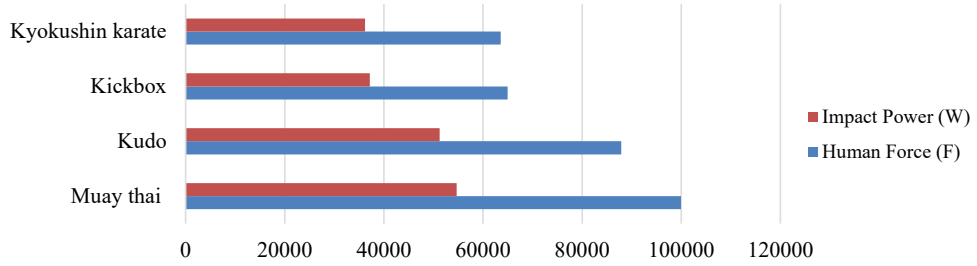

Figure 1. *Values of the striking power of the low kick*

From the data presented in Figure 1, it can be observed that Muay Thai competitors have the highest values for both measured indicators, followed by Kudo athletes. The differences and deviations observed between the average values and medians of the indicators result from the smaller number of subjects in these two sports and show differences from the normal Gaussian distribution. The values for karate and kickboxing athletes are almost identical.

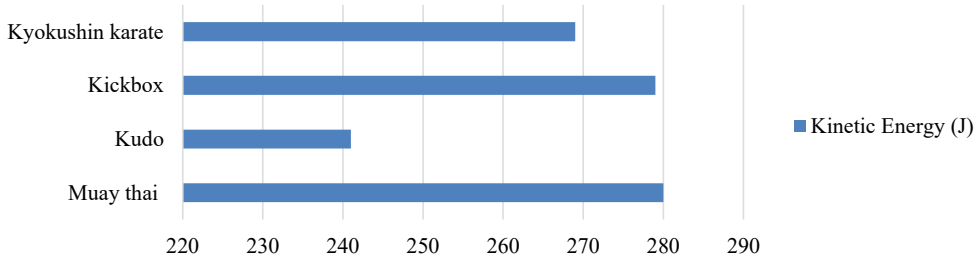

Figure 2. *Kinetic energy of a low kick*

Figure 2 illustrates the mean kinetic energy generated during the low kick. Here, again, the Muay Thai athletes exhibit higher values compared to those from other combat sports, whereas the Kudo competitors, again, show the lowest kinetic energy values for the low kick.

The generalized values presented in Table 2 demonstrate strong to very strong correlations between the studied indicators. The breakdown by technique reveals slight differences in the striking power parameters of these correlations, ranging from 0.891 to 0.992. The same explanation applies to the correlation between impact power and kinetic energy. By increasing the impact power of a low kick, its kinetic energy will also increase.

Table 2. *Generalized correlation matrix*

		Human Force (F)	Kinetic Energy (J)	Impact Power (W)
Human Force (F)	Pearson's *r*	—		
	p-value	—		
Kinetic Energy (J)	Pearson's r	.927	—	
	p-value	<.001	—	
Impact Power (W)	Pearson's r	.992	.891	—
	p-value	<.001	<.001	—

The study's comparison of the low kick technique across combat sports reveals statistically significant differences in the applied human force and impact power among athletes from the four disciplines. The calculated effect size (ε^2) indicates a significant effect for both human force and impact power in the low-kick technique (Table 3).

Table 3. *One-way ANOVA of low kick*

	Kruskal-Wallis			
	χ^2	*df*	*p*	ε^2
Human Force (Franklin)	20.495	3	<.001	0.599
Kinetic Energy (Joules)	7.479	3	.058	0.056
Impact Power (Watts)	23.855	3	<.001	0.630

No statistically significant differences in kinetic energy were found among the competitors. The estimated effect size ($\varepsilon^2 = 0.056$) indicates a small effect. To compare individual sports, a DSCF test was applied, which highlighted differences between the groups. The human force, kinetic energy, and impact power achieved by kickboxing and kudo competitors differ statistically significantly (W = 4.87, $p < .003$). Interestingly, in the low kick technique, the human force, kinetic energy, and impact power indicators of kickboxing and kyokushin karate competitors are equal, which is also confirmed by W = 3.05, $p = .14$. The comparison of the low kick technique shows differences in the human force and impact power of execution between elite competitors in kickboxing and Muay Thai (W = 4.58, $p = .004$). The measured kinetic energy levels do not show differences between the two combat sports. The execution technique of the low kick for Kyokushin Karate and Muay Thai does not differ in the measured kinetic energy level between these two combat sports. For the other two indicators, human force and impact power, statistically significant differences were found (W > 4.78, $p < .005$). When comparing the low kick executed by kyokushin karate and kudo athletes, statistically significant differences were observed in the human force and impact power of the strike. Kinetic energy values were closer (W = 3.96, $p = .05$), yet differences among athletes remained. No statistically significant differences were observed between the measured human force, kinetic energy, and impact power indicators of the low kick technique in elite kudo and muay thai competitors. This could result from similar execution techniques and training programs.

Kickboxing athletes showed the highest average values, followed by Muay Thai competitors. Kudo athletes had the lowest average values once again. The lower human force and impact power values in karate might be due to the absence of boxing gloves during the study, unlike in other combat sports.

Figures 3 and 4 highlight the higher values for the hook punch in kickboxing compared to other combat sports. The difference in the average kinetic energy values between kickboxing and kudo athletes is 100 J.

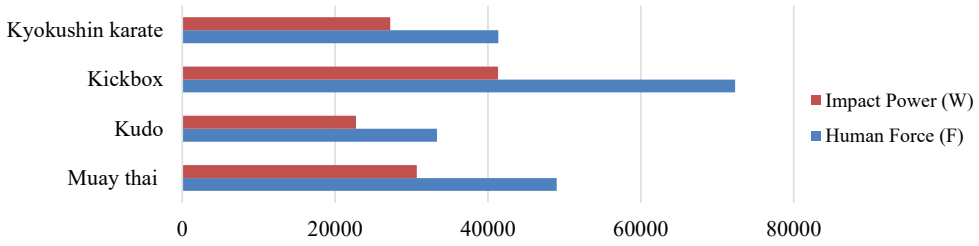

Figure 3. *Human force and impact power values for a hook punch*

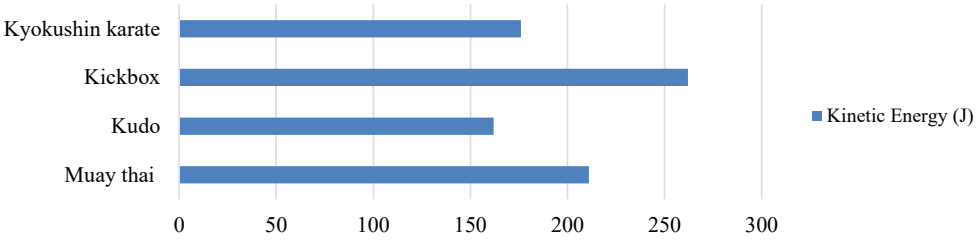

Figure 4. *Kinetic energy values for a hook punch*

The hook punch technique performed by the athletes shows higher empirical values of χ^2 (> 7,81; $p < .05$), suggesting that there are statistically significant differences in the human force, kinetic energy, and impact power with which athletes from the various combat sports execute this technique.

The DSCF test, applied to compare the groups in view, demonstrated statistically significant differences across all three indicators for kickboxing and kudo (W > 4.50, p < .05). On the other hand, the hook punch technique showed differences in the execution of human force between kickboxing and kyokushin karate. These differences were found in the human force, kinetic energy, and impact power of execution (W > 4.50, $p < .05$). The hook punch technique also varied in human force, kinetic energy, and impact power values among elite competitors of kickboxing and Muay Thai. Kyokushin karate and Muay Thai athletes differed statistically significantly in their execution of the hook punch.

The observed differences were across all three indicators, confirmed by W > 4.50, $p < .05$.

We find that for the hook punch technique, no statistically significant differences are observed between elite kyokushin karate and kudo athletes across all three indicators studied (W < 4.50, $p > .05$). This could be due to a similar execution method for the technique, as well as similar planning and management of the training process.

The hook punch technique shows statistically significant differences in human force, kinetic energy, and impact power among elite kudo and muay thai athletes (W > 4.50, $p < .05$). The calculated effect size indicates very large values for all three examined indicators ($\varepsilon^2 > .14$) (Table 4).

Table 4. *One-way ANOVA of the Hook Punch*

Kruskal-Wallis				
	χ^2	**df**	***p***	ε^2
Human Force (Franklin)	16.373	3	<.001	0.565
Kinetic Energy (Joules)	15.018	3	.002	0.518
Impact Power (Watts)	15.985	3	.001	0.551

DISCUSSION

The data presented in the study compares data on low kicks and hook punches in different combat sports, obtained using specialized equipment. Unfortunately, similar studies with which we can compare our results are still lacking.

In a Daily Mail article, the strongest hand punch recorded with the Powerkube platform was by Eddie Hall with a score of 208.901 Franklin (Lynch, 2024). The strongest kick registered on the same platform is by Joe Rogan with a score of over 150,000 Franklin (Riddle, M. 2025).

According to the data in some studies obtained using different research equipment, the average values for low kicks have significantly greater kinetic efficiency than those studied in other martial arts styles. In addition, the measured average values for low kicks in kyokushin karate significantly exceed the upper limit of the values obtained in similar studies (Akbaş et al., 2021; Corcoran et al., 2024).

The hook punch has significantly greater kinetic efficiency than the same one studied in other martial arts styles. The obtained data can be compared with those obtained in elite boxers, especially when the different measurement methodologies and performance conditions are taken into account. For example, the kinetic energy data for kickboxing are also higher than the similar data obtained in other studies (Akbaş et al., 2021; Corcoran et al., 2024).

The differences between the values obtained and those in the literature can be explained by the technique used, the biomechanical efficiency of the athletes, and the specific characteristics of the respective sport (Miu et al., 2019).

Age and sports experience correlate with the maximum striking power, but there is a critical point after which they lead to a diminishing effect on maximum striking power. The critical age is 31 years, and the critical point for experience is 11 years. After these critical points, athletes are advised to seek ways to compensate for these diminishing factors through nutrition or additional training (Brito et al., 2011; Eraslan, 2016).

In summary, the results obtained not only confirm the data from global literature but also indicate that with proper technique and intensive training, athletes can surpass the established values in other combat sports.

CONCLUSION

The analysis of measured values for the low kick technique shows that kyokushin karate competitors achieve the highest average values for both kinetic energy and impact power compared to competitors in other combat sports. The comparison of hook punches demonstrates that kickboxing competitors outperform the others across all measured indicators—human force, kinetic energy, and impact power —reflecting the effectiveness of boxing techniques in this sport. The results obtained from the analysis of variance for the low kick technique confirm the presence of statistically significant differences between combat sports in terms of human force and impact power, but not in kinetic energy. The correlation analysis performed establishes a very high dependence between human force, impact power, and kinetic energy in both low kick and hook punch, which emphasizes their mutual dependence. The results obtained confirm that strike execution varies significantly across combat sports, depending on the technique, training regimen, and possibly the equipment (e.g., gloves).

Regular measurement and comparison of competitors' progress across different training stages

and cycles will help objectively manage the training process. The results of this study can serve as a guide and source of information for the development of competitors in various combat sports, with the aim of improving the power of their strikes.

REFERENCES

Akbaş, A., Brachman, A., Gzik, B., & Bacik, B. (2021). The objective assessment of striking force in combat sports using sport-specific measurement devices: A review. *Archives of Budo, 17*, 205–218.

Arakchiyski, Z. (2002). *Kolichestvena otsenka na vatreshno-silovata struktura pri dvigatelni deystvia* [Quantitative assessment of the internal-force structure in motor actions]. *Sport i nauka*, (2), 11–17.

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

Eraslan, M. (2016). Assessment of perceived stress levels of kick-boxers based on age and gender variables / Yaş ve cinsiyet değişkenlerine göre kick boks sporcularının algılanan stres düzeylerinin incelenmesi. *Journal of Human Sciences 13*(3), 5069-5077, https://doi.org/10.14687/jhs.v13i3.4113

Kautzner, N., & Marques Junior. (2012, November). *Shotokan karate: Score of the techniques during the female kumite of competition. EFDeportes.com, Revista Digital, 17*(174), 1–8. https://www.efdeportes.com/efd174/shotokan-karate-score-of-the-techniques.htm

Loturco, I., Nakamura, F. Y., Artioli, G. G., Kobal, R., Kitamura, K., Cal Abad, C. C., Cruz, I. F., Romano, F., Pereira, L. A., & Franchini, E. (2016). Strength and power qualities are highly associated with punching impact in elite amateur boxers. *Journal of Strength and Conditioning Research, 30*(1), 109–116. https://doi.org/10.1519/JSC.0000000000001075

Lynch, K. (2024, April 26). *The new hardest puncher in the world! Ex-World's Strongest Man winner Eddie Hall breaks UFC star Alex Pereira's record on power-measuring machine. Daily Mail.* https://www.dailymail.co.uk/sport/mma/article-13351937

Miu, D., Visan, D., Bucur, D., & Petre, R. (2019). Improving the efficiency of martial arts by studying the fighting techniques, biomechanics. *International Journal of Bioscience, Biochemistry and Bioinformatics, 9*(2), 90–99. https://doi.org/10.17706/ijbbb.2019.9.2.90-99

Muhamad, M., & Haqiyah, A. (2018). Contribution of physical condition and self-efficacy towards the *Gyaku zuki chudan*. In *2nd International Conference on Sports Sciences and Health* (Vol. 7, pp. 120–124). Atlantis Press. https://doi.org/10.2991/icssh-18.2019.28

PowerKube. (2025). *PowerKube combat performance center pro.* https://www.powerkube.tech

R Core Team. (2024). *R: A language and environment for statistical computing* (Version 4.4) [Computer software]. https://cran.r-project.org

Riddle, M. (2025, January 16). *Joe Rogan's rib-crushing kicks leave UFC fans speechless. Bloody Elbow.* https://bloodyelbow.com/2025/01/16/joe-rogans-rib-crushing-kicks-leave-ufc-fans-speechless

The jamovi project. (2024). *jamovi* (Version 2.6) [Computer software]. https://www.jamovi.org

Vences Brito, A., Ferreira, M., Cortes, N., Fernandes, O., & Pezarat-Correia, P. (2011). Kinematic and electromyographic analyses of a karate punch. *Journal of Electromyography and Kinesiology, 21*(6), 1023–1029. https://doi.org/10.1016/j.jelekin.2011.09.007

Zerpa, C., Johnstone, K., Sanzo, P., & Przysucha, E. (2013). Power measures of athletes in combat sports using a modified rowing ergometer. *International Journal of Sports Science, 3*(6), 189–192.

Correspondence author:
Radoslav Penov, PhD
Department of Wrestling and Judo
National Sports Academy „Vassil Levski „
21, Acad. Stefan Mladenov Str.
Sofia, Bulgaria
E-mail: fighters.nsa@abv.bg

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