Physiological responses on Krabi-Krabong skill learning in students of Buriram province

Respuestas fisiológicas durante el aprendizaje de las técnicas de Krabi-Krabong en estudiantes de la provincia de Buriram

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Abstract

Objective: This research aimed to analyze the electromyographic (EMG) responses during Mai Ram Krabi-Krabong and striking techniques from an exercise physiology perspective, and to compare physiological responses in students of Buriram province who received Krabi-Krabong training and those who did not.
Method: The study was conducted in two phases: the first examined EMG responses during Krabi-Krabong techniques, while the second developed and studied the effects of Krabi-Krabong instruction in physical education classes. The study involved two groups of participants. The first group in study 1 consisted of 16 university students skilled in Krabi-Krabong techniques, who participated in the EMG analysis. The second group in study 2 comprised 50 high school students, divided equally into a control group receiving standard physical education instruction and an experimental group receiving Krabi-Krabong training. Both groups participated in weekly 50-minute sessions for 12 weeks. Assessments included computerized cognitive tests, and physical fitness tests.
Results: Results from the first study revealed the activation of specific muscle groups during 12 Mai Ram (16 sequences) and 5 striking techniques, emphasizing the full-body engagement of Krabi-Krabong. The second study found significant improvements in physical fitness, including upper body strength, cardiovascular endurance, leg muscle endurance, hand-forearm strength, static balance, and Krabi-Krabong skills in the experimental group. Additionally, Krabi-Krabong training enhanced executive functions in cognitive flexibility, inhibitory control, attention, and creativity, with all improvements being statistically significant at the .05 level.
Conclusions: Krabi-Krabong training significantly improves physical fitness and cognitive function in students.

Keywords

Physiology, physical fitness, Krabi Krabong, electromyography, cognitive function, physical education.

Resumen

Introducción: el entrenamiento físico que integra elementos culturales tradicionales, como el Krabi-Krabong, puede ofrecer beneficios tanto físicos como cognitivos.
Objetivo: esta investigación tuvo como objetivo analizar las respuestas electromiográficas (EMG) durante las técnicas de Mai Ram y golpeo de Krabi-Krabong desde la perspectiva de la fisiología del ejercicio, y comparar las respuestas fisiológicas entre estudiantes de la provincia de Buriram que recibieron entrenamiento en Krabi-Krabong y aquellos que no.
Metodología: el estudio se realizó en dos fases: la primera examinó las respuestas EMG durante las técnicas de Krabi-Krabong; la segunda desarrolló y evaluó los efectos de la instrucción en Krabi-Krabong en clases de educación física. Participaron dos grupos: el primero, 16 estudiantes universitarios expertos en Krabi-Krabong, para el análisis EMG; el segundo, 50 estudiantes de secundaria, divididos en un grupo control (educación física estándar) y un grupo experimental (entrenamiento en Krabi-Krabong), con sesiones semanales de 50 minutos durante 12 semanas. Las evaluaciones incluyeron pruebas de condición física y pruebas cognitivas informatizadas.
Resultados: los resultados del primer estudio revelaron la activación de grupos musculares específicos durante 12 secuencias de Mai Ram y 5 técnicas de golpeo, lo que demuestra el uso completo del cuerpo en Krabi-Krabong. El segundo estudio mostró mejoras significativas en la condición física del grupo experimental, incluyendo fuerza del tren superior, resistencia cardiovascular, resistencia muscular de las piernas, fuerza de manos y antebrazos, equilibrio estático y habilidades en Krabi-Krabong. Además, el entrenamiento mejoró las funciones ejecutivas como la flexibilidad cognitiva, el control inhibitorio, la atención y la creatividad, con todas las mejoras estadísticamente significativas al nivel de .05.
Conclusiones: el entrenamiento en Krabi-Krabong mejora significativamente la condición física y la función cognitiva en estudiantes.

Palabras clave

Actividad física, electromiografía, educación física, Krabi-Krabong, fisiología, función cognitiva, Educación física

Introduction

Krabi-Krabong is a martial art rooted in the defense of Thailand from ancient times, particularly during the Ayutthaya period. The practice of Krabi-Krabong is not merely about mastering self-defence techniques but also reflects the culture, traditions, and wisdom of Thailand, passed down through generations (Khamwichi & Srisiri, 2023). Today, Krabi-Krabong has been incorporated into physical education curricula to preserve cultural heritage and enhance students' physical fitness. It emphasizes the importance of structured movement and participation in sports activities, which are in line with modern educational approaches.

Under the Basic Education Core Curriculum, the subject group of Health and Physical Education outlines specific indicators and learning content related to both traditional Thai sports and international sports. The goal is to help students develop both physical and mental skills, such as sportsmanship, the ability to follow rules, and teamwork. One of the courses that emphasize the preservation of Thai sports is Krabi-Krabong, which has been incorporated into the curriculum to promote motor skills and overall physical fitness development (Ministry of Education, 2008).

The practice of Krabi-Krabong involves various aspects of physical fitness, such as strength, speed, agility, and coordination between the nervous and muscular systems, which directly impacts performance efficiency (Nulek et al., 2020). Learning this discipline plays a crucial role not only in developing sports skills but also in practical applications, such as self-defence in dangerous situations (Muadchaiyapum et al., 2020). However, in modern times, interest in Krabi-Krabong has declined, causing people to overlook its value and importance.

Based on the points mentioned above, the researcher is interested in studying the physiological impacts of learning Krabi-Krabong on secondary school students and adolescents. The aim is to gain deeper insights into the physical changes that occur after practising the skills. Additionally, the findings will contribute to enhancing the effectiveness of Krabi-Krabong courses, helping both students and teachers better understand the value of teaching and learning this discipline. This will, in turn, promote the sustainable preservation and continuation of Thailand's cultural heritage.

Method

Design and Participants

The study was divided into two phases. Phase 1 focused on examining the electromyographic responses generated during the practice of Mai Ram Krabi-Krabong and Krabi-Krabong sword-fighting techniques. Phase 2 aimed to study and develop the teaching of sword-fighting skills in a physical education course.

In Phase 1, the sample consisted of Physical Education students from the Faculty of Education at Buriram Rajabhat University, who had undergone training according to the curriculum of the Bachelor of Education (Physical Education). The sample size was determined using the G Power 3.1 software, with a statistical significance level set at 0.05, a test power (Power) of 0.80, and an effect size of 0.70, resulting in a total of 16 Physical Education students. The inclusion criteria were: 1) Physical Education students who had mastered sword-fighting skills and 2) students willing to participate in the study. Exclusion criteria included 1) students who were injured or ill and thus unable to participate in the testing and 2) participants who no longer wished to participate in the research.

In Phase 2, the sample consisted of secondary school students enrolled in a physical education course at Tajongpittayasan School, who were selected through purposive sampling and divided into two groups: a control group of 25 students and an experimental group of 25 students, totalling 50 participants. Group 1, the control group, did not receive sword-fighting skills training, while Group 2, the experimental group, underwent sword-fighting skills training. The inclusion criteria were: 1) secondary school students enrolled in a physical education course and 2) students willing to participate in the research. Exclusion criteria included: 1) students who were injured or ill and thus unable to participate in the practical skills training and 2) participants who no longer wished to participate in the research. Participants in the experimental group received instruction once per week for a duration of 50 minutes, scheduled during their regular physical education class every Wednesday.

Instrument

The instruments used for testing according to the objectives of the research in the two phases are as follows:

Phase 1: The analysis of muscle electromyography (EMG) during the performance of Krabi-Krabong 12 Mai Ram in 16 sequential movements and 5 patterns of strikes was conducted using the Wireless Bipolar Cometa Wave Plus EMG system. The EMG electrode pads were attached to the upper body muscles: Flexor Carpi Ulnalis, Extensor Carpi Ulnalis, Bicep Brachii, Triceps Brachii, Medial Deltoid, Pectoralis Major, Latissimus Dorsi, and Rectus Abdominis (Lenetsky et al., 2020; Tsai et al, 2005). For the lower body, the muscles analyzed included Vastus Lateralis, Rectus Femoris, Biceps Femoris, Gluteus Maximus, and Gastrocnemius (Camomilla et al., 2009) to analyze the Maximal Voluntary Isometric Contraction (MVC) and EMG Maximum Intensity during each movement performance.

Phase 2: The effects of training in the Krabi-Krabong 12 Mai Ram, 16 sequential movements, and 5 strike types were studied using two sets of tests. The first part focused on physical performance, which included assessments of muscle strength and endurance, cardiovascular and leg muscle endurance, flexibility, balance, and heart rate. Muscle strength and endurance were evaluated using three different tests: 60-second Sit-Ups (times), 30-second modified push-ups (times) for endurance, and hand grip strength (kg.). Cardiovascular and leg muscle endurance were tested through a 3-minute Step Up and Down exercise (times). Flexibility was assessed using the Sit and Reach test (cm.), following the standards set by the Department of Physical Education of Thailand (2019). Balance was measured with the Stork Stand Test (Francino Barrera et al., 2020). In addition, heart rate was monitored, with the peak heart rate (bpm.) being measured during the Muay Thai performance and the average heart rate (bpm.) recorded throughout the activity using the Polar Team H10 system. The second phase of the assessments, which focused on evaluating cognitive performance using the Computerized Cognitive Test Battery developed by the Department of Physical Education of Thailand (2024) to assess the participants' cognitive skills.

Procedures

The researcher conducted electromyography (EMG) testing on the physical education students who specialized in Krabi-Krabong throughout their performance on 12 Mai Ram (16 sequential movements) and 5 different striking techniques, as shown in Table 1. The data on the muscle groups involved in exerting force to achieve the proper postures were analyzed and summarized. This information was then used to develop educational content for teaching students in physical education classes, specifically focusing on the swordsmanship subject, emphasizing muscle exertion in executing the various techniques.

The experimental group of high school students participated in 50-minute sessions for 12 weeks program based on the developed teaching model for Krabi-Krabong skills under typical demonstration teaching methods employed by their instructor. During the instruction, the teacher observed the students' performance and intervened to explain or correct any incomplete skills to ensure that students could execute the movements efficiently.

After 12 weeks, a comparative analysis was conducted to assess cognitive performance and physical fitness between the control group (who received general sports instruction according to the standard curriculum) and the experimental group (who received swordsmanship instruction). This analysis was carried out after the completion of the experimental phase.

Table 1. Krabi-Krabong 12 Mai Ram (16 sequential movements) and 5 different striking techniques.

Type of Activities	Type of Movements
Krabi-Krabong 12 Mai Ram (16 sequential movements)	1. Thawai Bangkhom 2. Kuen Phrom Nang 3. Kuen Phrom Yuen 4. 1st Mai Ram: Loi Chai 5. 2nd Mai Ram: Khuang That 6. 3rd Mai Ram: Nep Khang 7. 4th Mai Ram: Tor Sok 8. 5th Mai Ram: Chuang Na Chuang Lang 9. 6th Mai Ram: Pok Na Pok Lang 10. 7th Mai Ram: Yak 11. 8th Mai Ram: Soi Dao 12. 9th Mai Ram: Khuang Tae 13. 10th Mai Ram: Hanuman Waek Fong Nam 14. 11th Mai Ram: Lot Lor

	15. 12th Mai Ram: Chuen Thian 16. Klab Hua Sanam
5 different striking techniques	Strike 1: Neck - Neck - Leg - Leg Strike 2: Neck - Neck - Leg - Lift Strike 3: Neck - Neck - Waist - Waist Strike 4: Neck - Neck - Waist - Waist - Head Strike 5: Neck - Neck - Waist - Waist - Head - Jab

Data analysis

Quantitative data were tested for normal distribution of Maximal Voluntary Isometric Contraction, EMG Maximum Intensity, cognitive performance, and physical fitness by Shapiro-Wilk method. When found that non-normal distribution data, Analyze the difference between 2 groups by Mann-Whitney U Test and within the group between 13 muscle groups with Friedman Test at the significant level .05 by SPSS 23.0 (SPSS Inc. Released 2015. IBM SPSS Statistics for Windows, Version 23.0 Armonk, NY: IBM Corp.)

Results

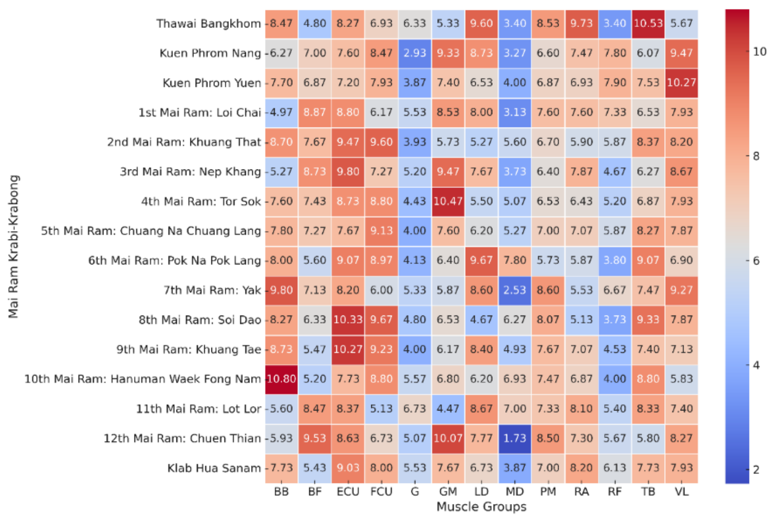
The research on muscle exertion to learning Krabi-Krabong techniques provided the following results. First, The main characteristics of the sample are shown in Table 2, and the analysis of internal muscle activation during Krabi-Krabong 12 Mai Ram (consisting of 16 sequential movements) and five striking techniques revealed significant differences in the ratio of EMG Maximum intensity to Maximal Voluntary Isometric Contraction across the 16 movements which was analyzed for differences in Mean Rank by the Friedman Test ($p < 0.05$). These findings are shown in Figures 1 and 2.

Table 2. Characteristics of the physical education students (n = 16).

Parameter	Mean ± SD
Age (year)	20.06 ± 0.68
Height (cm)	168.63 ± 8.31
Body weight (kg)	59.25 ± 9.21
BMI (kg/cm^2)	20.81 ± 2.76
HRmax (beat/min^{-1})	199.24 ± 0.68
HRavg (beat/min^{-1})	102.19 ± 10.51
HRpeak (beat/min^{-1})	137.94 ± 15.84

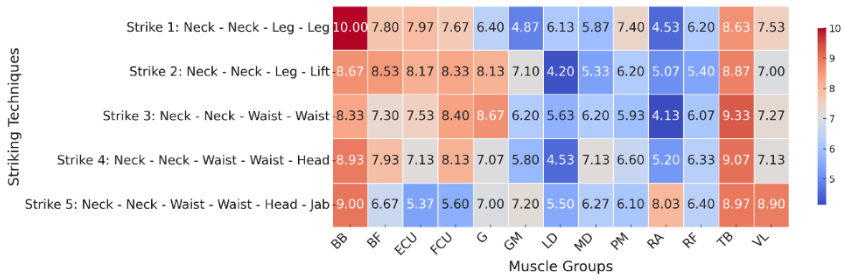
Note. BMI: Body Mass Index; HRmax: Maximum Heart Rate; HRavg: Average Heart Rate; HRpeak: Peak Heart Rate.

Figures 1. The EMG Maximum Intensity to Maximal Voluntary Isometric Contraction ratio in Krabi-Krabong 12 Mai Ram was shown as mean rank.



Note. BB: Bicep Brachii; BF: Biceps Femoris; FCU: Flexor Carpi Ulnalis; G: Gastrocnemius; LD: Latissimus Dorsi; MD: Medial Deltoid; PM: Pectoralis Major; RA: Rectus Abdominis; RF: Rectus Femoris; TB: Triceps Brachii; VL: Vastus Lateralis

Figures 2. The EMG Maximum Intensity to Maximal Voluntary Isometric Contraction ratio in Five Striking Techniques was shown as mean rank.



Note. BB: Bicep Brachii; BF: Biceps Femoris; FCU: Flexor Carpi Ulnalis; G: Gastrocnemius; LD: Latissimus Dorsi; MD: Medial Deltoid; PM: Pectoralis Major; RA: Rectus Abdominis; RF: Rectus Femoris; TB: Triceps Brachii; VL: Vastus Lateralis

Secondly, the physical fitness of high school students in Buriram Province who engaged in Krabi-Krabong training was evaluated. The main characteristics of high school students are shown in Table 3. Following a 12-week training program, the experimental group demonstrated a remarkable enhancement in performance compared to the control group in the modified 30-second push-up test, 3-minute step test, handgrip strength, and single-leg stance test which was analyzed for differences by Mann-Whitney U test ($p < 0.05$). These compelling results, presented in Table 4, emphasis the significant physical fitness benefits of Krabi-Krabong training.

Table 3. Characteristics of high school students.

Parameter	Experimental Group (n=25) Mean ± SD	Control Group (n=25) Mean ± SD
Age (year)	13.56 ± 0.65	13.80 ± 0.71
Height (cm)	154.32 ± 8.40	155.00 ± 6.56
Body weight (kg)	45.65 ± 9.26	46.00 ± 7.14
BMI (kg/cm^2)	19.03 ± 2.50	19.13 ± 2.76
HRmax (beat/min^{-1})	206.44 ± 0.65	206.20 ± 0.71

Note. BMI: Body Mass Index; HRmax: Maximum Heart Rate.

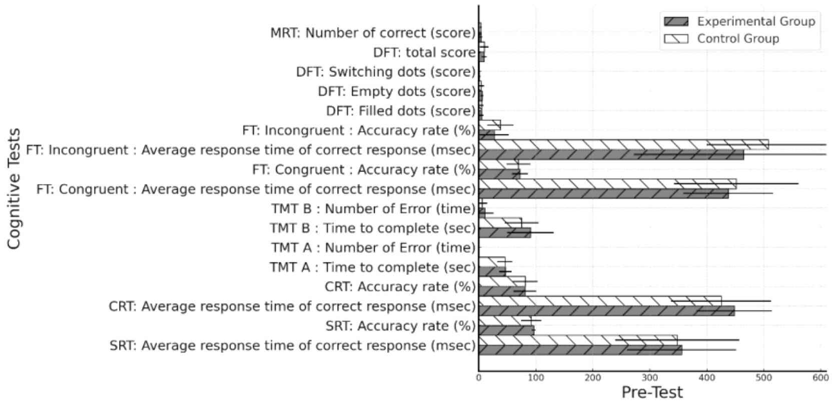
Table 4. Characteristics of high school students.

Parameter	Experimental Group (n=25) Mean ± SD	Control Group (n=25) Mean ± SD	U	*p*-value
Pre-test				
Sit and Reach (cm.)	1.33 ± 7.88	1.80 ± 6.39	297.50	0.770
Modified 30-second push-up test (Time)	18.12 ± 8.07	18.72 ± 7.42	296.00	0.748
Sit-up 60-second (Time)	24.40 ± 13.11	24.20 ± 10.57	290.50	0.669
3-minute step test (Time)	80.08 ± 38.21	81.72 ± 37.72	290.50	0.669
Handgrip strength (kg.)	25.89 ± 9.42	26.42 ± 8.93	287.50	0.627
Single-leg stance test (Second)	9.23 ± 5.90	9.33 ± 5.83	306.50	0.907
HRavg (beat/min^{-1})	106.92 ± 4.08	109.28 ± 5.20	231.00	0.113
HRpeak (beat/min^{-1})	137.12 ± 6.98	138.32 ± 7.16	284.50	0.586
Post-test				
Sit and Reach (cm.)	3.72 ± 6.37	2.36 ± 6.07	274.00	0.454
Modified 30-second push-up test (Time)	22.48 ± 5.12	18.36 ± 5.96	192.50	0.019*
Sit-up 60-second (Time)	28.24 ± 6.17	26.00 ± 7.69	251.00	0.231
3-minute step test (Time)	118.72 ± 30.49	90.48 ± 18.23	129.50	0.000*
Handgrip strength (kg.)	30.90 ± 9.25	24.46 ± 5.68	179.50	0.010*
Single-leg stance test (Second)	14.63 ± 8.74	8.73 ± 3.44	163.00	0.004*
HRavg (beat/min^{-1})	114.44 ± 1.98	111.80 ± 2.06	281.50	0.542
HRpeak (beat/min^{-1})	128.68 ± 8.57	129.36 ± 9.29	303.00	0.854

Note. HRavg: Average Heart Rate; HRpeak: Peak Heart Rate; * Significant with $p \leq 0.05$.

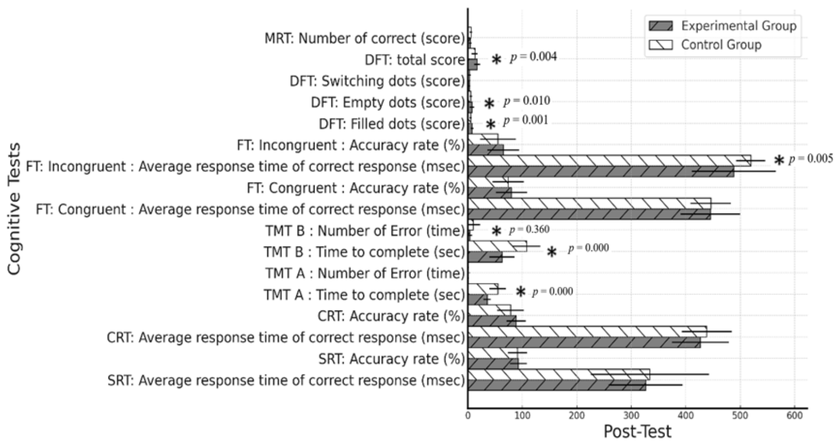
Finally, the cognitive performance of the students was evaluated. After the 12-week training, the experimental group scored significantly higher than the control group on the Trail Making Test, Flanker Test, and Design fluency test, which measures creative problem-solving ability ($p < 0.05$). These findings are illustrated in Figure 3 and 4.

Figure 3. The Cognitive Tests on 50 high school students before teaching Krabi-Krabong.



Note: SRT: Simple reaction time test; CRT: Choice reaction time test; TMT: Trail making test; FT: Flanker test; DFT: Design fluency test; MRT: Mental rotation test.

Figure 4. The Cognitive Tests on 50 high school students after 12 weeks of learning Krabi-Krabong.



Note: SRT: Simple reaction time test; CRT: Choice reaction time test; TMT: Trail making test; FT: Flanker test; DFT: Design fluency test; MRT: Mental rotation test; * Significant with $p \leq 0.05$.

Discussion

The ratio of maximal muscle electromyographic intensity during movements to the maximal muscle intensity during isometric contraction in the performance of Krabi-Krabong 12 Mai Ram, consisting of 16 sequential movements, revealed varied muscle engagement across 13 muscle groups. Each muscle exerted different levels of force to execute the sequences, ensuring accuracy in the movements of striking and parrying techniques. This aligns with the standards set by the Department of Physical Education, rooted in the ancient Thai wisdom of martial arts for warfare, which has evolved into a dance form to enhance students' motor skills and physical fitness (Kongkaew, 2021). A statistical analysis of muscle exertion across all sequences demonstrated significant variations ($p < .05$) in the activation of muscles such as the Extensor Carpi Ulnalis, Flexor Carpi Ulnalis, Triceps Brachii, Vastus Lateralis, Bicep Brachii, Latissimus Dorsi, Rectus Abdominis, Pectoralis Major, Biceps Femoris, Rectus Femoris, and Gluteus

Maximus during the 12 Mai Ram. This martial art is characterized by slow movements requiring muscle resistance against body weight. It necessitates coordination of posture, balance, and cognitive processes, including memorization, self-control, and mental imagery to maintain natural and elegant movements (Srinivas et al., 2021; Gramann et al., 2011).

The 5 striking techniques target the head, neck, torso, and legs using diagonal cuts, slashes, thrusts, and strikes. These movements are part of the weapon-handling skills that practitioners can adapt or integrate for self-defense or physical exercise purposes (Sookhanaphibarn et al., 2023). The ratio of maximal muscle electromyographic intensity during dynamic movements (EMG Maximum Intensity) to the maximal muscle intensity during isometric contraction (Maximal Voluntary Isometric Contraction: MVC) revealed statistically significant muscle exertion ($p < .05$) during the execution of the five striking techniques. Key muscles involved include the Triceps Brachii, Biceps Brachii, Extensor Carpi Ulnalis, Flexor Carpi Ulnalis, Gastrocnemius, Biceps Femoris, and Pectoralis Major. The striking techniques are classified as offensive movements characterized by rapid and forceful execution, requiring both muscular strength and contraction speed (Cid-Calfucura et al., 2023; Okilanda et al., 2024). Simultaneously, these techniques rely on cognitive abilities, including memorizing correct movement patterns, decision-making to target effectively, and efficient weapon-handling strategies (Yan et al., 2000; Russo et al., 2019; Li et al., 2021).

The analysis of the differences in the mean and standard deviation of physiological responses in physical fitness related to Krabi-Krabong learning among secondary school students in Buriram province revealed that after 12 weeks of training, the experimental group performed significantly better than the control group ($p < .05$) in the modified 30-second push-up test, 3-minute knee-up step test, hand grip strength test, and stork balance test. These results indicate improved physiological responses in physical fitness, including upper body and arm muscle strength and endurance, cardiovascular endurance, leg muscle endurance, maximal hand and forearm strength, and static balance capabilities. These advancements were more pronounced in students who received Krabi-Krabong training than those who did not. The training of Krabi-Krabong 12 Mai Ram, consisting of 16 sequential movements, involves continuous, rhythmic postures aligned with the natural flow of sword dance. These movements include repetitive use of muscles to counter body weight and knee flexion and extension to maintain stability during directional changes on a solid base. This resembles resistance training using body weight and the sword's weight as intensity factors, promoting upper body and arm muscle strength and endurance (Tanimoto et al., 2009; Radnor et al., 2020) and static balance (Rahman & Shaheen, 2010; Van Dieën et al., 2015; Jeong & Yoo, 2020). These findings are consistent with the muscles involved in the execution of Krabi-Krabong skills identified in Study 1, including the Extensor Carpi Ulnalis, Flexor Carpi Ulnalis, Triceps Brachii, Vastus Lateralis, Biceps Brachii, Latissimus Dorsi, Rectus Abdominis, Pectoralis Major, Biceps Femoris, Rectus Femoris, and Gluteus Maximus, which are key muscles in the upper body, arms, and legs.

In contrast, the five striking techniques are characterized by aggressive, rapid movements aimed at attacking targets using the sword. These offensive movements require speed and forceful muscle contraction to generate explosive power for precise strikes (Chung et al., 2016). This type of movement induces physiological responses in physical fitness, such as cardiovascular endurance (Bottoms & Wylde, 2017; Pastuhova & Andreyuk, 2018), leg muscle endurance (Rippetoe, 2000; Hekiert et al., 2022), and maximal hand and forearm strength (Sarvaiya & Puntambekar, 2022 Zuwayr & Malih 2024). The key muscles engaged during the execution of the five striking techniques include the Triceps Brachii, Biceps Brachii, Extensor Carpi Ulnalis, Flexor Carpi Ulnalis, Gastrocnemius, Biceps Femoris, and Pectoralis Major, highlighting the involvement of upper limbs, chest, and posterior leg muscles.

The analysis of the differences in the mean and standard deviation of cognitive abilities in Krabi-Krabong training among secondary school students in Buriram province revealed that, after 12 weeks of practice, the experimental group demonstrated significantly better results ($p < .05$) in the Trail Making Test, Flanker Test, and Design Fluency Test compared to the control group. These findings indicate that the practice of Krabi-Krabong, including the 12 Mai Ram (16 sequential movements) and five striking techniques, can enhance executive functions in the brain, particularly cognitive flexibility, inhibitory control, attention, and creativity (Ngambang et al., 2022; Yongtawee et al., 2022; Teba del Pino et al., 2024). This improvement can be attributed to the unique characteristics of Krabi-Krabong movements, which involve slow, rhythmic motions during the Mai Ram and rapid, forceful movements during striking techniques. Practitioners are required to maintain precise control and focus on the accuracy of each movement, both in the Mai Ram and striking sequences. Furthermore, they must inhibit impulsive responses when the opponent's movements deviate from expected patterns or when provoked emotionally. Additionally, Krabi-Krabong training fosters the ability to create and adapt strategies on the spot, allowing practitioners to generate creative and fluid attack patterns that are appropriate for the given situation (Miyake et al., 2000; Diamond, 2013; Lima et al., 2017; Ciaccioni et al., 2023).

Conclusions

The Krabi-Krabong 12 Mai Ram, consisting of 16 sequential movements and the five striking techniques, involves the engagement of major muscle groups, emphasizing motor skills and physical fitness. EMG analysis reveals significant variations in the activation of major muscle groups depending on the movement patterns of the Mai Ram and the striking techniques, which focus on speed and power, in alignment with the Department of Physical Education standards. Additionally, this practice promotes the development of creativity and cognitive abilities, such as cognitive flexibility and emotional inhibition. The training of Krabi-Krabong helps achieve a balance between slow and rapid movements, enhancing both physical performance and mental control.

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Human research ethics

The Human Research Ethics Committee of Buriram Rajabhat University (BRU: 049/2567) approved this research.

Conflict of Interest

The author declares that there are no interests.

References

Bottoms, L. M., & Wylde, M. J. (2017). In Response to “Determinants of Olympic Fencing Performance and Implications for Strength and Conditioning Training.” Journal of Strength and Conditioning Research, 31(2), e64–e66. https://doi.org/10.1519/JSC.0000000000000921

Camomilla, V., Sbriccoli, P., Di Mario, A., Arpante, A., & Felici, F. (2009). Comparison of two variants of a Kata technique (Unsu): The neuromechanical point of view. Journal of Sports Science & Medicine, 8(CSSI3), 29-35. Bottoms, L. M., & Wylde, M. J. (2017). In Response to “Determinants of Olympic Fencing Performance and Implications for Strength and Conditioning Training.” Journal of Strength and Conditioning Research, 31(2), e64–e66. https://doi.org/10.1519/JSC.0000000000000921

Ciaccioni, S., Castro, O., Bahrami, F., Tomporowski, P. D., Capranica, L., Biddle, S. J. H., Vergeer, I., & Pesce, C. (2024). Martial arts, combat sports, and mental health in adults: A systematic review. Psychology of Sport and Exercise, 70, 102556. https://doi.org/10.1016/j.psychsport.2023.102556

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

Chung, J. W., Kim, T. W., Woo, S. S., & Lee, O. (2016). Examination of Physique and Fitness in Elite National Fencing Athletes. The Official Journal of the Korean Academy of Kinesiology, 18(2), 19-31. https://doi.org/10.15758/jkak.2016.18.2.19

Teba del Pino, L., Robles Aguilar, J. A., Ramirez-Campillo, R., & Sáez de Villarreal, E. (2024). Psychophysiological responses to real and simulated professional bullfighting: a case study. Retos, 51, 833–839. https://doi.org/10.47197/retos.v51.101119

Department of Physical Education Thailand. (2019). Physical fitness test and norms for youth and people of Thailand. World Expert Company Limited.

Department of Physical Education Thailand. (2024). Computerized Cognitive Test Battery for youth and people of Thailand. Sport Science Bureau.

Diamond, A. (2013). Executive Functions. Annual Review of Psychology, 64(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Francino Barrera, G. F., Jiménez Torres, S. R., Coloma Díaz, C. C. de J., Delgado Vásquez, D. C., & Verdugo Millar, D. F. (2020). Efectos de un programa de ejercicios de control postural en el equilibrio corporal y precisión de lanzamiento en tiro con arco en categoría infantil y cadetes (Effects of a postural control exercise program on body balance and accuracy of throwing in arch. Retos, 37, 291–296. https://doi.org/10.47197/retos.v37i37.70956

Gramann, K., Gwin, J. T., Ferris, D. P., Oie, K., Jung, T. P., Lin, C. T., Liao, L. D., & Makeig, S. (2011). Cognition in action: imaging brain/body dynamics in mobile humans. De Gruyter, 22(6), 593-608. https://doi.org/10.1515/RNS.2011.047

Hekiert, B., Prokopczyk, A., Sokołowski, M., Klimczak, J., & Guzik, P. (2022). The fencing endurance test is associated with a ranking position in the national classification and body composition analysis in elite female fencers. Arch Budo, 18, 235-240.

Jeong, B., & Yoo, K. (2020). Effects of a Complex Exercise Program on the Distance between Knees and Balance in Individuals in their 20s with Genu Varum. Journal of International Academy of Physical Therapy Research, 11(4), 2244–2252. https://doi.org/10.20540/jiaptr.2020.11.4.2244

Khamwichai, K., & Srisiri, S. (2023). The development of blended physical education lesson plans on hitting skills in Krabi Krabong course of lower secondary school students. Doctoral dissertation, Srinakharinwirot University.

Kongkaew, P. (2021). The Guidelines for Teaching and Learning in Krabi Krabong to Enhance Awareness of the Conservation of Thai Wisdom Sports. FEU Academic Review. 15(3). 60-77.

Lenetsky, S., Brughelli, M., Nates, R. J., Neville, J. G., Cross, M. R., & Lormier, A. V. (2020). Defining the phases of boxing punches: A mixed-method approach. The Journal of Strength & Conditioning Research, 34(4), 1040-1051. https://doi.org/10.1519/JSC.0000000000002895

Li, W., Kong, X., Zhanng, Y., Luo, Y., & Ma, J. (2021). Effects of combat sports on functional network connectivity in adolescents. Neuroradiology, 63(11), 1863–1871. https://doi.org/10.1007/s00234-021-02713-y

Lima, R. F., Da Silva, V. F., De Oliveira, G. L., De Oliveira, T. A. P., Fernandes Filho, J., Mendonça, J. G. R., Borges, C. J., Militao, A. G., Freire, I. A., & Valentim-Silva, J. R. (2017). Practicing karate may improves executive functions of 8-11-year-old schoolchildren. Journal of Physical Education and Sport, 17(4), 2513-2518. http://doi.org/10.7752/jpes.2017.04283

Ministry of Education. (2008). The basic education core curriculum: Physical education core curriculum. Bureau of Academic Affairs and Education Standards.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. Cognitive psychology, 41(1), 49-100. https://doi.org/10.1006/cogp.1999.0734

Muadchaiyapum, S., Butcharoen, J., & Soachalerm, A. (2020). Effects of physical education activity learning on sword and pole subject on enhancing enjoyment of primary school students in Bangkok. Journal of Health, Physical Education and Recreation, 46(2), 130–140.

Ngambang, J., Sriisan, P., & Homsombat, T. (2022). Effects of two-handed sword training program on cognition in healthy college students. Journal of Science and Technology, 5(2), 116–132.

Nulek, E., Vongsrangsap, S., Tanphanich, T., & Poonsri, W. (2020). The development of 1-2 dancing skills in Krabi-Krabong subject by using 24 channel practices for Grade 2 students at Taling Chan Witthaya School. Journal of Health, Physical Education and Recreation. 46(2). 141-148.

Okilanda, A., Suganda, M. A., Chaeroni, A., Rozi, M. F., Saputra, M., Nugroho, S., Bhosle, J., Mishra, R., Singh, J., Rajpoot, Y. S., Govindasamy, K., Elayaraja, M., & Gogoi, H. (2024). Comparative analysis of elevated and floor push-up exercises for activation of the pectoralis major muscle. Retos, 57, 747-752. https://doi.org/10.47197/retos.v57.107264

Pastuhova, V. A., & Andreyuk, N. L. (2018). The influence of vestibular load on the heart vessel system of high qualification fencer. Journal of Education, Health and Sport, 8(10), 199-208. http://doi.org/10.5281/zenodo.1473005

Radnor, J. M., Moeskops, S., Morris, S. J., Mathews, T. A., Kumar, N. T., Pullen, B. J., Robert, M. W., Jason, P. S., Zach, G. I., Jon, O. L., & Lloyd, R. S. (2020). Developing athletic motor skill competencies in youth. Strength & Conditioning Journal, 42(6), 54-70. http://doi.org/10.1519/SSC.0000000000000602

Rahman, S. A. A., & Shaheen, A. A. (2010). Efficacy of weight bearing exercises on balance in children with Down syndrome. Egyptian Journal of Neurology, Psychiatry and Neurosurgery, 47(1), 37-42.

Rippetoe, M. (2000). Strength and conditioning for fencing. Strength & Conditioning Journal, 22(2), 42. https://doi.org/10.1519/SSC.0b013e31826e7283

Russo, G., & Ottoboni, G. (2019). The perceptual–Cognitive skills of combat sports athletes: A systematic review. Psychology of Sport and Exercise, 44, 60-78. https://doi.org/10.1016/j.psychsport.2019.05.004

Sarvaiya, P. H., & Puntambekar, A. (2022). Correlation between lower limb power and agility on hand grip strength in three different positions in young fencers. International Journal of Innovative Research in Medical Science, 7(12). 751-755. https://doi.org/10.23958/ijirms/vol07-i12/1582

Sookhanaphibarn, T., Tingsabhat, S., & Choensawat, W. (2023, October). Utilizing self-learning software for the acquisition and exploration of standard dance notation fundamentals in Krabi Krabong arts education. In 2023 IEEE 12th Global Conference on Consumer Electronics (GCCE) (pp. 473–474)

Srinivas, N. S., Vimalan, V., Padmanabhan, P., & Gulyás, B. (2021). An overview on cognitive function enhancement through physical exercises. Brain Sciences, 11(10), 1289. https://doi.org/10.3390/brainsci11101289

Tanimoto, M., Kawano, H., Gando, Y., Sanada, K., Yamamoto, K., Ishii, N., Tabata, I., & Miyachi, M. (2009). Low-intensity resistance training with slow movement and tonic force generation increases basal limb blood flow. Clinical physiology and functional imaging, 29(2), 128-135. https://doi.org/10.1111/j.1475-097X.2008.00847.x

Tsai, C. L., Huang, K. S., & Chang, S. S. (2005). Biomechanical analysis of EMG activity between badminton smash and drop shot. In Proceedings of the International Society of Biomechanics (ISB) Congress, Ohio.

Van Dieën, J. H., Van Leeuwen, M., & Faber, G. S. (2015). Learning to balance on one leg: motor strategy and sensory weighting. Journal of neurophysiology, 114(5), 2967-2982. https://doi.org/10.1152/jn.00434.2015

Yan, J. H., Thomas, J. R., Stelmach, G. E., & Thomas, K. T. (2000). Developmental features of rapid aiming arm movements across the lifespan. Journal of motor behavior, 32(2), 121-140. https://doi.org/10.1080/00222890009601365

Yongtawee, A., Park, J., Kim, Y., & Woo, M. (2022). Athletes have different dominant cognitive functions depending on type of sport. International Journal of Sport and Exercise Psychology, 20(1), 1-15. https://doi.org/10.1080/1612197X.2021.1956570

Zuwayr, R. M., & Malih, F. A. (2024). The effect of purposeful three-dimensional training on developing some motor abilities and skill performance among female fencing players. Retos, 61, 8–20. https://doi.org/10.47197/retos.v61.109386

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