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Relationships of Selected Parameters of Isokinetic Strength and Explosive Power in Mixed Martial Arts Fighters

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Abstract

In mixed martial arts (MMA), muscle strength manifests in multiple directions, movement velocities and all types of muscle contractions, with explosive and maximal strength considered the most relevant for performance. The aim of the study was to elucidate the relationships between isokinetic strength and explosive power in MMA fighters. The study involved 17 male MMA fighters competing at national level (18.00±1.00 years), with a competitive record of 2.00±1.50 fights. The following tests were administered to determine explosive power by Optogait: standard countermovement push-up, kneeling countermovement push-up, and kneeling stop push-up for upper limbs, and countermovement jump, countermovement jump with free arms, and squat jump for lower limbs. Time to peak torque (TTPT) and peak torque (PT) as indicators of isokinetic strength were measured by HUMAC NORM with a focus on the extensors and flexors of the knee, hip, shoulder, and elbow joints during concentric, eccentric, and isometric muscle contractions. The results showed significant correlations ($p<0.05$; $r>0.5$) between explosive power of lower limbs and PT of knee and hip extensors during selected contractions. In upper limbs, results showed significant correlation ($p<0.05$; $r>0.5$) between performance in standard countermovement push-up and PT of elbow and shoulder flexors during selected contractions. The results showed that TTPT did not significantly affect the level of explosive power ($p>0.05$), except in the case of elbow flexors during concentric contraction ($p=0.024$; $r=-0.543$). The level of isokinetic strength of lower limbs affects the level of explosive power in complex movement, which may be beneficial for executing specific movements in fights.

Keywords: *muscle strength, time to peak torque, peak torque, isokinetic dynamometry, combat sports, MMA*

Introduction

Mixed martial arts (MMA) incorporates techniques from various combat sports. Because of its complexity, athletes must not only master a wide range of techniques but also achieve a high level of strength, condition and all-around physical readiness (Amtmann, 2004).

After considering the specificities of MMA, Lenetsky and Harris (2012) identify four determining motor abilities: explosive strength, absolute strength, endurance, and flexibility. The most successful fighters possess elite fighting skills and extraordinary strength and conditioning levels (Kostikiadis et al., 2018; Tota, Pilch, Piotrowska, & Maciejczyk, 2019)

Due to the nature and variety of MMA, muscle strength is exerted in various directions, at different speeds, and in all muscle modes (Folhes, Reis, Marques, Neiva, & Marques, 2022). Therefore, MMA demands high absolute strength in both upper and lower limbs in concentric, eccentric, and isometric modes (Bagley et al. 2015; Plush, Stuart, Nosaka, & Barley, 2022). Andrade, Flores, Andreato and Coimbra (2019) agree that high levels of dynamic and isometric strength in upper and lower limbs of MMA athletes increase the level of skills used in matches.

According to Spanias, Nikolaidis, Rosemann and Knechtle (2019), upper and lower limb strength plays a key role in grappling. Both isometric and dynamic strength are important in grappling. According to Vecchio, Hirata and Franchini (2011), approximately 50% of MMA matches end during ground fighting, so it is important to develop these skills. Maximal strength also positively impacts performance, endurance, and injury prevention (James, Haff, Kelly, & Beckman, 2016).

Another important fact is that punch force comes from the lower limbs. Force generated by the legs is further transmitted to the trunk and the upper limbs. This factor is a key determinant that differentiates the stand-up fighting of MMA fighters at a higher performance level from those with a lower level of technical and physical readiness (Spanias, Nikolaidis, Rosemann, & Knechtle, 2019).

The expression of power is also crucial for MMA fighters, especially when performing punches and kicks, where immediate application of force in unloaded conditions is essential. Aagaard, Simonsen, Andersen, Magnusson and Dyhre-Poulsen (2002) noted that a punch is delivered in approximately 50–250 ms. Thus, the rate of force development, which determines the ability to produce a high level of force in a short time, is decisive for the effectiveness of strikes (James, Kelly, & Beckman, 2013).

Although research in MMA is growing, there is still a limited systematic comparison of isokinetic strength across multiple joints and contractions among fighters. Most studies focus on isolated muscle groups or single contraction types, which restricts understanding of how different isokinetic parameters relate to explosive power crucial for MMA performance.

Understanding the relationships between muscle strength indicators may contribute to the optimization of testing protocols in combat sports and expand knowledge about optimizing power development in MMA. The aim of the study is to elucidate the relationships between explosive power of upper and lower limbs and isokinetic parameters such as time to peak torque and peak torque during concentric, eccentric, and isometric muscle contractions in MMA fighters.

Methods

Participants

The research sample included 17 male MMA fighters of national performance level. Their chronological age (median±quartile deviation) was 18.00±1.00 years, their sports age was 3.001 years and they had completed 2.00±1.50 fights. The weekly training load included five MMA sessions focused on striking (75 minutes), five jiu-jitsu sessions focused on grappling (75 minutes), and two weight sessions (60 minutes). General anthropometric characteristics are shown in Table 1.

Table 1. Anthropometrics characteristics of the research sample

	BH (cm)	BW (kg)	SMM (kg)	PBF (%)	BFM (kg)
Med±QD	178.90±3.80	72.30±6.05	36.62±3.07	8.70±1.75	6.10±1.35
Min/Max	164.70/186.80	53.40/81.40	25.30/44.61	3.00/14.30	2.20/10.50

Note. BH: body height; BW: body weight; SMM: skeletal muscle mass; PBF: percentage of body fat; BFM: body fat mass; VFA: visceral fat area; Med: median; QD: quartile deviation; Min: minimum value; Max: maximum value

Procedures and measurements

Before the measurements, participants were informed and consented to the purpose and procedures of testing, which was conducted in accordance with the Declaration of Helsinki (Harris, Macsween, & Atkinson, 2017). The research was approved by the ethics committee of the University of Presov (ECUP042025PO).

Basic anthropometric parameters of the research sample were measured by the BSM 170 stadiometer (Biospace, Seoul, North Korea) and by InBody 720 (Biospace, Seoul, North Korea) with focus on body weight, skeletal muscle mass, percentage of body fat and body fat mass. Subsequently, participants performed a 5-minute pretest warm-up on a cycle ergometer at o workload of 50 watts and a cadence of 80 rpm, followed by a 5-minute individualized segment comprising mobility and isometric exercises.

Explosive power was measured by Optogait (Microgate Srl, Bolzano, Italy). Standard countermovement push-up (SCPu), kneeling countermovement push-up (KCPu) and kneeling stop push-up (KSPu) tests were used to determine the explosive power of upper limbs. The reliability established by intra-class correlation coefficient (ICC) in relation to rate of force development is good for SCPu (ICC=0.77) and excellent for KCPu (ICC=0.90) and KSPu (ICC=0.93) (Dhahbi et al., 2017). For lower-body explosive power assessment, countermovement jump (CMJ), countermovement jump with free arms (CMJ FA), and squat jump (SJ) were used. The reliability of CMJ, CMJ FA, and SJ was established as excellent (ICC=0.997-0.998) (Glatthorn et al., 2011). All tests of explosive power consisted of three trials with one minute rest.

Time to peak torque (TTPT) and peak torque (PT) as indicators of isokinetic strength were measured by HUMAC NORM (Cybex NORM®, Humac, CA, USA) focusing on the extensors and flexors of knee, hip, shoulder, and elbow joints in concentric, eccentric, and isometric muscle contractions in the dominant limb. Dominant limb was identified according to hemispheric lateralization using a limb-preference question collected during demographic data collection. The reliability of PT measurements by Cybex HUMAC NORM isokinetic dynamometer was established by intra-class correlation coefficient as excellent (ICC=0.90-0.98) (Impellizzeri, Bizzini, Rampinini, Cereda & Maffiuletti, 2008). During concentric and eccentric muscle contraction, muscle strength was measured in the range of motion 90° at angular velocity $60°\cdot s^{-1}$. An angular velocity of $60°\cdot s^{-1}$ was selected because lower testing velocities enable the expression of maximal PT and are widely recognized as a reliable standard for assessing maximal isokinetic strength (Kambič, Lainscak, & Hadžić, 2020). During isometric muscle contraction, muscle strength was measured in 60°. Isokinetic strength testing was conducted following the instructions predefined in the isokinetic dynamometer's software. Maximal elongation of tested limb was set as anatomical zero (0°). Testing consisted of two maximal-effort trials preceded by three submaximal-effort trials to familiarize participants with the test procedure. The best result of the two trials was selected for further analysis. Visual feedback and verbal motivation were provided during muscle strength testing on the isokinetic dynamometer to ensure maximal stimulation of moral-volitional qualities.

Statistical analysis

Based on the Shapiro-Wilk test for normality, non-parametric statistical methods were used for further analysis, and Spearman's correlation coefficient was used to determine correlations between selected parameters at $p<0.05$ and $p<0.01$. The effect size was estimated according to Cohen (1998) as follows: 0.1≤r<0,3 – small; 0.3≤r<0.5 – medium; r≥0.5 – large. Statistical analysis was performed using SPSS Statistics 27.0 software (IBM, Armonk, USA).

Results

The results of explosive power and isokinetic strength are shown in Table 2 and Table 3.

Table 2. Descriptive statistics of explosive power

Med±QD Min/Max					
SCPu (cm)	**KCPu (cm)**	**KSPu (cm)**	**CMJ (cm)**	**CMJ FA (cm)**	**SJ (cm)**
10.90±2.20	46.60±20.90	39.90±15.00	36.30±3.00	43.50±1.95	33.90±3.65
4.90/22.10	19.30/67.70	15.90/55.10	22.60/47.00	27.20/53.70	23.60/43.10

Note. Med: median; QD: quartile deviation; Min: minimum value; Max: maximum value; SCPu: standard countermovement push-up; KCPu: kneeling countermovement push-up; KSPu: kneeling stop push-up; CMJ: countermovement jump; CMJ FA: countermovement jump with free arms; SJ: squat jump

Table 3. Descriptive statistics of isokinetic strength

Med±QD Min/Max TTPT (s)						
	E con	**E ecc**	**E iso**	**F con**	**F ecc**	**F iso**
EL	0.64±0.18	1.08±0.25	1.75±0.63	1.21±0.22	0.87±0.16	2.30±0.44
	0.34/1.08	0.67/2.00	0.36/3.68	0.73/1.47	0.39/1.33	0.66/4.81
SH	0.49±0.12	1.40±0.19	1.81±0.62	0.46±0.36	0.70±0.17	1.43±0.54
	0.28/0.90	0.61/2.17	0.58/3.03	0.14/1.39	0.27/1.54	0.60/2.81
KN	0.52±0.10	1.11±0.17	2.61±0.45	0.53±0.13	0.96±0.19	1.67±1.05
	0.32/0.68	0.69/1.61	0.32/3.96	0.31/1.28	0.42/1.36	0.33/3.42
HI	0.39±0.09	1.34±0.20	3.10±0.54	0.42±0.19	0.72±0.20	1.76±0.54
	0.28/0.74	0.69/2.48	1.37/4.69	0.22/1.07	0.23/1.28	0.40/2.88
PT (n×m-1)						
	E con	**E ecc**	**E iso**	**F con**	**F ecc**	**F iso**
EL	39.00±6.50	46.00±8.00	42.00±9.00	50.00±12.50	65.00±12.00	73.00±15.50
	23.00/57.00	28.00/69.00	27.00/75.00	26.00/76.00	33.00/96.00	30.00/102.0
SH	100.00±16.0	108.00±18.5	113.00±12.5	58.00±13.00	81.00±21.00	73.00±5.00
	52.00/125.00	56.00/159.00	56.00/155.00	22.00/80.00	38.00/104.00	30.00/121.0
KN	220.0±19.00	221.00±39.5	259.00±40.0	117.00±9.50	125.00±19.50	121.00±13.50
	125.00/308.0	155.00/309.0	149.00/366.0	68.00/157.0	80.00/168.0	84.00/187.0
HI	255.00±40.00	304.50±58.00	297.00±51.00	144.50±21.007	141.50±16.508	130.50±10.50
	127.00/335.00	184.00/442.00	146.00/355.00	5.00/194.00	7.00/190.0	81.00/175.00

Note. Med: median; QD: quartile deviation; Min: minimum value; Max: maximum value; E: extensors; F: flexors; con: concentric; ecc: eccentric; iso: isometric; TTPT: time to peak torque; PT: peak torque; EL: elbow; SH: shoulder; KN: knee; HI: hip

The correlation analysis of upper-limb explosive power and isokinetic strength of the elbow and shoulder extensors and flexors is shown in Table 4.

Table 4. Correlations between explosive power of upper limbs and isokinetic strength of elbow and shoulder extensors and flexors

ELBOW	SCPu	KCPu	KSPu	SHOULDER	SCPu	KCPu	KSPu
E con TTPT	0.210	0.197	-0.055	E con TTPT	0.065	0.205	-0.094
E con PT	0.222	0.006	0.320	E con PT	0.463	0.259	0.405
E ecc TTPT	-0.082	0.126	0.116	E ecc TTPT	-0.054	0.017	-0.292
E ecc PT	0.256	0.028	0.361	E ecc PT	0.407	0.250	0.186
E iso TTPT	-0.015	0.075	0.376	E iso TTPT	0.287	0.297	0.490*
E iso PT	0.116	0.015	0.370	E iso PT	0.172	0.001	0.256
F con TTPT	-0.543*	-0.269	-0.012	F con TTPT	-0.365	-0.098	-0.172
F con PT	0.516*	0.269	0.284	F con PT	0.703**	0.422	0.332
F ecc TTPT	-0.054	0.076	0.033	F ecc TTPT	0.417	0.316	0.230
F ecc PT	0.542*	0.272	0.319	F ecc PT	0.630**	0.291	0.248
F iso TTPT	0.363	0.575*	0.327	F iso TTPT	-0.007	-0.242	-0.269
F iso PT	0.502*	0.236	0.299	F iso PT	0.509*	0.280	0.125

*Note. SCPu: standard countermovement push-up; KCPu: kneeling countermovement push-up; KSPu: kneeling stop push-up; E: extensors; F: flexors; con: concentric; ecc: eccentric; iso: isometric; TTPT: time to peak torque; PT: peak torque; *: p<0.05; **: p<0.01*

The correlation analysis showed that performance in the SCPu was significantly associated, with a large effect size, with the level of PT of elbow flexors during concentric (r=0.516, p=0.034), eccentric (r=0.542, p=0.025), and isometric (r=0.502, p=0.040) muscle contractions. In addition, the performance in the SCPu is significantly related, with a large effect size, to lower TTPT of elbow flexors during concentric muscle contractions (r=-0.543, p=0.024). Moreover, performance in the SCPu is significantly influenced, with a large effect size, by the level of PT of shoulder flexors in concentric (r=0.703, p=0.002), eccentric (r=0.630, p=0.007), and isometric (r=0.509, p=0.037) muscle contractions. On the other hand, in relation to performance in the KCPu, results showed a significant association, with a large effect size, to higher TTPT of elbow flexors during isometric muscle contraction (r=0.575, p=0.016). Likewise, the results showed that performance in the KCPu significantly correlated, with a medium effect size, with higher TTPT of shoulder extensors during isometric muscle contraction (r=0.490, p=0.046).

The correlation analysis of explosive power of lower limbs and isokinetic strength of knee and hip extensors and flexors is shown in Table 5.

Table 5. Correlations between explosive power of lower limbs and isokinetic strength of knee and hip extensors and flexors

KNEE	CMJ	CMJ FA	SJ	HIP	CMJ	CMJ FA	SJ
E con TTPT	-0.316	-0.225	-0.295	E con TTPT	0.169	0.232	0.229
E con PT	0.573*	0.632**	0.685**	E con PT	0.612**	0.678**	0.615**
E ecc TTPT	0.055	-0.085	0.073	E ecc TTPT	-0.293	-0.178	-0.443
E ecc PT	0.470	0.559*	0.554*	E ecc PT	0.379	0.424	0.206
E iso TTPT	0.265	0.471	0.264	E iso TTPT	0.275	0.311	0.204
E iso PT	0.466	0.640**	0.571*	E iso PT	0.500*	0.562*	0.507*
F con TTPT	0.069	0.079	0.062	F con TTPT	0.081	0.082	0.010
F con PT	0.477	0.631**	0.652**	F con PT	0.411	0.486*	0.507*
F ecc TTPT	0.271	0.367	0.312	F ecc TTPT	-0.289	-0.213	-0.141
F ecc PT	0.701**	0.792**	0.749**	F ecc PT	-0.146	-0.123	-0.118
F iso TTPT	0.118	0.284	0.168	F iso TTPT	0.455	0.418	0.188
F iso PT	0.603*	0.750**	0.686**	F iso PT	-0.087	-0.029	-0.076

*Note. CMJ: countermovement jump; CMJ FA: countermovement jump with free arms; SJ: squat jump; E: extensors; F: flexors; con: concentric; ecc: eccentric; iso: isometric; TTPT: time to peak torque; PT: peak torque; *: p<0.05; **: p<0.01*

Based on the correlation analysis, the level of PT of knee extensors during concentric muscle contraction was significantly associated with performance in the CMJ (r=0.573, p=0.016), CMJ FA (r=0.632, p=0.006), and SJ (r=0.685, p=0.002), with a large effect size. Additionally, the level of PT of hip extensors during concentric muscle contraction was also significantly associated with performance in the CMJ (r=0.612, p=0.009), CMJ FA (r=0.678, p=0.003), and SJ (r=0.615, p=0.009), with a large effect size. On the contrary, the PT of knee flexors during concentric muscle contraction was significantly associated with performance in the CMJ FA (r=0.631, p=0.007) and SJ (r=0.652, p=0.005), with a large effect size. The PT of hip flexors during concentric muscle contraction was also significantly associated with performance in the CMJ FA, with a medium effect size (r=0.486, p=0.048), and with performance in the SJ, with a large effect size (r=0.507, p=0.038).

In relation to eccentric muscle contraction, statistically significant relationships with a large effect size were observed between PT of knee extensors and performance in the CMJ FA (r=0.559, p=0.020) and SJ (r=0.554, p=0.021). Additionally, PT of knee flexors was significantly associated, also with a large effect size, with performance in the CMJ (r=0.701, p=0.002), CMJ FA (r=0.792, p<0.001), and SJ (r=0.749, p=0.001). In terms of isometric muscle contraction, PT of knee extensors was significantly associated with performance in the CMJ FA (r=0.640, p=0.006) and SJ (r=0.571, p=0.017), with a large effect size. Likewise, PT of hip extensors was significantly related to CMJ (r=0.500, p=0.041), CMJ FA (r=0.562, p=0.019) and SJ (r=0.507, p=0.038), with a large effect size. On the contrary, PT of knee flexors during isometric muscle contraction was significantly associated with performance in CMJ (r=0.603, p=0.010), CMJ FA (r=0.750, p=0.001) and SJ (r=686, p=0.002), with a large effect size.

Discussion

Our study aimed to elucidate the relationships between explosive power and isokinetic parameters TTPT and PT in MMA fighters. The correlations between PT of upper and lower limb muscles and explosive power tests emphasize muscle strength´s role in executing powerful movements, which are essential for MMA performance.

Regarding the upper limbs, statistically significant relationships with large effect sizes were observed between performance in SCPu and PT of elbow and shoulder flexors in concentric, eccentric, and isometric muscle contractions. In study by Zhou et al. (2023), strong correlations were found between shoulder internal rotation PT in concentric muscle contraction at an angular velocity of 60°·s-1 and maximal punch force in boxers. Moreover, shoulder internal rotation PT at an angular velocity of 180°·s-1 showed a stronger correlation with maximal punching force. These findings indicate that fighters with greater isokinetic strength in these areas can produce more powerful punches. The stronger associations observed for the SCPu may be due to the significantly higher mechanical and neuromuscular demands it places on the elbow and shoulder flexors compared to the kneeling variations. Consequently, SCPu performance more accurately reflects maximal upper-limb force-production capacity, making it a more sensitive indicator of the relationship between isokinetic strength and explosive pushing ability. In contrast, the KCPu and KSPu greatly reduce external loading and stability demands, which probably weaken these associations.

In terms of TTPT, correlation analysis showed that a lower TTPT of elbow flexors in concentric muscle contraction statistically correlated with a large effect size with performance in SCPu. However, higher TTPT of elbow flexors in isometric muscle contraction statistically correlated with performance in KCPu. It was also observed that higher TTPT of shoulder extensors positively influences performance in KSPu. Additionally, higher TTPT of shoulder extensors positively influenced performance in the KSPu. These findings support the notion that upper limb strength is essential for punching power and grappling efficiency, consistent with the research by García-Pallarés, López-Gullón, Muriel, Díaz and Izquierdo (2011). The limited influence of TTPT observed in our study may be attributed to several neuromechanical factors. Early-phase torque production is predominantly determined by quick neural activation, including motor unit recruitment speed and discharge rate modulation, which TTPT does not directly quantify (Del Vecchio, 2019). Furthermore, TTPT is measured under controlled isokinetic conditions, performed at a constant angular velocity, which does not replicate the multi-joint nature of explosive actions and is therefore not specific to MMA or other dynamic sport movements, which limits its ecological validity (Maffiuletti et al., 2016).

Our findings also revealed associations between isometric muscle contraction and explosive power of the lower limbs. Specifically, the PT of knee extensors showed a positive relationship with performance in the CMJ FA and SJ. Similarly, the PT of hip extensors was significantly linked to performance in CMJ, CMJ FA, and SJ. Moreover, the PT of knee flexors during isometric muscle contraction was associated with enhanced performance in all jump tests, further emphasizing the role of maximal strength in generating explosive movements. These results highlight the importance of both dynamic and static strength in lower-limb extensors for vertical jump performance. Our findings are consistent with Chen et al. (2023), who found significant correlations between PT of knee extensors at angular velocities of 60°·s-1, 180°·s-1, 240°·s-1 ,and CMJ performance in elite boxers, suggesting that PT in concentric contraction plays a crucial role in explosive jump performance. Moreover, the correlation between PT and vertical jump height in CMJ was the strongest at 240°·s-1. The study by Detanico, Pupo, Graup and Santos (2016) confirmed that isokinetic strength and vertical jump performance can distinguish between advanced and novice judokas, emphasizing the importance of concentric strength of the lower limb extensors. Furthermore, knee extension PT at an angular velocity of 60°·s-1 showed a stronger correlation with maximum punching force compared to PT at 180°·s-1 (Zhou et al., 2023). Interestingly, Hammami, Ouergui, Zinoubi, Zouita and Moussa, (2014) identified a significant relationship between PT and jump height in elite Tunisian taekwondo athletes, supporting the idea that PT and explosive performance are closely connected in various combat sports. Moreover, the study also did not observed a significant correlation between TTPT and jump height for angular velocities of 60°·s-1 and 180°·s-1. Strong correlations between PT of knee and hip extensors in concentric contraction and performance in CMJ, CMJ FA, and SJ indicate that PT in concentric contraction plays a crucial role in explosive jump performance. Our findings are supportive of findings by McErlain-Naylor, King and Pain (2014), who demonstrated that maximal isometric torque of knee extensors significantly contributes to the variability in jump height.

Our results showed significant associations between the PT of knee flexors and performance in CMJ, CMJ FA, and SJ. These findings suggest that eccentric strength of knee flexors is a critical determinant of explosive power. Similar conclusions were drawn by Nishiumi, Nishioka, Saito, Kurokawa and Hirose (2023), who conducted a systematic review examining the relationships between eccentric strength variables during jumping and lower limb eccentric strength in relation to vertical jump performance. This review emphasized that eccentric strength during the downward phase of CMJ and eccentric strength in movements such as squats and knee extensions are associated with jump height and reactive strength index. These findings suggest that enhancing eccentric strength of knee flexors through strength training may lead to increased explosive power, which is crucial for athletes in combat sports and other disciplines requiring lower limb strength.

The practical implications of our findings suggest that strength training for MMA fighters should emphasize the muscle groups and contraction modes that demonstrated significant associations with explosive performance. For the upper limbs, this includes concentric, eccentric, and isometric strength of the elbow and shoulder flexors, which were positively related to explosive push-up performance. For the lower limbs, enhancing concentric, eccentric, and isometric strength of the knee and hip extensors and flexors may improve vertical jump performance. Prioritizing contraction modes strongly associated with explosive outputs may therefore support more targeted performance-oriented strength development in MMA athletes.

It should be noted that our study has some limitations. The research did not include MMA fighters of all weight categories or a wider age range, which limits the generalizability of the findings to elite adult fighters. Therefore, it would be helpful to expand the research to include fighters of all weight categories and to increase the sample size. The main limitation of the study is the use of general tests of explosive power. General tests were selected because they minimize the influence of technical proficiency inherent to striking and grappling, allowing a clearer assessment of the fighters´ underlying neuromuscular capabilities. In the future, it would be more appropriate to apply specific tests, such as punches against a punch sensor measuring impact force, for better ecological validity. Most research focuses on the isokinetic strength of the knee joint, so it was difficult to compare the findings in the hip, elbow, and shoulder joints. Since there is limited existing research on these muscle groups, the study could provide valuable insights and set a precedent for future research.

Conclusion

The findings of our study provide valuable insights into the relationships between isokinetic strength in concentric, eccentric, and isometric muscle contraction and explosive power in MMA fighters. The most notable relationships in the upper limbs were observed between the SCPu and PT of elbow and shoulder flexors, particularly during concentric, eccentric, and isometric muscle contractions. In the lower limbs, the most notable relationships were found between the PT of knee extensors and flexors and performance in CMJ FA and SJ during concentric, eccentric, and isometric muscle contractions, as well as between the PT of hip extensors in concentric and isometric contractions and performance in the CMJ, CMJ FA, and SJ. While PT proved to be a reliable predictor of explosive performance, TTPT did not appear to influence the quick execution of upper or lower-limb actions. This suggests that maximal strength capacity, rather than the speed of reaching peak force, may be more critical for power output in MMA fighters. Additionally, these findings provide coaches with guidance to optimize the development of explosive power by targeting key muscle groups, including the knee and hip extensors and elbow and shoulder flexors.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial and financial relationships that could be construed as a potential conflict of interest.

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