

Improving peak torque strength of male karate students after eight weeks of strength training

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Abstract:

In this study, we investigated the effects of an eight-week strength development program on male karate students from Vietnam National University-Ho Chi Minh City (VNU-HCM). *Objectives:* The main objective was to assess the impact of this strength development program on key muscle groups crucial for karate performance, including the head, hip, elbow, and shoulder regions. *Method:* Eleven male karate practitioners from VNU-HCM participated in an experimental eight-week strength development program. Force torque measurements of the head, hip, elbow, and shoulder muscle groups were taken before and after the intervention. Statistical analysis was conducted to evaluate the significance of observed changes. *Results:* The eight-week strength development program resulted in significant enhancements in the force torque of the head, hip, elbow, and shoulder muscle groups among male karate practitioners from VNU-HCM. These improvements were statistically significant, with values ranging from $P < 0.05$ to $P < 0.001$. *Conclusion:* The study concludes that the eight-week strength development program is appropriate and effective for increasing muscle contraction force in male karate practitioners at VNU-HCM. The significant increases in peak torque observed in the head, hip, elbow, and shoulder muscles underscore the program's efficacy. These findings offer valuable insights for strength training and can be a reference for future studies or training programs. Moreover, the results suggest that such a program can be seamlessly integrated into the training routine of karate practitioners to enhance their overall performance and muscle strength. This study establishes a foundational understanding of how targeted strength training can benefit specific muscle groups crucial for martial arts performance, thereby providing valuable insights for further research and practical applications in sports training.

Keywords: strength development program, knee flexor, hip flexor, elbow flexor, shoulder flexor

Introduction

Practitioners of karate, a combat sport characterized by full-contact engagements, participate in two distinct disciplines: kumite and kata. Kumite involves sparring between two opponents to score points during the competition (IPPON, WASSARI, and YUKO), while kata showcases traditional karate forms performed in a choreographed manner (Aminaei, Yazdani, & Amirseifadini, 2017; Chaabene, Negra, Capranica, Prieske, & Granacher, 2019). Consequently, kumite athletes devote a significant portion of their training to developing technical skills and sparring, which can sometimes lead to a decreased emphasis on strength and power training sessions.

Achieving peak performance in karate requires specific physiological and physical characteristics influenced by technique proficiency, technical skills, training regimen, dietary habits, and psychological state (Zhu, Li, & Jankowicz-Pytel, 2020; Romanova et al., 2022; Yulfadinata, Setijono, Muhammad, Ayubi, & Kusnanik, 2022). Strength, explosiveness, and speed are crucial physical attributes for performance enhancement in karate (Mischenko et al., 2020; Et al S, 2021). During the recent COVID-19 pandemic, many athletes were confined to their homes, prohibited from leaving unless absolutely necessary, and all sports and recreational centers were closed (Vargas, 2020).

Karate practitioners often focus heavily on technical skills, potentially neglecting the development of muscle strength and power, which are crucial for optimal performance and injury prevention. The imbalance between training for technique and physical conditioning can lead to insufficient strength in critical muscle groups, increasing the risk of injury and reducing overall athletic performance.

This study addresses the physical conditioning gap among male karate practitioners, specifically those from Vietnam National University-Ho Chi Minh City (VNU-HCM). It aims to enhance understanding of how a structured strength development program can impact muscle groups essential for karate, particularly given the specific demands of kumite and kata.

Plyometric training is an effective method for enhancing strength, power, and neuromuscular explosiveness in Karate practitioners, especially in kicking techniques (Suchomel, Wagle, Douglas, Taber,

Harden, Haff, & Stone, 2019; Douglas, Pearson, Ross, & McGuigan, 2017). Studies suggest that a plyometric regimen, such as three sets of five consecutive tuck leaps, can significantly enhance lower limb jumping performance and round kick power potential in elite Karate athletes (Margaritopoulos, Theodorou, Methenitis, Zaras, Donti, & Tsolakis, 2015).

Research also indicates that different training interventions yield varying results. For instance, an eight-week plyometric-based training program significantly improved anaerobic performance in upper and lower body regions, while a nine-week strength–power training regimen specifically enhanced physical performance and power in female Karate athletes (Aminaei, Yazdani, & Amirseifadini, 2017; Nowakowska, Zatoń, & Wierzbicka-Damska, 2017).

While power capacity is closely linked to karate performance, certain traditional power tests, such as the counter-movement jump (CMJ), may not fully capture the power capabilities of karate practitioners. Nevertheless, CMJ remains widely used to assess changes in power capacity and neuromuscular explosiveness (Roschel, et al, 2009).

Furthermore, the ability to execute rapid horizontal movements, essential in kumite scenarios, may enhance defensive capabilities and provide opportunities for reactive kicks or punches in response to opponents' attacks (Katić, Blažević, & Zagorac, 2010). Despite the importance of horizontal movement in kumite performance, limited research exists on how plyometric and kumite training impact athletes' horizontal movement abilities.

Tudor Bompa (1996; 2021) and Fleck & Kraemer (1987) summarized from numerous studies that when the strength differential (SD) between agonist and antagonist muscles of a joint increases, the risk of injury to that joint also increases. Bompa (1996) suggested that coaches need to assess and implement training programs to increase the strength of weak muscle groups and reduce the SD between agonist and antagonist muscles, thereby reducing the risk of injury to athletes. The preparatory phase, which includes strength training programs aimed at developing general and maximum strength, is an appropriate time to develop balanced agonist and antagonist muscle groups because athletes are not under the pressure of competitive performance.

In this study, we aimed to examine the effects of an eight-week strength development program on male Karate students from VNU-HCM.

Eleven male karate practitioners from VNU-HCM participated in an eight-week experimental strength development program. The force torque of the head, hip, elbow, and shoulder muscle groups was measured before and after the intervention. Statistical analysis was performed to determine the significance of any observed changes.

The assessment results for the 11 male karate team members from VNU-HCM (average age 20.12 ± 2.21 years, average height 168.67 ± 5.68 cm, average weight 62.76 ± 7.14 kg) indicated that the flexor muscle groups in the shoulders, elbows, hips, and knees were significantly weaker than the extensor muscle groups. Therefore, it is essential to develop strength in these muscle groups to balance the strength of agonist and antagonist muscle groups at the joints.

Methods and materials

Research Methodology: The study used the following methods: document synthesis and analysis, statistical techniques, pedagogical experimentation, and explosive power assessment using isokinetic measurements.

Pedagogical Experimentation Method: An eight-week experimental program (EP) was developed based on the theories of Bompa (1996) and Kraemer & Fleck (2014). The program was implemented during the preparatory phase of the 2023 training plan for the VNU-HCM Karate student team and comprised two phases:

(a) Anatomical adaptation phase:

Explosive Power Assessment Method: The Biodex System 4Pro-2012 machine was used to evaluate the strength of flexion–extension in four joints: shoulders, elbows, hips, and knees, operating at a velocity of 60 °/s.

Research Objective: The aim is to enhance the strength of the four flexor muscle groups across four joints over an eight-week strength development program, focusing on reducing strength imbalances between agonist and antagonist muscles in male Karate athletes of the VNU-HCM team.

During the initial four-week period, training occurred three times per week, comprising four exercises targeting the four muscle groups, with 8–12 repetitions, three sets, and intensity set at 60–75% of 1 repetition maximum (1 RM), employing the circuit training method.

(b) Maximum strength development phase:

During this phase, which lasted four weeks, training was performed three times per week. Four exercises targeted the same muscle groups using three to four repetitions, three sets, and an intensity set at 90–95% of 1 RM, employing the maximum intensity method.

Statistical Analysis in the Study: SPSS 20.0 and Microsoft Excel software were employed to analyze parameters such as mean (M) values, standard deviation (SD), d-value, growth rate (W%), t-test, chi-square test, and ANOVA to evaluate the research results.

Results

Variation of Peak Torque Moments at the Knee Joint

The results of the variation of peak torque moments after the EP targeting the flexor muscle group of left and right knees, along with the average of both legs among male Karate students, are detailed in Table 1.

The results in Table 1 indicate that the average peak torque moment for both legs before the EP was $(avg)1 = 110.52 \pm 12.03$, whereas after the EP, it rose to $(avg)2 = 125.39 \pm 9.38$, indicating an increase of 14.87 Pt. This suggests a significant development with a growth rate of $W\% = 12.61\%$, demonstrating statistical significance at the probability level $P = 0.002$. Analyzing individual legs, the peak torque moment for the right knee flexor was $(avg)1 = 114.12 \pm 15.72$, which increased to $(avg)2 = 127.75 \pm 9.61$ after the EP, which is a difference of $d = 13.63$ Pt and a growth rate of $W\% = 11.27\%$, statistically significant at $P = 0.021$. Similarly, for the left knee flexor, the peak torque moment shifted from $(avg)1 = 106.92 \pm 11.82$ to $(avg)2 = 123.02 \pm 10.56$, indicating a difference of $d = 16.10$ Pt and a growth rate of $W\% = 14.00\%$, statistically significant at $P = 0.002$. These findings collectively support the conclusion that the EP significantly enhances strength.

Variation of Peak Torque Moments at the Elbow Joint

Table 1 details the variation in peak torque moments after the EP targeting the flexor muscle group of right and left elbows, along with the average of both arms among male karate students.

Table 1: Variation of Peak Torque Moments at Knee and Elbow Joints (n = 11)

Variations in peak knee bending force moment										
	M_1	SD_1	M_2	SD_2	d	W%	t	p		
Left leg (Pt)	106.92	11.82	123.02	10.56	16.10	14.00	3.98	0.002		
Right leg (Pt)	114.12	15.72	127.75	9.61	13.63	11.27	2.98	0.021		
(Avg)2 legs (Pt)	110.52	12.03	125.39	9.38	14.87	12.61	4.72	0.002		
Variations in peak elbow lever force moment										
	M_1	SD_1	M_2	SD_2	d	W%	t	p		
Left hand (Pt)	38.17	3.16	43.34	3.94	5.17	12.69	2.35	0.053		
Right hand (Pt)	40.13	2.48	48.96	1.06	8.83	19.82	7.03	0.001		
(Avg) 2 hands (Pt)	39.08	1.29	46.15	1.67	7.07	16.59	9.53	0.001		

The results from Table 1 show that:

After eight weeks of experimentation, the peak torque moment of elbow flexion increased by 16.59%, which is statistically significant at the probability level $P = 0.001$. Analysis for each arm indicates that the peak torque moment of left elbow flexion was $(avg)1 = 38.17 \pm 3.16$ before the experiment and $(avg)2 = 43.34 \pm 3.94$ after, a difference of $d = 5.17$ Pt, with a growth rate of $W\% = 12.69\%$ and $P = 0.053$. Similarly, the peak torque moment of right elbow flexion was $(avg)1 = 40.13 \pm 2.48$ initially and increased to $(avg)2 = 48.96 \pm 1.06$ after the experiment, a difference of $d = 8.83$ Pt, with a growth rate of $W\% = 19.82\%$ and $P = 0.001$. Thus, it can be concluded that the experimental program significantly enhanced the strength of the elbow flexor muscle groups for male Karate students.

Variation of Peak Torque Moments at the Hip Joint

Table 2 details the peak torque moment variation after the EP for the thigh flexor muscle group in the right and left thighs and the average of both thighs among male karate students.

The results presented in Table 2 show that the average peak torque moment of both thighs was $(avg)1 = 129.98 \pm 33.96$ initially, and after the EP, it increased to $(avg)2 = 167.53 \pm 23.03$ with a growth rate of $W\% = 25.24\%$ and a statistically significant variation at $P = 0.023$. Analysis of each thigh revealed that for left thigh flexion, the initial peak torque moment was $(avg)1 = 132.53 \pm 38.62$, which increased to $(avg)2 = 160.36 \pm 18.41$ after the EP, showing a difference of 27.83 Pt and a growth rate of $W\% = 19.00\%$. However, this difference was not statistically significant at $P = 0.052$. Conversely, for right thigh flexion, the initial peak torque moment was $(avg)1 = 127.42 \pm 31.33$, which increased to $(avg)2 = 174.7 \pm 34.27$ after the EP, indicating a difference of $d = 47.28$ Pt and a growth rate of $W\% = 31.30\%$, with statistical significance at $P = 0.015$. Thus, it can be concluded that the EP was effective.

Table 2: Variation of Peak Torque Moments at the Thigh and Shoulder Joints (n = 11)

Variation of Peak Torque Moments in Thigh Flexion										
	M_1	SD_1	M_2	SD_2	d	W%	t	p		
Left thigh (Pt)	132.53	38.62	160.36	18.41	27.83	19.00	2.21	0.052		
Right thigh (Pt)	127.42	31.33	174.7	34.27	47.28	31.30	3.07	0.015		
(Avg) 2 thigh (Pt)	129.98	33.96	167.53	23.03	37.55	25.24	2.89	0.023		
Variation of Peak Torque Moments in Shoulder Flexion										
	M_1	SD_1	M_2	SD_2	d	W%	t	p		
Left shoulder (Pt)	37.48	4.80	50.16	7.18	12.68	28.94	3.98	0.005		
Right shoulder (Pt)	40.28	6.7	50.19	8.08	9.91	21.91	2.95	0.02		
(Avg) 2 shoulder (Pt)	38.88	5.23	50.17	6.25	11.29	25.36	4.93	0.002		

Variation of Peak Torque Moments at the Shoulder Joint

Table 2 depicts the variation of peak torque moments after the EP for the shoulder flexor muscle group in the right and left shoulders, along with the average of both shoulders among male karate students.

From Table 2, it is observed that:

The average peak torque moment of both shoulders before the experiment was $(avg)1 = 38.88 \pm 5.23$, which rose to $(avg)2 = 50.17 \pm 6.25$ after the experiment, indicating an increase of $d = 11.29$ Pt. This corresponds to a growth rate of $W\% = 25.36\%$, with statistical significance at the probability level of $P = 0.005$. Analysis for each shoulder indicates that the peak torque moment of left shoulder flexion was $(avg)1 = 37.48 \pm 4.80$ initially and increased to $(avg)2 = 50.16 \pm 7.18$ after the EP, resulting in a difference of $d = 12.68$ Pt and a growth rate of $W\% = 25.36\%$, which is statistically significant at $P = 0.005$. Similarly, for right shoulder flexion, the initial peak torque moment was $(avg)1 = 40.28 \pm 6.70$, which increased to $(avg)2 = 50.17 \pm 6.25$ after the experiment, with a difference of $d = 9.91$ Pt, a growth rate of $W\% = 21.91\%$, and statistical significance at $P = 0.02$. Consequently, it can be concluded that the EP was effective.

Discussion

After eight weeks of implementing the strength development program, the results demonstrate a significant increase in peak torque (Pt) among male karate athletes from VNU-HCM in knee flexor, hip flexor, elbow flexor, and shoulder flexor muscle groups. These differences exhibit statistical significance, with probability thresholds ranging from $P < 0.05$ to $P < 0.001$. Consequently, it can be inferred that the eight-week strength development experimental program for male students in the VNU-HCM Karate team is appropriate and effective in enhancing muscle strength, as evidenced by peak torque measurements. A comparison with the results of some published studies indicates that while the knee flexor and elbow flexor strength of male students in the VNU-HCM karate team surpasses that of healthy adolescents, it remains weaker compared to male athletes in various European martial arts.

Our results are similar to those of eight karate athletes from Ho Chi Minh City (Bui et al, 2017). Furthermore, compared to 10 Portuguese boxing athletes with an average peak torque of 136 ± 23 (Silva, et al, 2016), the male karate athletes from VNU-HCM exhibit weaker average peak torque in both legs. Compared to seven martial artists with peak torque of the left leg averaging 151 ± 37.5 and the right leg averaging 153.6 ± 44.8 , the male karate athletes demonstrate a smaller difference. As reported by Hoshikawa, Muramatsu, Iida, Uchiyama, Nakajima, & Kanehisa (2010), compared to amateur volleyball athletes from Shizuoka, Japan, with an average peak torque of both legs at 134.8 ± 22.4 , male karate athletes from VNU-HCM display a smaller average peak torque in both legs. Similarly, compared to shot put athletes averaging 123 ± 19.4 , Sumo athletes averaging 112.4 ± 15.1 , rowing athletes averaging 112.2 ± 18.6 , Karate athletes averaging 111.8 ± 22.1 , soccer athletes averaging 112.2 ± 17.8 , and water polo athletes averaging 108.7 ± 8.6 , male karate athletes from VNU-HCM show larger differences, respectively: shot put = 3.63 Nm, Sumo = 14.23 Nm, rowing = 14.43 Nm, Karate = 14.83 Nm, soccer = 14.43 Nm, water polo = 17.93 Nm. According to Kotrljanovic, Atanasov, Veljovic, & Drid, (2016), the results indicate that male Karate athletes from the Serbian team have a peak torque of the left leg at 143.44 ± 34.27 , right leg at 145.67 ± 22.65 , and an average peak torque of both legs at 144.56 ± 28.46 , all surpassing male Karate athletes from VNU-HCM. Therefore, it can be inferred that male Karate athletes from VNU-HCM possess relatively good knee flexion strength compared to other athletes but still fall short compared to Japanese volleyball athletes, Portuguese boxing athletes, and Serbian Karate athletes. Compared to seven martial artists from Serbia (Kotrljanovic, Atanasov, Veljovic, & Drid, 2016), with peak torque of the left hand at 95.1 ± 12.3 , right hand at 94.7 ± 14.7 , and an average peak torque of both hands at 94.9 ± 13.5 , male karate athletes from VNU-HCM exhibit lower values. Compared to 30 healthy young men (Frey-Law, Laake, Avin, Heitsman, Marler, & Abdel-Malek, 2012) with an average peak torque of both hands at 42.3 ± 9.5 , male Karate athletes perform better. Compared to 22 healthy young men (Ruivo, Pizarat-Correia, & Carita, 2012) with an average peak torque of both hands at 45.13 ± 6.53 , male karate athletes from VNU-HCM demonstrate superior performance. Compared to 22 Judo athletes from Portugal with an average peak torque of both hands at 64.71 ± 16.10 , male karate athletes from VNU-HCM exhibit lower values. Therefore, it can be concluded that male karate athletes from VNU-HCM possess commendable elbow flexion strength compared to non-athletic young men but still lag behind Judo athletes from Portugal and Karate athletes from Serbia.

Conclusion

This comparative study provides insight into the muscular strength profile of male Karate athletes from VNU-HCM in relation to athletes from various other sports disciplines.

The results show that male Karate athletes from VNU-HCM generally exhibit weaker average peak torque in both legs compared to Karate athletes from Serbia, Portuguese boxers, and Japanese volleyball players. This underscores the potential benefit of targeted strength training programs to enhance lower limb strength among male Karate athletes from VNU-HCM.

Regarding upper limb strength, male Karate athletes from VNU-HCM exhibit lower peak torque in both hands compared to martial artists from Serbia, suggesting an area for improvement in their training regimen.

However, they outperform non-athletic young men in elbow flexion strength, which is indicative of the positive influence of Karate training on upper-body muscular strength.

Overall, while male Karate athletes from VNU-HCM demonstrate certain strengths in muscular performance, such as commendable elbow flexion strength, there are areas, notably lower limb strength, where enhancements could optimize their athletic performance and competitiveness on the global stage. Thus, tailored strength training programs are recommended to address these areas of improvement and maximize the overall performance of male Karate athletes from VNU-HCM.

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