



RELATIONSHIP BETWEEN ANAEROBIC
CAPACITY AND AVERAGE POWER
OUTPUT IN TAEKWONDO ATHLETES

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Annotation

Introduction. Taekwondo, as an Olympic sport, has evolved over the years with numerous changes to the rules of competition, which has led to the study of some of the variables involved in athletes. **The purpose of the study** is to determine the correlation relationship between the indices of anaerobic performance in taekwondo athletes of both sexes 17-21 years old. **Research objectives:** to analyze the state of scientific and methodological literature on the research topic; to reveal the role of anaerobic working capacity of athletes of both sexes and to determine its influence on the effectiveness of competitive activity; to develop methodological approaches to increasing anaerobic performance in training athletes (men and women) in taekwondo. **Material and methods.** To solve these problems in our study, the method of correlation analysis was used, where the number of subjects was 415 taekwondo fighters of all weight categories, both sexes, with a random sample of subjects. Variables assessed were derived from physical fitness scores using power output and aerobic performance (RAST) instruments. The **results** obtained were positive, at which the level of the correlation relationship was 0.989 for girls, 0.994 for men, which means that the variable indicators behaved linearly, allowing, due to the average output power, to improve anaerobic performance in both sexes.

Conclusion. Average power output interacts with anaerobic performance, which allows this variable to be used in terms of training efficiency, since it can be used for shorter periods of time than stimulation with aerobic performance. Our study is of a general nature and can serve as a representative and reference material for other studies in taekwondo.

Key words: anaerobic load, average power output, taekwondo.

Анотація

Вступ. Тхеквондо, як олімпійський вид спорту, еволюціонував протягом багатьох років з внесенням численних змін до правил змагань, що призвело до вивчення деяких змінних показників у спортсменів. **Мета дослідження** – визначити кореляційний взаємозв'язок між показниками анаеробної працездатності у тхеквондистів обох статей 17-21 років. **Завдання дослідження:** проаналізувати стан науково-методичної літератури з теми дослідження; виявити роль анаеробної працездатності спортсменів обох статей і визначити її вплив на ефективність змагальної діяльності; розробити методичні підходи до підвищення анаеробної працездатності при підготовці спортсменів (чоловіків і жінок) в тхеквондо. **Матеріал і методи.** Для вирішення цих завдань в нашому дослідженні, був використаний метод кореляційного аналізу, де кількість випробовуваних складало 415 тхеквондистів всіх вагових категорій, обох статей, з рандомною вибіркою випробовуваних. Оцінювані змінні були отримані за допомогою показників фізичної підготовленості з використанням

інструментів для визначення вихідної потужності і аеробного працездатності (RAST). Отримані **результати** були позитивними, при яких рівень кореляційної взаємозв'язку склав для дівчат 0,989, для чоловіків 0,994. Це свідчить, що змінні показники поведились лінійно, дозволяючи за рахунок середньої вихідної потужності поліпшити анаеробну працездатність у спортсменів обох статей.

Висновок. Середня вихідна потужність взаємодіє з анаеробною працездатністю, що дозволяє використовувати цю змінну, з точки зору ефективності тренувального процесу, оскільки її можна використовувати на більш коротких проміжках часу в порівнянні зі стимуляцією аеробної працездатності. Наше дослідження носить загальний характер і може служити репрезентативним і довідковим матеріалом для інших досліджень в тхеквондо.

Ключові слова: анаеробне навантаження, середня вихідна потужність, тхеквондо.

Анотація

Введение. Тхэквондо, как олимпийский вид спорта, в течение многих лет эволюционировал с многочисленными изменениями в правила соревнований, что привело к изучению некоторых переменных показателей у спортсменов. **Цель исследования** – определить корреляционную взаимосвязь между показателями анаэробной работоспособности у тхэквондистов 17-21 лет. **Задачи исследования:** проанализировать состояние научно-методической литературы по теме исследования; выявить значение анаэробной работоспособности у спортсменов обоих полов и определить ее влияние на эффективность соревновательной деятельности; разработать методические подходы к повышению анаэробной работоспособности при подготовке спортсменов (мужчин и женщин) в тхэквондо. **Материал и методы.** Для решения поставленных в нашем исследовании задач, был использован метод корреляционного анализа, где количество испытуемых составило 415 тхэквондистов всех весовых категорий, обоих полов, с рандомной выборкой испытуемых. Оцениваемые переменные были получены с помощью показателей физической подготовленности с использованием инструментов для определения исходной мощности и аэробной работоспособности (RAST). Полученные результаты были положительными, при которых уровень корреляционной взаимосвязи составил для девушек 0,989, для мужчин 0,994. Это означает, что переменные показатели вели себя линейно, позволяя за счет средней выходной мощности улучшить анаэробную работоспособность у обоих полов.

Вывод. Средняя выходная мощность взаимодействует с анаэробной работоспособностью, что позволяет использовать эту переменную, с точки зрения эффективности тренировочного процесса, поскольку ее можно использовать на более коротких промежутках времени по сравнению со стимуляцией аэробной работоспособности. Наше исследование носит общий характер и может служить репрезентативным и справочным материалом для других исследований в тхэквондо.

Ключевые слова: анаэробная нагрузка, средняя выходная мощность, тхэквондо.

Introduction. Taekwondo as a sports discipline has evolved over the years, undergoing many changes in rules and competitions since it was recognized as an Olympic sport; thus, he managed to awaken a greater interest in the study of indicators of the effectiveness of training athletes in taekwondo [13,20].

One of the most important variables that we can evaluate in sports competitions (kyorougi) is the execution of the fastest possible movements, that is, the speed of their movements when performing kicks and punches, as well as the speed of movements that require significant energy consumption [17, 22].

Therefore, sports results in tae-

kwondo should be constantly analyzed, since the physiological requirements for athletes are always the same, due to the fact that not all athletes react in the same way to different combat situations, taking into account age, gender, qualifications, etc. [5, 22].

One of the defining physiological variables in the performance of a competitive fight is anaerobic working capacity, which is defined as the maximum effort that can be maintained only for a few seconds; it is a very important physical quality for athletes in most high-intensity interval sports.

In view of the above, anaerobic ability in this discipline is expressed

through acceleration, displacement, single kicks and serial kicks, jumps and movements with a change in direction of movement [2, 14, 17]. In addition, in taekwondo competitions, athletes usually attack or counterattack intensively for a short period of time [17]. Similarly, during a fight, athletes carry out intense attacking actions with pauses, in accordance with the rules, from 1 to 5 seconds, reaching a peak heart rate of 90% (HRmax), creating, as a result, high requirements for anaerobic metabolism [4, 5, 6, 7, 21], which corresponds to the high degradation of phosphagen and glucose as energy sources. These data are observed in competitions in which

athletes reach a maximum heart rate of 90% of their maximum heart rate, and the concentration of lactate in the blood, extracted on average, is 12.2 mmol • l-1, general values, considering the dynamics of the fight [3, 6, 16, 21].

In connection with the above, determining the model and physiological requirements of a taekwondo athlete is of great importance for improving and optimizing athletic performance. Many authors agree and consider speed (speed of reaction and movement) and strength (maximum strength and strength endurance) as irreplaceable properties, which are their main source of energy stability, phosphagens and the glycolytic pathway [1]. This indicates that taekwondo fighters require more power and anaerobic performance in the lower extremities, which can be critical during combat, promoting more vigorous performance in intermittent and high intensity activities [15]. Therefore, the timely determination of anaerobic performance through reliable and validated tests is essential for taekwondo practitioners when the goal is to improve athletic performance.

Several tests are used to assess the effectiveness of anaerobic performance, one of which is the

Run-Based Anaerobic Sprint test (RAST) for its English abbreviation; it is used to assess anaerobic performance. This test shows reliable results and no significant difference when confirmed with other more common and used tests such as the Wingate test [18, 23, 24]. It should also be pointed out that this test offers information on peak power, average power, minimum power and fatigue index of athletes [14]. However, as far as this study is concerned, it will mainly take into account the average power output.

In line with the above, several authors have shown that RAST is a powerful and reproducible procedure for assessing anaerobic strength. It is recognized as a good predictor of running results (35 to 400 meters) and can be easily added to your workouts [13, 24, 25, 26, 27, 28]. The aim of this study is to determine the correlation between anaerobic capacity and mean power output in taekwondo athletes as measured by the running anaerobic sprint test (RAST).

The purpose of the study is to determine the correlation relationship between the indices of anaerobic performance in taekwondo athletes of both sexes 17-21 years old. **Research objectives:** to analyze the state of scientific and method-

ological literature on the research topic; to reveal the role of anaerobic working capacity of athletes of both sexes and to determine its influence on the effectiveness of competitive activity; to develop methodological approaches to increasing anaerobic performance in training athletes (men and women) in taekwondo. **Material and methods.** A descriptive quantitative correlation study conducted among 415 taekwondo athletes of all weight categories, both genders, classified, belonging to different teams, between December 2018 and November 2019. This study included older taekwondo athletes of both sexes who signed information about their prior consent in front of their parents, their willingness to participate in this study. **Organization of the study.** To collect information, permission was officially obtained from each taekwondo athlete. After confirming this procedure, the objectives of the study were explained to all study participants. In addition, some socio-demographic data were taken, such as age, gender, and others.

Results. A running anaerobic sprint test (RAST) was used to measure anaerobic performance and average power. For its abbreviation in English, which is a test protocol designed to assess anaerobic ca-

Table 1

Average power output and anaerobic capacity of taekwondo athletes in the youth category of the two sexes

| Characteristics | Average Power Output (W) | Anaerobic Capacity (W) |
|-----------------|--------------------------|------------------------|
| Cat. Youth | | |
| Female gender | | |
| Average | 760,9 | 4428,76 |
| Median | 745,3 | 4334,3 |
| DE/RIC | 262,75 | 1556,65 |
| Male gender | | |
| Average | 1089,6 | 6320,08 |
| Median | 1115,2 | 6537,05 |
| DE/RIC | 462,53 | 2688,45 |

* Note: W = W, SD = standard deviation, IQR = interquartile range

Table 2

Correlation between average power and anaerobic capacity in the youth category of both sexes

| characteristic | Anaerobic Capacity Male gender | | Anaerobic Capacity Female gender | |
|-------------------------|-----------------------------------|---------|-------------------------------------|---------|
| | coefficient | Valor P | coefficient | Valor P |
| Average Power Output | 0.994 | 0.000 | 0,989 | 0.000 |

capacity using a repeat rate protocol [14]. Because of its accuracy and simplicity, RAST is commonly used by exercise professionals to monitor physical performance [14]. It is a robust and well-researched tool for measuring anaerobic strength in athletes [24, 25, 27]. RAST can determine two main metrics using a performance-based protocol: 1) anaerobic capacity and 2) anaerobic energy [10, 24].

Initially, the weight in kilograms of athletes was measured using a medical scale to determine body weight, the main data for calculating the RAST test. Subsequently, an appropriate warm-up was carried out, which corresponded to an intensity of 2 to 3 on the Borg Perceived Effort Scale. Subsequently, the RAST was applied to taekwondo athletes who completed six maximum sprints, adapted to a distance of 18 meters, with a 10 second cool down

between each sprint. The distance was determined and marked with two cones to distinguish between their boundaries, there were several experts who calculated the time of each sprint in order to confirm and avoid measurement errors, in addition, the expert recorded the time used to complete each of the speed sprints (estimate to hundredths of a second). Finally, after obtaining the necessary data, calculations were carried out, which are as follows:

Maximum Power Output (MPO):
The following formula was used to obtain this value: $\text{Body weight (kg)} * \text{Distance (mts)}^2 \div \text{Time (s)}^3$

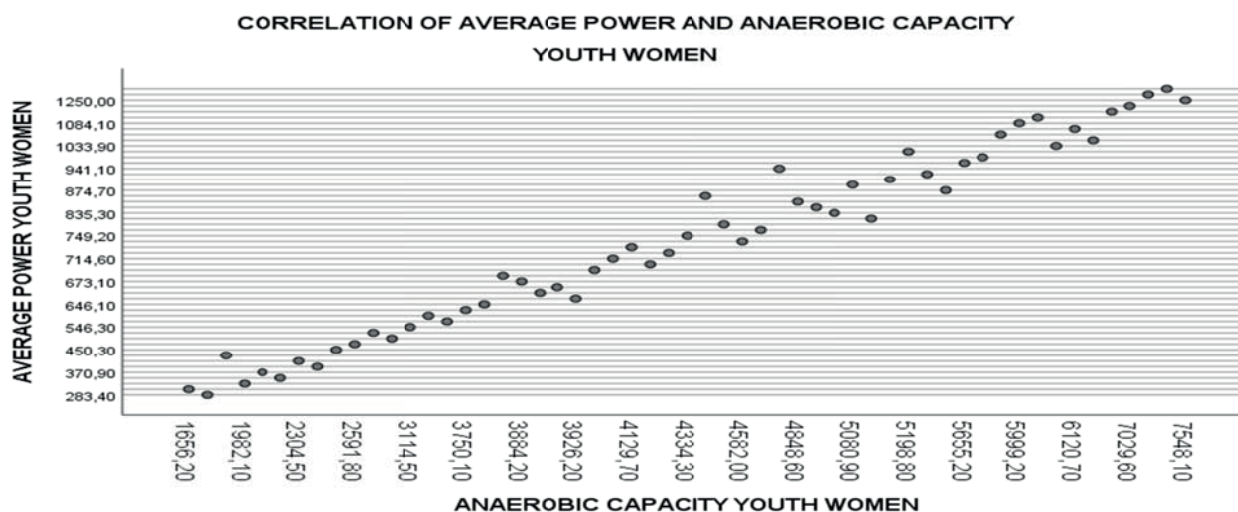
From the six sprint times and TDC, the following values can be calculated: maximum power output (maximum value) minimum power output (minimum value) average power output (the sum of six values \div 6); the latter on which this research will be based. The data ob-

tained is expressed in watts (W).

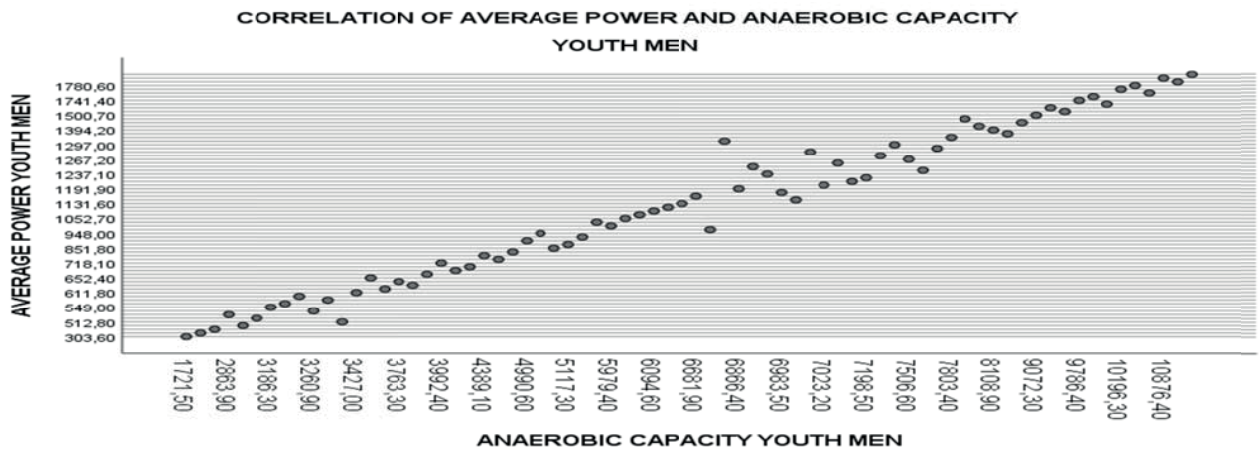
For the calculation of the anaerobic capacity, the total work performed during the test was used; those sum of the maximum output powers (Table 1.).

This study was conducted in accordance with the rights protected by the 2013 Declaration of Helsinki (Declaration of Helsinki and World Medical Association, 1975) [9]. In this sense, by signing informed consent, the participants were informed about the purpose of the study, the procedures to be followed, voluntary participation and the confidentiality of the information. Participants were identified by codes in the analyzed database.

For data analysis, all information was entered into Excel and then transferred to statistical software SPSS version 25. Normal continuous variables were expressed as mean and standard deviation (SD);



Graph 1. The relationship between average power and anaerobic capacity in the female category



Graph 2. Correlation between average power and anaerobic capacity in the male category

otherwise they were presented as statistical mean. For the variables anaerobic capacity and mean power output, Pearson's coefficient was used and a two-sided significance of $p \leq 0.05$ was found (Table 2.).

This graph allows us to observe the correlation between mean power and anaerobic performance variables in the database, remembering that correlation is a measure of the linear relationship between two quantitative variables. This scatter plot allows us to identify variables with a high correlation (close to 1), which indicates a linear relationship between the two variables. A strong correlation can be observed between the average power output and anaerobic capacity $p 0.989$ (Graph 1).

This graph allows us to observe the correlation between the mean power and anaerobic capacity variables in the database. This scatter plot allows us to identify variables with a high correlation (close to 1), which indicates a linear relationship between the two variables. A strong correlation can be observed between the average power output and anaerobic capacity $p 0.994 989$ (Graph 2).

Discussion. The aim of this study was to determine the correlation between anaerobic power and mean

power output in taekwondo athletes using the RAST test. The results obtained in this study show that there is a positive and directly proportional correlation between these two variables in both men and women. Therefore, higher average power is associated with the athlete's ability to maintain their strength over time, that is, with greater anaerobic performance [11].

In terms of mean power, the results obtained for both males $1089.6 (\pm 462.53)$ and females $760.9 (\pm 262.75)$ were higher compared to other studies [11, 18, 19, 20]. The results obtained in comparison with other studies can be explained by the fact that in this study a distance of 20 yards or 18.22 meters was occupied, which differs from other studies conducted by 35 meters; this intervention had to be adapted to the provisions that were envisaged in the assessment of athletes in taekwondo.

Anaerobic performance, as in other texts, called anaerobic power, is one of the abilities in terms of regulating the maximum need for taekwondo, because oppositions are very close to periodic, that is, almost without pauses or with a pause of maximum 5 seconds dur-

ing a fight. This forces us to justify this study by the fact that said power can be stimulated by average power output, this symbiosis between both variables apparently allows us to know that a variable maintained by a similar energy input and stimulation of similar fibers responds to dependence on similar substrates, which means that when you train one of them, the other is also immediately proportionally stimulated.

It is methodologically more effective to train the average power output, since the duration of this stimulus does not exceed 7 seconds.

Conclusion. Finally, taekwondo fighters require a solid base to withstand constant and intermittent spurts, eliminating a 5 second pause in the contraction, so providing a medium power stimulus becomes a very reliable and effective process for consistently stimulating anaerobic performance, which is more effective and the average power stimulation time is shorter which also increases oxygen consumption. In taekwondo athletes, VO_{2max} is moderate to high, however, some researchers argue that VO_{2max} does not determine success in competition, with a greater emphasis on technical and tactical aspects.

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