湖南大学学报（自然科学版）
Journal of Hunan University (Natural Sciences)

第 50 卷 第 2 期
2023 年 2 月

Available online at http://jonuns.com/index.php/journal/index

Vol. 50 No. 2
February 2023

https://doi.org/10.55463/issn.1674-2974.50.2.12

The Effect of Caffeine Intake on the Reaction Level of Karate Players

Ahmed Harb Abu Zaida[1]*, Tariq Abdel-Wahhab Abu Al-Jedyan[2], Eyad Ali Abuselmiya[3]

[1] Associate Professor, Sports Training, Faculty of Education and Sports, Al-Aqsa University, Gaza, Palestine

[2] Assistant Professor, Sports Training, Faculty of Education and Sports, Al-Aqsa University, Gaza, Palestine

[3] Assistant Professor, Sports Health Sciences, Faculty of Education and Sports, Al-Aqsa University, Gaza, Palestine

* Corresponding author: ah.abuzayda@alaqsa.edu.ps

Received: December 17, 2022 ▪ Review: January 10, 2023 ▪ Accepted: February 2, 2023 ▪ Published: February 27, 2023

Abstract: Caffeine is the most prevalent in the last two decades, as it is used to improve cognitive and motor performance during training; it is an aid in generating energy for athletes. The reaction time is affected by hesitation and exaggerated waiting during the competition. This insufficiency is caused by the poor level of abilities of the players, as the reaction time is one of the indicators of success in karate. This study aimed to investigate the effects of caffeine on the level of reaction during specific karate combat class Kumite on the skills (Kisami Zuki, Gyaku Zuki, Mawashi-Geri, and Ura Mawashi Geri) and compare it with the placebo. The researchers followed the quasi-experimental approach, and the study was conducted on a sample consisting of eight Karate players of real combat class Kumite; the mean and standard deviations of the basic measurements of the sample are as follows: age: 19.75 + 2.12, height: 173.87 + 7.7, mass: 70.5 + 10.58, training age: 12.37 + 3.66. The amount of caffeine was determined as 6 mg/kg, and the procedures were carried out without the knowledge of the study sample by taking caffeine or placebo, where the players took placebo on the first day of the measurement, and caffeine on the second day. The results showed that there were statistically significant differences in the level of reaction in the skills under study between taking caffeine and placebo, where the percentage of improvement in the skill of Kisami Zuki (13.63%) in favor of caffeine intake, the improvement percentage for Gyaku Zuki skill was (10.63%) in favor of caffeine intake, the improvement percentage for Mawashi-Geri skill (12.76%) in favor of caffeine intake, and the improvement rate for Ura Mawashi Geri skill (13.72%) in favor of caffeine intake. In conclusion, there is a need to increase the interest of Karate officials in educating players and coaches about the importance of using nutritional supplements, especially caffeine, in the specified and permitted dosage to improve the reaction time during the Karate competitions.

Keywords: caffeine, reaction, kumite, karate.

摄入咖啡因对空手道选手反应水平的影响

摘要：咖啡因是过去二十年中最流行的，因为它被用来提高训练期间的认知和运动表现；它有助于为运动员产生能量。反应时间受到比赛中犹豫和夸张等待的影响。这种不足是由于球员的能力水平低下造成的，因为反应时间是空手道成功的指标之一。本研究旨在调查咖啡因对特定空手道格斗类组手（月喜佐美、倒像、圆形腹泻和反向腹泻）技能反应水平的影响，并将其与安慰剂进行比较。研究人员采用准实验方法，对由八名实战组手空手道选手组

成的样本进行了研究；样本基本测量值的均值和标准差如下：年龄：19.75±2.12，身高：173.87±7.7，体重：70.5±10.58，训练年龄：12.37±3.66。咖啡因的量被确定为 6 毫克/公斤，并且在研究样本不知情的情况下通过服用咖啡因或安慰剂进行了程序，球员在测量的第一天服用安慰剂，第二天服用咖啡因. 结果表明，服用咖啡因和安慰剂在所研究技能的反应水平上存在统计学显着差异，其中月喜佐美(13.63%)的技能改善百分比有利于咖啡因摄入，改善百分比倒像技能(10.63%)有利于咖啡因摄入，圆形腹泻技能提高率(12.76%)有利于咖啡因摄入，反向腹泻技能提高率(13.72%)有利于咖啡因摄入. 总之，有必要提高空手道官员的兴趣，让他们了解在规定和允许的剂量下使用营养补充剂（尤其是咖啡因）的重要性，以提高空手道比赛期间的反应时间。

关键词：咖啡因、反应、组手、空手道。

1. Introduction

Scoring is one of the most important goals of karate players, particularly kumite fighters. Therefore, players seek to develop their physical and motor abilities to reach the appropriate format to win competitions. Karate has become a fast sport that requires a high level of reaction. Karate was included in the Olympic Games in Tokyo (2020), which was a starting point for this competition to improve its course, whether at the level of the game or even at the level of the players. The Organizing Committee of the Los Angeles Olympics (2028) also noted the possibility of including karate in its participating games in this tournament.

KUMITE combat players need many instructions and directions during the competition, and this information is obtained by the player directly from the coach by following him visually, where he is directed to implement a certain movement group, punch, or kick, so the speed of reaction helps in the process of selecting the appropriate skills [29].

The reaction time represents the neuromuscular compatibility by analyzing the stimuli and sending them to the brain, the motor response is by sending nerve signals to the part to be moved [12].

Many particular situations require a quick and accurate reaction to the opponent's actions. The reaction depends on making an appropriate and perceptive decision by anticipating the opponent's performance [36].

Therefore, it is assumed that karate players seek to develop their reaction level in response to the level of the opponent's attack, as it is defined as the time elapsed between the appearance of the stimulus and the response [16].

Combat sports require more cognitive and proactive skills because these games have a different nature from team sports, where the distance between the two players is very short, and this requires a quick reaction to implement the movements [31].

Continuing training helps reduce the reaction time by developing the cognitive skills and sensory functions of karate players [9, 28, 36].

The authors believe that the level of reaction is affected during the competition, so it is preferable to compensate the body with certain alternatives and means that help the player continue performance without any reduction, such as energy drinks, specifically caffeine.

[24] state that energy drinks that contain many psychoactive ingredients such as taurine, glucoronolactone, and caffeine, increase focus, reaction speed, and improve the mood of the player, thus increase the level of motor perception.

This was confirmed by [14] where he reviewed more than 100 studies dealing with the use of caffeine, where he concluded that consuming moderate amounts of caffeine increases energy and reduces the feeling of fatigue and stress during physical activity. It accelerates reaction, accuracy, ability to focus, attention, enhances short-term memory, and improves the neuromuscular coordination.

Caffeine has a number of positive physiological factors associated with increased aerobic and anaerobic performance and is the most psychoactive drug in the world [10, 17].

Caffeine has been most prevalent in the last decade as it is used to improve cognitive and motor performance during training and has become an energy aid for recreational and competitive athletes [21]. It has been widely consumed by athletes to boost morale and generate energy since it was removed from the World Anti-Doping Agency (WADA) prohibited list [4, 27].

According to the International Medical Council of the Olympic Committee (IOC), caffeine is allowed in sports as long as its urine concentration is less than 12 mcg/ml [6].

1.1. Importance of This Study

The importance of the study lies in the fact that it is one of the few studies that dealt with the use of caffeine in karate, as many studies have shown the importance of using caffeine in sports to improve many abilities at certain doses. [25] confirm that the use of caffeine reduces the latency period and thus improves reaction time. The study of [23] showed significantly increased mental alertness after 50 min of caffeine intake and significant improvement in reaction time, accuracy of responses, ability to focus, and attention. Also, it's effect on short-term memory and the ability to solve difficult problems.

In the final report of the Military Food and Nutrition Board Committee, it was concluded that consumption of 150 mg of caffeine has a positive effect on all abilities of the individual, as the effect of caffeine can last for up to 10 h after caffeine intake [22].

[7] suggest that a dose of 200-400 mg of caffeine can enhance both alertness during multiple stimuli and show improvement in performance, accuracy, response speed, and reaction time.

Several studies have also determined the effect of caffeine on health variables and the ability to generate energy, in addition to the appropriate amount that improves the effectiveness of physical performance and reaction times and this amount is 1-6 mg/kg of body weight mass [26, 37].

Also, studies of [11, 19] indicated that athletes, who consume low-to-moderate doses of caffeine (3-9 mg/kg), are not accustomed to it or eat food with a low percentage of caffeine. They clearly have energy and have a significant impact on physical performance.

Advanced athletes, who are accustomed to consuming caffeine, require higher amounts of up to 11 mg/kg [38].

After this presentation, it shows us the importance of using caffeine in the sports field in general and karate in particular in appropriate doses, and researchers believe that the use of caffeine will develop and improve the performance of the players and their mental and motor abilities, and thus will reflect positively on the reaction time.

1.2. Problem Statement

Through the author's follow-up of the KUMITE fighting class of karate and careful observation, the researchers showed weakness and insufficiency of the KUMITE fighting players at the level of the types of attack, and the hesitation was clear among the players, and hesitation increases the time in performing the attack, as [36] confirms that the reaction time is affected by hesitation and exaggerated waiting during the competition, and thus the time becomes longer, and this insufficiency is caused by the poor level of abilities of the players, as the reaction time is an indicator of success in karate [9].

Therefore, the author believes that by using stimuli, the players will increase the level of their abilities, as caffeine is a stimulus that helps in this regard. [21] confirm that caffeine is the most prevalent in the last two decades, as it is used to improve cognitive and motor performance during training, it is an aid in generating energy for athletes.

Caffeine also reduces stress and mental fatigue during physical activity, enhances motor and cognitive performance, increases attention, speeds up the reaction, and accuracy of reactions, enhances short-term memory, increases the ability to solve problems, increases the ability to make the right decisions, enhances functional abilities and neuromuscular coordination [14].

Through reviewing the studies that dealt with the use of caffeine for karate players, the author found a scarcity of research that dealt with this topic, and therefore this study is considered one of the few studies that dealt with this topic, hence the importance of using caffeine to improve the level of reaction time for karate players.

1.3. Purpose of the Study

The study aimed to identify the effect of caffeine intake on the reaction level of KUMITE combat class karate players.

1.4. Hypotheses of the Study

- There is a statistically significant effect of caffeine on the reaction level of KUMITE combat class karate players.
- There is no statistically significant effect of placebo on the reaction level of KUMITE combat class karate players.
- There are statistically significant differences between caffeine and placebo intake on the reaction of KUMITE combat class karate players in favor of caffeine.

1.5. Definition of the Terms

- *Caffeine:* Caffeine is a plant compound found naturally in the diet [33].
- *Reaction:* The time that elapses between the appearance of the stimulus and the beginning of the performance [20].
- *Karate:* It is a competitive combat sport characterized by changing playing situations that appear through sudden circumstances, which requires the player to have multiple reactions using defense and attack techniques [1].
- *Actual combat (Kumite):* A fight in a specific time between equal players in class, weight, age group, and of the same type, each trying to thwart the other's attempts with the attack to score points, using the limbs (arms and legs) in the areas where the attack and shooting are authorized within the framework of the Karate Law [1].

1.6. Fields of the Study

- *The human domain:* The study was conducted on a sample of eight karate players in the kumite fighting category.
- *Temporal domain:* the study was conducted from 27/8/2022 to 31/8/2022.
- *Spatial domain:* Beit Lahia Youth Club, Palestinian Youth Institute, Gaza, Palestine.

2. Methods/Materials

The researchers used the quasi-experimental approach by designing one experimental group with a measurement test with placebo and caffeine intake, due to its suitability for the study.

2.1. Sampling Process and Sample Size

The study population included 18 karate players who were chosen in a deliberate way, including eight players for the exploratory study and eight players for the basic study.

2.1.1. Criteria for Selecting a Study Sample

- A certified player from the Palestinian Karate Federation;
- Having practiced karate for a period of no less than three years;
- Having a 1st Dan black belt.

Table 1. Homogeneity of the study sample

Basic Variables	Measuring unit	Mean	SD	Median	Skewness
Height	cm	173.87	7.71	173	0.11
Weight	kg	70.5	10.58	70.5	0
Age	Year	19.75	2.12	19	1.061
Training Age	Year	12.37	3.66	11	0.3068

It is clear from Table 1 that the values of the skewness coefficients give a direct indication that the study sample is free from defects in the non-equilibrium distributions, as the skew coefficient ranges in all variables between ±3, which indicates the homogeneity of the study sample in the variables under study.

2.2. Data Collection Procedure

A simple reaction-level measurement test and its validity and reliability were designed by the researchers.

We measured the level of reaction for the skills under study, Kisami Zuki, Gyaku Zuki, Mawashi-Geri, and Ura Mawashi Geri, and these skills are the most used skills in martial arts competitions in Kumite.

2.2.1. Simple Reaction Test

Light signals have been placed on the punching bag with a suitable height and a suitable view for both the player and camera. Masking tape was placed 1 meter from the punching bag to perform the skill. The player performs the skill after an assistant gives him a light signal.

2.2.2. Record

After analyzing the video of the skills under study, the simple reaction time is extracted and recorded, from the start of the appearance of the stimulus represented by the light signal until the end of the skill represented by touching the punching bag correctly. TROKER program analyzes the times of the skills under study and extracts the simple reaction time.

2.3. Study Devices

Stadiometer, medical scale, video camera, computer, light signals, adhesive tape, and battery.

2.4. Pilot Study

After the researchers completed the agreed upon administrative procedures and after making sure of the preparation and readiness of the place as well as the players, the researchers conducted a pilot study whose objective was to calculate the scientific coefficients of the variables under research "validity and reliability" and to ensure the safety of the tools used, which are:

The date of the survey: Saturday (27/8/2022).

Venue: The fight hall in the Beit Lahia Youth Club.

The size of the study sample: 8 players from outside the main study sample.

The study identified all the procedures that will be used during the shooting process, the camera specifications, dimensions, lights, assistants, the program (Tracker), which will analyze the times of each player in the skills used to identify the level of reaction time of the players.

Table 2. The discriminant validity of the skills (n = 2)

Skills	Unit	Discriminant		Indiscriminate		(t) value
		M	SD	M	SD	
Kisami Zuki	(S)	0.355	0.035	0.425	0.021	..2.5*
Gyaku Zuki	(S)	0.39	0	0.46	0.014	7.077*
Mawashi Geri	(S)	0.43	0.056	0.53	0.028	2.27*
Ura Mawashi Geri	(S)	0.485	0.035	0.55	0	2.63*

It is clear from Table 2 that there are statistically significant differences between the two discriminant and indiscriminate groups in the variables under study in favor of the discriminant group, which indicates the validity of the physical tests under research, as the value of (t) ranged between 2.27* as the lowest value and 7.077* as the largest value, and by comparing the calculated (t) values to the tabular value (t), it was found that it is significant, and this gives a direct indication of the validity of the variables under study.

Table 3. The stability coefficient of the skills under study between the first and second application

Skills	Unit	1st application		2nd application		(r) value
		M	SD	M	SD	
Kisami Zuki	(S)	0.39375	0.032486	0.36	0.032514	0.818259*
Gyaku Zuki	(S)	0.42625	0.029246	0.43125	0.032266	0.929136*
Mawashi Geri	(S)	0.4775	0.046214	0.47	0.036253	0.861206*
Ura Mawashi Geri	(S)	0.51875	0.029001	0.5225	0.024928	0.834866*

It is clear from Table 3 that there is a statistically significant correlation at the level of significance (0.05) between the first and second applications of the skills under study and that the values of the correlation coefficient (stability) ranged between 0.818259* as the lowest value and 0.929136 as the largest value. By comparing the values of (r), the computed and tabular ones were found to be significant, and this gives a direct indication of the stability of the variables under discussion.

2.5. Study Application Protocol

1. Emphasis on the implementation and application of the study in two days, such as training days, so that the players take the placebo on the first day, on Monday (29/8/2022), and then take caffeine on the second day, Wednesday (31/8/2022), without knowing players are in this order to obtain accurate results.

2. Taking the written approval of the Palestinian Karate Federation to apply and implement the study on the players.

3. Determining the study sample and its number: 16 karate players, 8 players to conduct the basic study on them, and 8 players with a lower level to conduct the exploratory study on them.

4. Meeting the members of the study sample and informing them of the procedures for implementing the study, taking the basic data for them, informing them of the risks in consuming caffeine, informing them not to take any substances containing caffeine 48 h before conducting the study, and signing a consent form by the sample players the study.

5. Visiting the medical center for an electrocardiogram to identify any risks that may result from caffeine intake.

6. The implementation of the exploratory study on a sample outside the main sample of 8 players with a level lower than the level of the main sample, to extract the validity and reliability coefficients of the study variables.

7. The first day of the study was Monday (29/8/2022), the players were given the placebo 60 minutes before the start of the measurement process, then a 15-minute self-warm-up process was conducted, then the test was carried out to measure the level of the reaction by implementing Skills under study (Kisami Zuki, Gyaku Zuki, Mawashi-Geri, Ura Mawashi Geri).

8. The second day of the study was Wednesday (31/8/2022), the players were given 6 mg/kg of caffeine 60 min before the start of the measurement process, preceded by a warm-up period in the same conditions as the first day.

9. The video camera process was conducted for all the skills under study on the first and second days of the players to analyze the times of the skills under study to extract the simple reaction time of the players.

2.6. Study Variables

Independent variable: Caffeine.

Dependent variable: The reaction level of the karate players.

2.7. Statistical Analysis

Means, standard deviations, skewness coefficient, the correlation coefficient, and T-test were used.

3. Results and Discussion

Within the limits of the study sample, its objectives and hypotheses, and in light of the results that were reached, it is clear from Table 4 regarding the differences in the reaction level of the karate players, the Kumite fighting class, using the placebo and caffeine for the skills under study (Kisami Zuki, Gyaku Zuki, Mawashi-Geri, Ura Mawashi Geri), there were significant statistically significant differences between the first measurement as a result of taking placebo and the second measurement as a result of caffeine intake with a size of 6 mg/kg, where the value (t) calculated for the skill of Kisami Zuki was 3.375* with an improvement rate in favor of the effect of caffeine intake (13.63%), and the calculated (t) value for the skill of Gyaku Zuki was 3.387* with an improvement in favor of the effect of caffeine intake (10.63%), and the calculated (t) value for the skill of Mawashi-Geri (4.842*) with an improvement in favor of the effect of caffeine intake (12.76%), and the calculated (T) value for the skill of Ura Mawashi Geri (7.446*) came with an improvement in favor of the effect of caffeine intake (13.72%).

Table 4. The differences in the reaction level of the karate players

Skills	Unit	Placebo		Caffeine		Improvement	(t) value
		M	SD	M	SD	Rate %	
Kisami Zuki	(S)	0.393	0.032	0.326	0.047	13.63	3.375*
Gyaku Zuki	(S)	0.426	0.029	0.353	0.053	10.63	3.387*
Mawashi Geri	(S)	0.477	0.046	0.385	0.028	12.76	4.842*

Continuation of Table 4							
Ura Mawashi Geri	(S)	0.518	0.029	0.413	0.027	13.72	7.446*

Through these results, researchers indicate that caffeine intake plays a major role in increasing the players' concentration during performance and thus improving the level of reaction and results, whether at the level of training or even at the level of competition, and this is consistent with the results of the study [26], which indicates that caffeine intake had a clear effect on the aerobic capacity of male and female athletes,and an increase in the percentage of men in muscle strength tests despite giving them the same amount.

The researchers also believe that the differences were significant because the players are not accustomed to caffeine intake, which led to a clear increase in the differences and the rate of improvement, and this is consistent with the study [11, 19] that athletes who take low-to-moderate caffeine doses (3-9 mg/kg) and who are not accustomed to it or take it in a low manner increases their energy percentage clearly and has a significant impact on physical performance.

The results of this study also agree with the results of study [2, 4], where the results showed that caffeine intake in a dose of 5 mg/kg improves performance and anaerobic abilities more than a dose of 2 mg/kg.

The results of the current study also agreed with the results of the study [2] on stronger effect of a dose of 5 mg/kg than 2 mg/kg on the level of motor performance of female athletes.

The results of the current study showed an improvement rate in the level of punching skills (Kisami Zuki, Gyaku Zuki) relatively more than kicking skills (Mawashi-Geri - Ura Mawashi Geri), where researchers attribute this increase in the improvement rate in the level of punching skills to two reasons, the first reason is that Punching skills are closer and faster to reach the goal, and kicking skills with the foot take a longer preparation and execution period, and the second reason is that the level of kicking skills of the players in the study sample basically suffers from weak performance, and this is consistent with the results of the study [18] where the analysis result was 10. The studies have concluded that caffeine-induced increases in maximal strength were limited to the upper body.

The results of the current study also agreed with the results of the study [13] that caffeine increases the speed and accuracy of passing in football, the study of [34] that caffeine improves coordination, speed, and accuracy during the protocol for measuring rugby skills, a study [32], where caffeine intake enhanced performance during sprints, and the study [15] showing a clear effect on sprints, where it was less time when caffeine was consumed compared to a placebo.

The results of this study differ with the results of the studies of [3, 5], where no effect of caffeine was found when examining the same test (leg pressure) at a dose of 6 mg/kg on trained players. In addition, the study [8] indicates that a dose of 6 mg/kg of caffeine has little effect on the maximum strength during the jumping performance of female university players. In the study [35], the performance in simulated matches was not affected by caffeine intake, which enhances anaerobic ability with a little improvement in the cognitive functions of taekwondo players in Hong Kong. In the study [30], caffeine did not lead to any change in the parameters of fighting intensity between the first and second fights, but the intensity of the fighting decreased after placebo; in conclusion, caffeine reduces reaction time in non-stressful situations and delays fatigue during back-to-back taekwondo fights.

4. Conclusion

Considering the objectives and hypotheses of the research, the sample and its characteristics, the method used, and through the analysis of the data, the following conclusions were reached:

Caffeine intake had a positive impact on the level of reaction of the Kumite combat players in karate in the skills under study, where the results showed:

1. Improvement of the Kisami Zuki skill in favor of caffeine intake.
2. Improvement in the Gyaku Zuki skill in favor of caffeine intake.
3. Improvement in the Mawashi-Geri skill in favor of caffeine intake.
4. Improvement in the Ura Mawashi Geri skill in favor of caffeine intake.
5. Differences in the percentage of improvement between punching (Kisami Zuki and Gyaku Zuki) and kicking skills (Mawashi-Geri - Ura Mawashi Geri) in favor of punching skills.

4.1. Recommendations

1. The researchers recommend that karate officials increase awareness about educating players and coaches on the importance of using nutritional supplements, especially caffeine, in the specified and permitted proportions.
2. Interest in doing future studies on the effect of caffeine on the different individual games.
3. Increasing interest in different types of nutritional supplements that improve special abilities.
4. Clarifying the correct proportions that players should take to prevent health damage.

References

[1] ABU ZAYDA A. and ABU AL-JEDYAN T. Achievement index in the kumite competition in karate (analytical study). *The Scientific Journal of Physical Education and Sports Sciences,* 2020, 38(1): 183-201. https://doi.org/10.21608/ejsk.2020.154298

[2] ARAZI H., HOSEINIHAJI M., and EGHBALI E. The effects of different doses of caffeine on performance, rating of perceived exertion and pain perception in teenagers female karate athletes. *Brazilian Journal of Pharmaceutical Sciences*, 2016, 52(4): 685–692. https://doi.org/10.1590/s1984-82502016000400012

[3] ASTORINO T. A., ROHMANN R. L., and FIRTH K. Effect of caffeine ingestion on one-repetition maximum muscular strength. *European Journal of Applied Physiology*, 2008, 102(2): 127–132. https://doi.org/10.1007/s00421-007-0557-x

[4] BACKHOUSE S. H., BIDDLE S. J., BISHOP N. C., and WILLIAMS C. Caffeine ingestion, affect and perceived exertion during prolonged cycling. *Appetite*, 2011, 57(1): 247-252. https://doi.org/10.1016/j.appet.2011.05.304

[5] BECK T. W., HOUSH T. J., SCHMIDT R. J., JOHNSON, G. O., HOUSH D. J., COBURN J. W., and MALEK M. H. The acute effects of a caffeine-containing supplement on strength, muscular endurance, and anaerobic capabilities. *Journal of Strength and Conditioning Research*, 2011, 20(3): 506-510. https://doi.org/10.1519/00124278-200608000-00008

[6] BELL D. G., JACOBS I., and ELLERINGTON K. Effect of caffeine and ephedrine ingestion on anaerobic exercise performance. *Medicine and Science in Sports and Exercise*, 2001, 33(8): 1399-1403. https://doi.org/10.1097/00005768-200108000-00024

[7] BRUNYÉ T. T., MAHONEY C. R., LIEBERMAN H. R., GILES G. E., and TAYLOR H. A. Acute Caffeine Consumption Enhances the Executive Control of Visual Attention in Habitual Consumers. *Brain and Cognition*, 2010, 74: 186-192. https://doi.org/10.1016/j.bandc.2010.07.006

[8] BURKE B. I., TRAVIS S. K., GENTLES J. A., SATO K., LANG H. M., and BAZYLER C. D. The Effects of Caffeine on Jumping Performance and Maximal Strength in Female Collegiate Athletes. *Nutrients*, 2021, 13(8): 2496. https://doi.org/10.3390/nu13082496

[9] CHAABÈNE H., HACHANA Y., FRANCHINI E., MKAOUER B., and CHAMARI K. Physical and physiological profile of elite karate athletes. *Sports Medicine*, 2012, 42(10): 829-843. https://doi.org/10.1007/BF03262297

[10] DAVIS J. and GREEN J. Caffeine and Anaerobic Performance Ergogenic Value and Mechanisms of Action. *Sports Medicine*, 2009, 39(10): 813-832. https://doi.org/10.2165/11317770-000000000-00000

[11] DEL COSO J., SALINERO J. J., GONZÁLEZ-MILLÁN C., ABIÁN-VICÉN J., and PÉREZ-GONZÁLEZ B. Dose response effects of a caffeine-containing energy drink on muscle performance: A repeated measures design. *Journal of the International Society of Sports Nutrition*, 2012, 9(1): 21. https://doi.org/10.1186/1550-2783-9-21

[12] DER G. and DEARY I. J. Age and sex differences in reaction time in adulthood: Results from the United Kingdom health and lifestyle survey. *Psychology and Aging*, 2006, 21(1): 62-73. https://doi.org/10.1037/0882-7974.21.1.62

[13] FOSKETT A., ALI A., and GANT N. Caffeine enhances cognitive function and skill performance during simulated soccer activity. *International Journal of Sport Nutrition and Exercise Metabolism*, 2009, 19(4): 410-423. https://doi.org/10.1123/ijsnem.19.4.410

[14] GLADE M. J. Caffeine - Not just a stimulant. *Nutrition*, 2010, 26(10): 932-938. https://doi.org/10.1016/j.nut.2010.08.004

[15] GLAISTER M., MUNIZ-PUMARES D., PATTERSON S. D., FOLEY P., and MCINNES G. Caffeine supplementation and peak anaerobic power output. *European Journal of Sport Science*, 2015, 15(5): 400-406. https://doi.org/10.1080/17461391.2014.962619

[16] GODINHO M., MENDES R., MELO F., and BARREIROS J. Instrução e demonstração. In: *Controlo motor e aprendizagem: fundamentos e aplicações.* FMH edições, Cruz Quebrada, 2002: 151-162.

[17] GREER F., MCLEAN C., and GRAHAM T. Caffeine, performance, and metabolism during repeated Wingate exercise tests. *Journal of Applied Physiology*, 1998, 85(4): 1502-1508. https://doi.org/10.1152/jappl.1998.85.4.1502

[18] GRGIC J., TREXLER E., LAZINICA B., and PEDISIC Z. Effects of caffeine intake on muscle 406 strength and power: A systematic review and meta-analysis. *Journal of the International Society of Sports Nutrition*, 2018, 15: 11. https://doi.org/10.1186/s12970-018-0216-0

[19] GRGIC J., MIKULIC P., SCHOENFELD B. J., BISHOP D. J., and PEDISIC Z. The Influence of Caffeine Supplementation on Resistance Exercise: A Review. *Sports Medicine*, 2019, 49(1): 17-30. https://doi.org/10.1007/s40279-018-0997-y

[20] HEIRANI A., VAZINI TAHER A., SOORI Z., and RAHMANI M. Relationship between choice reaction time and expertise in team and individual sports: A gender differences approach. *Australian Journal of Basic and Applied Sciences*, 2012, 6(8): 344-348. https://www.cabdirect.org/cabdirect/abstract/20133032554

[21] HENDRIX C. R., HOUSH T. J., MIELKE M., ZUNIGA J. M., CAMIC C. L., JOHNSON G. O., and HOUSH D. J. Acute effects of a caffeine-containing supplement on bench press and leg extension strength and time to exhaustion during cycle ergometry. *Journal of Strength and Conditioning Research*, 2010, 24(3): 859-865. https://doi.org/10.1519/JSC.0b013e3181ae7976

[22] INSTITUTE OF MEDICINE (US) COMMITTEE ON MILITARY NUTRITION RESEARCH. *Caffeine for the Sustainment of Mental Task Performance: Formulations for Military Operations*. National Academies Press (US), Washington, District of Columbia, 2001. https://doi.org/10.17226/10219

[23] KENNEDY M. D., GALLOWAY A. V., DICKAU L. J., and HUDSON M. K. The cumulative effect of coffee and a mental stress task on heart rate, blood pressure, and mental alertness is similar in caffeine-naïve and caffeine-habituated females. *Nutrition Research*, 2008, 28(9): 609-614. https://doi.org/10.1016/j.nutres.2008.06.003

[24] MALINAUSKAS B. M., AEBY V. G., OVERTON R. F., CARPENTER-AEBY T., and BARBER-HEIDAL K. A survey of energy drink consumption patterns among college students. *Nutrition Journal*, 2007, 6: 35. https://doi.org/10.1186/1475-2891-6-35

[25] MARTIN F. H. and GARFIELD J. Combined effects of alcohol and caffeine on the late components of the event-related potential and on reaction time. *Biological Psychology*, 2006, 71(1): 63-73. https://doi.org/10.1016/j.biopsycho.2005.01.004

[26] MIELGO-AYUSO J., CALLEJA-GONZALEZ J., DEL COSO J., URDAMPILLETA A., LEÓN-GUEREÑO P., and FERNÁNDEZ-LÁZARO D. Caffeine Supplementation and Physical Performance, Muscle Damage and Perception of Fatigue in Soccer Players: A Systematic

Review. *Nutrients,* 2019, 11(2): 440. https://doi.org/10.3390/nu11020440
[27] MOHR M., NIELSEN J. J., and BANGSBO J. Caffeine intake improves intense intermittent exercise performance and reduces muscle interstitial potassium accumulation. *Journal of Applied Physiology,* 2011, 111(5): 1372-1379. https://doi.org/10.1152/japplphysiol.01028.2010
[28] MORI S., OHTANI Y., and IMANAKA K. Reaction times and anticipatory skills of karate athletes. *Human Movement Sciences,* 2002, 21(2): 213-230. https://doi.org/10.1016/s0167-9457(02)00103-3
[29] NEWELL K. M. and MCGINNIS P. M. Kinematic information feedback for skilled performance. *Human Learning,* 1985, 4: 39-56.
[30] SANTOS V. G., SANTOS V. R., FELIPPE L. J., ALMEIDA JR. J. W., BERTUZZI R., KISS M. A., and LIMA-SILVA A. E. Caffeine reduces reaction time and improves performance in simulated-contest of taekwondo. *Nutrients,* 2014, 6(2): 637-649. https://doi.org/10.3390/nu6020637
[31] SCHMIDT R. A. and LEE T. *Motor Control and Learning: A Behavioral Emphasis.* Human Kinetics, Champaign, Illinois, 2011.
[32] SCHNEIKER K. T., BISHOP D., DAWSON B., and HACKETT L. P. Effects of caffeine on prolonged intermittent-sprint ability in team-sport athletes. *Medicine & Science in Sports & Exercise,* 2006, 38(3): 578-585. https://doi.org/10.1249/01.mss.0000188449.18968.62
[33] SOKMEN B., ARMSTRONG L. E., KRAEMER W. J., CASA D. J., DIAS J. C., JUDELSON D. A., and MARESH C. M. Caffeine use in sports: considerations for the athlete. *Journal of Strength and Conditioning Research,* 2008, 22(3): 978-986. https://doi.org/10.1519/JSC.0b013e3181660cec
[34] STUART G. R., HOPKINS W. G., COOK C., and CAIRNS S. P. Multiple effects of caffeine on simulated high-intensity team-sport performance. *Medicine & Science in Sports & Exercise,* 2005, 37(11): 1998-2005. https://doi.org/10.1249/01.mss.0000177216.21847.8a
[35] SUN F., SIU A. Y.-S., WANG K., ZHANG B., CHAN M.-H., CHAN K.-H., KONG P.-S., MAN K.-Y., and CHOW G. C.-C. Effects of Caffeine on Performances of Simulated Match, Wingate Anaerobic Test, and Cognitive Function Test of Elite Taekwondo Athletes in Hong Kong. *Nutrients,* 2022, 14(16): 3398. https://doi.org/10.3390/nu14163398
[36] VENCES DE BRITO A. and CILVA C. Reaction Time in Karate Athletes, IDO-Movement for Culture. *Journal of Martial Arts Anthropology,* 2011, 11(4): 35–39.
[37] VENIER S., GRGIC J., and MIKULIC P. Caffeinated Gel Ingestion Enhances Jump Performance, Muscle Strength, and Power in Trained Men. *Nutrients,* 2019, 11(4): 937. https://doi.org/10.3390/nu11040937
[38] WILK M., FILIP A., KRZYSZTOFIK M., MASZCZYK A., and ZAJAC A. The Acute Effect of Various Doses of Caffeine on Power Output and Velocity during the Bench Press Exercise among Athletes Habitually Using Caffeine. *Nutrients,* 2019, 11(7): 1465. https://doi.org/10.3390/nu11071465

参考文:

[1] ABU ZAYDA A. 和 ABU AL-JEDYAN T. 空手道组手比赛成绩指数（分析研究）。体育与运动科学杂志，2020, 38(1): 183-201. https://doi.org/10.21608/ejsk.2020.154298
[2] ARAZI H.、HOSEINIHAJI M. 和 EGHBALI E. 不同剂量的咖啡因对青少年女性空手道运动员的表现、感知用力等级和疼痛感知的影响。巴西药学杂志，2016 年，52(4)：685–692。https://doi.org/10.1590/s1984-82502016000400012
[3] ASTORINO T. A.、ROHMANN R. L. 和 FIRTH K. 摄入咖啡因对一次重复最大肌肉力量的影响。欧洲应用生理学杂志，2008 年，102(2)：127–132。https://doi.org/10.1007/s00421-007-0557-x
[4] BACKHOUSE S.H.、BIDDLE S.J.、BISHOP N.C. 和 WILLIAMS C. 咖啡因摄入、长时间骑行期间的影响和感知用力。食欲，2011 年，57(1)：247-252。https://doi.org/10.1016/j.appet.2011.05.304
[5] BECK T.W.、HOUSH T.J.、SCHMIDT R.J.、JOHNSON、G.O.、HOUSH D.J.、COBURN J.W. 和 MALEK M.H. 含咖啡因补充剂对力量、肌肉耐力和无氧能力的急性影响。力量与体能研究杂志，2011 年，20(3)：506-510。https://doi.org/10.1519/00124278-200608000-00008
[6] BELL D. G.、JACOBS I. 和 ELLERINGTON K. 摄入咖啡因和麻黄碱对无氧运动表现的影响。运动与锻炼中的医学与科学，2001，33(8)：1399-1403。https://doi.org/10.1097/00005768-200108000-00024
[7] BRUNYÉ T. T.、MAHONEY C. R.、LIEBERMAN H. R.、GILES G. E. 和 TAYLOR H. A. 急性咖啡因摄入增强了习惯性消费者对视觉注意力的执行控制。大脑与认知，2010，74：186-192。https://doi.org/10.1016/j.bandc.2010.07.006
[8] BURKE B.I.、TRAVIS S.K.、GENTLES J.A.、SATO K.、LANG H.M. 和 BAZYLER C.D. 咖啡因对女大学生运动员跳跃表现和最大力量的影响。营养素，2021 年，13(8)：2496。https://doi.org/10.3390/nu13082496
[9] CHAABÈNE H.、HACHANA Y.、FRANCHINI E.、MKAOUER B. 和 CHAMARI K. 精英空手道运动员的身体和生理概况。运动医学，2012, 42(10): 829-843. https://doi.org/10.1007/BF03262297
[10] DAVIS J. 和 GREEN J. 咖啡因和厌氧性能增效价值和作用机制。运动医学，2009, 39(10): 813-832. https://doi.org/10.2165/11317770-000000000-00000
[11] DEL COSO J.、SALINERO J. J.、GONZÁLEZ-MILLÁN C.、ABIÁN-VICÉN J. 和 PÉREZ-GONZÁLEZ B. 含咖啡因能量饮料对肌肉表现的剂量反应效应：重复测量设计。国际运动营养学会杂志，2012 年，9(1)：21。https://doi.org/10.1186/1550-2783-9-21
[12] DER G. 和 DEARY I. J. 成年期反应时间的年龄和性别差异：英国健康和生活方式调查的结果。心理与衰老，2006, 21(1): 62-73. https://doi.org/10.1037/0882-7974.21.1.62
[13] FOSKETT A.、ALI A. 和 GANT N. 咖啡因可增强模拟足球活动中的认知功能和技能表现。国际运动营养与运动代谢杂志，2009，19(4)：410-423。https://doi.org/10.1123/ijsnem.19.4.410

[14] GLADE M. J. 咖啡因 - 不仅仅是兴奋剂。营养学，2010 年，26(10)：932-938。https://doi.org/10.1016/j.nut.2010.08.004
[15] GLAISTER M.、MUNIZ-PUMARES D.、PATTERSON S. D.、FOLEY P. 和 MCINNES G. 补充咖啡因和峰值无氧功率输出。欧洲运动科学杂志，2015 年，15(5)：400-406。https://doi.org/10.1080/17461391.2014.962619
[16] GODINHO M.、MENDES R.、MELO F. 和 BARREIROS J. 指导和演示。在：电机控制与学习：基础与应用。FMH 版，断十字，2002：151-162。
[17] GREER F.、MCLEAN C. 和 GRAHAM T. 重复温盖特运动测试期间的咖啡因、性能和新陈代谢。应用生理学杂志，1998，85（4）：1502-1508。https://doi.org/10.1152/jappl.1998.85.4.1502
[18] GRGIC J.、TREXLER E.、LAZINICA B. 和 PEDISIC Z. 摄入咖啡因对肌肉 406 强度和爆发力的影响：系统回顾和荟萃分析。国际运动营养学会杂志，2018 年，15：11。https://doi.org/10.1186/s12970-018-0216-0
[19] GRGIC J.、MIKULIC P.、SCHOENFELD B. J.、BISHOP D. J. 和 PEDISIC Z. 补充咖啡因对抵抗运动的影响：综述。运动医学，2019，49(1)：17-30. https://doi.org/10.1007/s40279-018-0997-y
[20] HEIRANI A.、VAZINI TAHER A.、SOORI Z. 和 RAHMANI M. 选择反应时间与团队和个人运动专业知识之间的关系：性别差异方法。澳大利亚基础与应用科学杂志，2012 年，6(8)：344-348。https://www.cabdirect.org/cabdirect/abstract/20133032554
[21] HENDRIX C. R.、HOUSH T. J.、MIELKE M.、ZUNIGA J. M.、CAMIC C. L.、JOHNSON G. O. 和 HOUSH D. J. 含咖啡因的补充剂对卧推和腿部伸展强度的急性影响以及循环测力期间的疲劳时间。力量与体能研究杂志，2010 年，24(3)：859-865。https://doi.org/10.1519/JSC.0b013e3181ae7976
[22] 医学研究所（美国）军事营养研究委员会。用于维持心理任务性能的咖啡因：军事行动的配方。国家科学院出版社（美国），华盛顿，哥伦比亚特区，2001 年。https://doi.org/10.17226/10219
[23] KENNEDY M. D.、GALLOWAY A. V.、DICKAU L. J. 和 HUDSON M. K. 咖啡和精神压力任务对心率、血压和精神警觉性的累积影响在未接触咖啡因和习惯咖啡因的女性中相似。营养研究，2008，28(9)：609-614. https://doi.org/10.1016/j.nutres.2008.06.003
[24] MALINAUSKAS B.M.、AEBY V.G.、OVERTON R.F.、CARPENTER-AEBY T. 和 BARBER-HEIDAL K. 大学生能量饮料消费模式调查。营养杂志，2007 年，6：35。https://doi.org/10.1186/1475-2891-6-35
[25] MARTIN F. H. 和 GARFIELD J. 酒精和咖啡因对事件相关电位的晚期成分和反应时间的综合影响。生物心理学，2006，71(1)：63-73. https://doi.org/10.1016/j.biopsycho.2005.01.004
[26] MIELGO-AYUSO J.、CALLEJA-GONZALEZ J.、DEL COSO J.、URDAMPILLETA A.、LEÓN-GUEREÑO P. 和 FERNÁNDEZ-LÁZARO D. 咖啡因补充和身体表现、肌肉损伤和足球疲劳感 玩家：系统回顾。营养素，2019 年，11(2)：440。https://doi.org/10.3390/nu11020440
[27] MOHR M.、NIELSEN J. J. 和 BANGSBO J. 摄入咖啡因可改善强烈的间歇性运动表现并减少肌肉间质钾的积累。应用生理学杂志，2011，111(5)：1372-1379. https://doi.org/10.1152/japplphysiol.01028.2010
[28] MORI S.、OHTANI Y. 和 IMANAKA K. 空手道运动员的反应时间和预期技能。人体运动科学，2002 年，21(2)：213-230。https://doi.org/10.1016/s0167-9457(02)00103-3
[29] NEWELL K. M. 和 MCGINNIS P. M. 技能表现的运动学信息反馈。人类学习，1985，4：39-56。
[30] SANTOS V.G.、SANTOS V.R.、FELIPPE L.J.、ALMEIDA JR。J. W.、BERTUZZI R.、KISS M. A. 和 LIMA-SILVA A. E. 咖啡因可减少反应时间并提高跆拳道模拟比赛中的表现。营养素，2014 年，6(2)：637-649。https://doi.org/10.3390/nu6020637
[31] SCHMIDT R. A. 和 LEE T. 电机控制和学习：行为重点。人体动力学，伊利诺伊州香槟市，2011 年。
[32] SCHNEIKER K. T.、BISHOP D.、DAWSON B. 和 HACKETT L. P. 咖啡因对团队运动运动员长时间间歇冲刺能力的影响。运动与锻炼中的医学与科学，2006 年，38(3)：578-585。https://doi.org/10.1249/01.mss.0000188449.18968.62
[33] SOKMEN B.、ARMSTRONG L. E.、KRAEMER W. J.、CASA D. J.、DIAS J. C.、JUDELSON D. A. 和 MARESH C. M. 咖啡因在运动中的使用：运动员的注意事项。力量与体能研究杂志，2008 年，22(3)：978-986。https://doi.org/10.1519/JSC.0b013e3181660cec
[34] STUART G. R.、HOPKINS W. G.、COOK C. 和 CAIRNS S. P. 咖啡因对模拟高强度团队运动表现的多重影响。运动与锻炼中的医学与科学，2005，37(11)：1998-2005。https://doi.org/10.1249/01.mss.0000177216.21847.8a
[35] SUN F., SIU A. Y.-S., WANG K., ZHANG B., CHAN M.-H., CHAN K.-H., KONG P.-S., MAN K.-Y., 和 周 G. C.-C. 咖啡因对香港精英跆拳道运动员模拟比赛、温盖特无氧测试和认知功能测试成绩的影响。营养素，2022 年，14(16)：3398。https://doi.org/10.3390/nu14163398
[36] VENCES DE BRITO A. 和 CILVA C. 空手道运动员的反应时间，我愿意文化运动。武术人类学杂志，2011，11(4)：35–39.
[37] VENIER S.、GRGIC J. 和 MIKULIC P. 摄入含咖啡因的凝胶可增强受过训练的男性的跳跃表现、肌肉力量和爆发力。营养素，2019 年，11(4)：937。https://doi.org/10.3390/nu11040937
[38] WILK M.、FILIP A.、KRZYSZTOFIK M.、MASZCZYK A. 和 ZAJAC A. 不同剂量的咖啡因对习惯性使用咖啡因的运动员在卧推练习中的功率输出和速度的急性影响。营养素，2019，11(7)：1465. https://doi.org/10.3390/nu11071465