

Biomechanics and anthropometry in karate-do. current vision of applied sports sciences

Summary

The objective of the research was to analyze the physical, somatotypical and motor conditions of the karate fighters of the EIDE of Cienfuegos through anthropometric and biomechanical studies to increase performance and prevent injuries in the years 2021 and 2022. The primary source of information was the base of data available in the Department of Kinanthropometry of the Institute of Sports Medicine of Cienfuegos. The results show that there is a need to delve into Anthropometry and sciences applied to sports, particularly those linked to Sports biomechanics. However, the publications referring to Martial Arts, particularly Karate-do, are still limited. The objective of this review is to contextualize Anthropometry and Sports Biomechanics as necessary tools to focus on the limitations of the Mawashi Geri technique, based on the relationship between anthropometric and biomechanical studies, the technique can be perfected and the risk of injuries reduced. Therefore, it is necessary to find a proposal that provides new anthropometric data that can be used for biomechanical studies and medical control of sports training in karate fighters from Cienfuegos.

Keywords: anthropometry, biomechanics, somatotype, anthropometric profile

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Introduction

Currently, the global sports science community is undergoing a developmental change. The Anthropometry and Sports Biomechanics relationship investigates the limitations of flexibility in the lower extremities to improve kicking techniques, thus preventing injuries that can be caused by lack of knowledge of anthropometric and biomechanical sciences. Being an important factor the integration of sciences applied to sports with the application of new information technologies and telecommunications (ICT), specifically kinanthropometry and photogrammetry from biomechanical research. Anthropometric profile studies have had developing perspectives since the 21st century. Among the researchers who stand out in this context are Nariño R Alonso, et al.,¹⁻⁴ Rodriguez, Leon, Martinez, Gomez (2022). The authors consider that anthropometric measurements provide a correct analysis of the human body, particularly the somatotype, and are determinant for diagnosis and selection of sports talents. In addition, they show differences between sex, age and level of training. Since the 21st century, studies have been carried out in sciences applied to sport, in disciplines such as: Morphology, Physiology and Nutrition. However, there is little research that relates Anthropometry to Sports Biomechanics. However, there is some research that supports the importance of relating these sciences, such as: Oviedo Bueno, et al.,⁵⁻¹⁰ Carvajal, Leon; González, Deturnel and Echavarría (2018); Ramos AB^{11,12-14}

Previous authors study the athlete's somatotype from biomechanics to compare it with a model that indicates certain parameters that characterize a specific sport. However, they are limited in anthropometric measurements such as height, weight, muscle areas and body fat, flexibility of the lower extremities are some of the measurements that are made, but many investigations that deal with anthropometric and biomechanical studies for correction do not prevail. technique and sports performance. In this way, there are sports that need to delve into the location of the biomechanical points that make up each body segment to analyze the areas of greatest vulnerability, thus strengthening them to increase sports performance and reduce the risk of injuries, particularly Karate-do sport. Among the authors who investigate these regularities are: Valdés Quetglas

Tabares.^{15,16} Which state that studies of the athlete's somatotype should be related to biomechanics as tools to improve sports technique and reduce the risk of injury. However, there are few investigations that address this problem in the combat sport of Karate-do. They are limited to measuring height, but body fat without predicting what anomalies can occur when a karate fighter does not have the ideal somatotype required for adequate muscle-joint mobility.

The development of these sciences applied to sports is relevant in order to increase the performance of the rowing sport, thus comparing different athletes with biomechanical models and establishing work strategies designed in the technical preparation of the athlete with a differentiated character. Taking into account age, sex, level of training to eradicate incorrect techniques that cause injuries. One of the aspects that influence is the somatotype of the athlete. These elements limit the sporting gesture, which can cause limitations in muscle-joint mobility. However, these studies should be carried out more frequently, with a view to physical abilities and injury prevention. According to the search carried out to date, there are few anthropometric studies that relate biomechanics as an integrative science capable of supporting these studies, in order to increase sports performance and avoid the risk of injuries. In Latin America and Europe are some of the regions that are projected in these branches of science applied to sport. At the national level, the studies carried out and published in relation to anthropometry and biomechanics in karate fighters have been a necessity due to ignorance of them. What are the anthropometric and biomechanical characteristics in the karate fighters of the EIDE of Cienfuegos in the years 2021 and 2022? Analyze the physical, somatotypical and motor conditions of the karate fighters of the EIDE of Cienfuegos through anthropometric and biomechanical studies to increase performance and prevent injuries in the years 2021 and 2022.

Methods

Anthropometry and biomechanics: sciences that study the human somatotype

The sciences applied to sport seek the best performance in athletes. At the international and national level, this knowledge is

addressed. Nariño, Alonso, Hernández (2016) assure that it is a scientific discipline that is closely related to Physical Ergonomics and is developed in different fields of application. It is the science that studies the dimensions of the human body, the knowledge and techniques to carry out the measurements, as well as their statistical treatment. Studies of this type are also carried out in Cuba. There is evidence of an impact on anthropometry and biomechanics through ICT. Ross (1980) cited by Carvajal¹⁷ assumes that anthropometry as a science is an important link in the sciences applied to sports and biomedicine, since it allows the description and quantification of the physical characteristics of human beings, allows the assessment of the composition of the human body, diagnosing the conditions of the athlete in the practice of physical activity. When dealing with this topic, Sancio, Arcodia, Roselló³ consider that anthropometry applies its knowledge to the measurement of the human body based on movement from a biomedical point of view. This science studies the structure and functioning of the organism in sporting activity. In addition, they suggest that Anthropometry should be the most widely used diagnostic technique to assess the degree or level of physical-motor development. The authors study it with this scientific approach: León² and Sancio³ show the development of anthropometry for the health of the athlete from the morphological, physiological and nutritional evolution for raise the quality of life of high performance athletes. These investigations analyze the Body Mass Index, which indicates low nutritional states in the adolescent athletes that were selected. That is, there is malnutrition, it is evident that the anthropometric indicators in the muscular and fat areas of the arm and the correspondence between weight for height, are low with respect to the established measures.

Carvajal,¹⁷ Ramos et al.,¹¹ and Rodríguez CA¹⁸ refer that anthropometric studies through the somatotype can also be applied to sports in order to obtain better sports results and performance. Different studies are established, such as:

- I. The somatotype of an athlete comparing it with the "ideal" or reference for their sport modality;
- II. Study of the somatotype of an athlete and comparison with a determined population; and
- III. Comparison of the somatotype of different populations.

In the case of the investigations of Oviedo Bueno, et al.,⁵ and López C, et al.,⁶; Arturo Clavijo R, et al.,⁷ already reflect points of view to establish the relationships between the anthropometry and biomechanics sciences, they focus on the first and second study, in the case of the third anthropometry and its relationship with the nutrition. In this sense, there is a certain pattern somatotype for each sports modality and this pattern is more restricted as the level of sports performance, age, category, and sex increases. This type of study must be systematic from the lower categories to the higher ones. Therefore, it is important to compare the somatotype of the same athlete at different times. The athlete's kinanthropometric profile is one of the elements that is most frequently addressed in the scientific community of sciences applied to sport. Carvajal¹⁷ evaluates physical characteristics such as body composition, weight, and height with the scope of sports results. In addition, they consider that, in order to carry out anthropometric studies, it is necessary to know the functionality and biological structure of the human body; muscle-joint mobility. However, a diagnosis of the athlete's somatotype is needed, in its absolute linear, volumetric and spatial dimensions of the different tissues that make up the organism. In this way, Oviedo, Bueno and Munguía⁵ state that the anthropometric profile is the basis for correcting technical deficiencies, which serve as support for the

preparation of training plans in the selection and training of talents. In this way, it is essential to relate these anthropometric indicators with the biomechanical ones, to know exactly the possibilities of their muscular-articular mobility, the angles that the joints have, the development of physical capacity. All these indicators based on establishing physiological adaptations in the body to achieve good performance and sports technique. The purpose of these studies is that the Morphology, Physiology, Biochemistry and Biomechanics disciplines seek links that are related to achieve mastery in athletes and avoid the risk of injuries.

Quintero, Carvajal and Setién¹⁴ refer that it is necessary to relate anthropometric indicators, such as height, weight, circumference and length measurements, thickness of skin folds and biomechanics, with the study of trajectory, center of gravity, speed and time. of reaction. Anthropometric measurement allows us to measure body weight, height, lengths, diameters, perimeters, circumferences, and skin folds, where anthropometric information is processed through the application of different statistical methods, to obtain information on somatotype, body composition, and the proportionality of different body parts. It is a scientific specialty that is related to the measurement of man in a diversity of morphological, biomechanical perspectives with the study of the movement of man in sports activity. This knowledge must be studied by the coaches, thus knowing how to apply the training loads, and achieve a favorable performance for the sport. Zavala, Fuentes and Yáñez¹⁰ refer that the anthropometric technique allows us to measure body weight, height, lengths, diameters, perimeters, circumferences and skin folds, where anthropometric information is processed through the application of different statistical methods, to obtain information on somatotype, body composition, and proportionality of different parts of the body. It is a scientific specialty that is related to the measurement of man in a diversity of morphological, biomechanical perspectives with the study of the movement of man in sports activity.

The somatotype defines the morphological constitution of the individual through three values that quantify the three dominant components: endomorphic, mesomorphic and ectomorphic in a longitudinal study of a sample of 12 to 17 years old, (Carter, 1990, p.388) cited by López C⁶ According to the authors, men tend to be more mesomorphic with age and women more endomorphic. It is evident that these patterns change with age and the systematic work that is planned from the individual training plan, that carries out development and training work. These definitions are contextualized in the anthropometric studies of Karate-do. Age should be considered at the time of selecting talents for a certain sport discipline. The initiators of the somatotype study were Hippocrates and Galen who gave it a classification that included two types of subjects: consumptive or thin, and apoplectic or muscular. times later Leonardo da Vinci established an aesthetic model based on body components. They designed somatotype estimation methodologies determined by the somatotype components and dimensions are:

Endomorphy: Relative to the fatness or thinness of a person, it is derived from the sum of three skin folds: triceps, subscapularis and suprailiac.

Mesomorphy: Refers to musculoskeletal relativity, expresses the fat-free mass relative to height and is derived from the humerus and femur diameters, flexed arm circumference and calf circumference, both corrected.

Ectomorphy: referring to the linearity of the body

According to Tellez. (2002) cited by Zavala,¹⁰ Fuentes and Yáñez (2018) allude that anthropometry is a useful tool to know and determine

the sports profile of an athlete, as well as to detect talents from specific disciplines. It is a method that offers useful and appropriate information on body composition, even managing to contribute to assessing a person's nutritional status and change trends over time, as a result of genetic and environmental factors. In the specific case of athletes, it also allows you to modify certain components, improving performance according to the sport you want to practice. Karate as a contact sport, an important point is the somatotype to have a great reach followed by good muscular strength. On the other hand, athletes who prefer to use hand techniques have a greater development of the mesomorph component and therefore their kicks and punches are faster. According to Valbuena and González. (2012) cited by Benavides, Salazar and Díaz (2021). There are three somatotype classifications. Endomorphy (Refers to the relative amount of fat. Its predominance indicates obesity, Mesomorphy (Refers to muscular development. Its predominance implies great muscular development.), Ectomorphy (Refers to the relative linearity of the subject's physique.). However, they do not contextualize it. Based on the prevention of injuries that can be generated when it is related to biomechanics, the studies of these scientific disciplines provide a clearer and more synthesis of what anthropometry is and what it is for.

Anthropometric studies allow the estimation of body composition, the study of morphology, dimensions and proportionality in relation to sports performance, nutrition and growth. In the case of the sample, the karate fighters have an Endomorphic somatotype, which is why it is considered favorable for research, however, work must continue in a multidisciplinary way based on the quality of life of the karate fighters. In the same way Gonzalvo, Dicz and Fernández. (2007) cited by Azevedo, Miguel, Diego, Hernández and Fernández (2018) states that the somatotypical characteristics of athletes are related to maximum sports performance, which is called morphological profile, this knowledge becomes an element of great importance. importance for sports science professionals. They make it possible to determine and assess the physical and physiological characteristics that athletes have, allow to capture information for an appropriate start, follow-up and prescription of training, in addition to allowing forecasts about a certain future sporting ability, thus identifying the anthropometric characteristics and composition body is a great indicator for the identification of outstanding and healthy sports performance.

According to Benavides, Salazar and Díaz (2021) and Quintero, Carvajal and Setién¹⁴ consider that anthropometric profiles make it possible to prepare the athlete, identify athletes within the sports discipline groups and later, for example, if they are the characteristics of the mass of body fat, skeletal muscle development, determines the amount of adipose tissue, so interdisciplinary work must be carried out aimed at the health of the athlete. In addition, it must be the basis on which the sports team begins its process. A long-term process will have its best results if it starts well, and if it has a correct plan that develops its sports performance. All these contributions have great significance in sciences applied to sport. The relationship between anthropometry and biomechanics are mediators of the biological variables related to sports performance. In this way, they provide clear information on the structure of the athlete at a given moment and physiological, morphological and biochemical adaptations when carrying out systematic physical activity based on sports performance.

The Karate-do. anthropometric and biomechanical studies

Despite the fact that karate complies with the entire Olympic cycle, like other sports it is not yet in the Olympic Games, therefore this may be a weakness that is evidenced by little scientific evidence

that investigates the correspondence of motor, anthropometric characteristics in Karate- do. Rodríguez, Martí and Alba (2002) cited by Valdés, Quetglas, Tabares and Ruíz (2020) consider that by establishing the relationships between the anthropometric and biomechanical indicators in the karate fighters of Cienfuegos, it allows the training and development of possible sports talents to the conformation of the national team. In Cienfuegos, Karate-Do is part of the pyramid of high performance in Cuba, for this reason its systematic practice, from the areas of mass sports, to the most specialized centers such as the Schools of School Sports Initiation, the Higher Schools of Improvement Athletic; to Higher Schools and the Training of High Performance Athletes. Karate-Do programs are also developed in higher education and it is inserted as an optional sport and undergraduate specialty in some faculties of physical culture, in the latter case, oriented to the technical-methodological preparation of future professionals. Relevant results have been achieved in university games. However, it is necessary to perfect the athlete's preparation program and although some requirements of the analyzed sport are known, for these categories a profile of requirements is not determined that supports the karate preparation and with it its scientificity, contributing to improve the performance of the athlete. sports performance.

Other authors, including Grosser cited by González, Peña, Mena,¹⁶ argue that sports technique establishes the ideal model of a movement related to sports discipline. The realization of the ideal movement that is aspired to, that is, the method for performing the optimal motor action by the athlete. Ramón et al., (2012) cited by Torres¹⁹ refers that flexibility determines the ability to move a joint or series of joints through complete joint mobility (ADM), without restrictions or pain. We could even consider that in order to contemplate a minimum of flexibility, it can be adjusted to a specific ROM that guarantees optimal joint and functional function. It is important to know the amplitude limit of the joints, and before any exercise of flexibility to carry out an adequate warm-up, these risk areas must be protected and injuries to the lower limbs should be avoided when executing kicking techniques. The optimal motor action is determined by the efficiency of the movements aimed at achieving an objective. Technical perfection allows:

- I. Travel less space in the execution of the movement.
- II. Use less force.
- III. Take less time to perform the action.

Mastering the technique of a movement allows efficiency during its execution and therefore increases speed during its execution. It has been shown that the technical efficiency of each movement allows saving and rationalizing efforts, which guarantees carrying out the movements in less time and with less energy expenditure. González, Peña, Mena (2021) refer that technical preparation can be considered as a pedagogical process supported by biological laws of the development of motor skills and habits that are necessary for the successful performance of sports activity and that are intended to lead to a athlete in the best possible shape to a competition from the technical point of view and that allow him to achieve victory. This means that the athlete who best learns and applies the technique in combat will be, among other aspects, the one who is in the best condition to achieve victory.

The improvement of sports technique means the conscious development of sports movement capabilities, as well as the precision and conscious consolidation of technical actions. The teaching of sports technique and its improvement constitute an important part in

the preparation of the future athlete in different sports. The role of technique is wide and varied. But in all sports, the teaching is carried out following a methodology built on the general bases of the creation of representations on the studied technique, the practical mastery of the appropriate actions and movements, the assessment of the mistakes made and their elimination.

When collecting information on sports technique, some characteristics are considered to be taken into account about it, among them we can mention the following:

- I. It is determined from the model functional structure.
- II. It can only be applied by the athlete.
- III. The person who performs it is related to temporal-spatial factors.
- IV. It's purpose is the execution of functional structures.
- V. The evaluation is made from the number of errors that are made in your execution with respect to the model structure.
- VI. Requires executions under a certain structural pattern, at different speeds.

Considering these criteria, the coach must take into account that the technique

Sporting is a perpetually changing element of sporting mastery that is perfected on the basis of an increase in the athlete's motor potential and the corresponding precision of the biodynamic structure of sporting effort. It is the teaching and improvement that is imparted to the athlete of the execution of movements and actions that constitute the elements to carry out the training and fight the fights. In the sport of Karate-Do, the technical elements are aimed at kata (form) and kumité (combat). The execution according to the technical fundamentals of Karate-Do, has a direct relationship with physical and tactical preparation and performs with the characteristics of each of these. Technical preparation is divided into: General technical preparation and Special technical preparation. The first type of preparation is aimed at the general technical instruction of the athlete and his knowledge in the sphere of the general fundamentals of the technique of the exercises. Also complete the arsenal of motor skills and habits that are useful in life and in sports. Valdés, Quetglas, Tabares and Ruíz (2020) show that the training phase of the karate fighter assimilates the specific technique of his sport, that is, he must learn the laws of the mechanics of the movements and the actions of his sport with the aim of achieving the specialization of each movement. It can be seen that technical preparation is a very important component in the preparation of an athlete because it will be here where the habits and skills of each sport will be assimilated and especially the one we are dealing with in this investigation, Karate-Do, without ruling out the other components of the preparation since it works as a system.

We believe that by solving the problems of mastering the correct technique, the correct ways of executing the movements, the proper distribution of forces and then improvement, we can solve the development of variability, that is, executing the technique in different situations of the game. combat. From this derives the importance of anthropometric and biomechanical characterization in the sports context. On the general theory of sports training of Matveev. (2001) cited by Valdés et al.¹⁵ consider that when talking about individual properties that support sports predisposition, it is subject to a set of criteria and methods such as: anthropometric, physiological, pedagogical and others. According to Matveev the approaches in the diagnosis of predisposition sports comprehensive. In the biodiagnostic approach, they are the morphometric approaches whose base are

measurements, such as longitudinal and transverse dimensions, circumferences, mass, specific weight. As well as possible changes in some biological functional parameters of the organism. Biomechanics analyzes the movements, corrects the technique in phases and focuses the biomechanical points of the joints based on sports performance and reducing the risk of injuries. the researchers Valdés, Quetglas, Tabares and Ruíz¹⁵ and González, Peña, Mena (2021) coincide with the previous approaches, since anthropometric profiles support studies of physical capacities from biomechanics and provide essential tools for a good preparation of the athlete. However, they socialize it with time and mark sports and with ball sports, they do not experience it with combat sports, which are immersed in Martial Arts.

González, Peña, Mena (2021) investigate the errors of the technique, linked to anthropometric measurements in the karate fighters of Cienfuegos. It is necessary to select athletes of the appropriate size and weight to perform the kicking techniques, since those of lower body weight and greater size are a fast reaction sport. The karatecas present the possibility of greater height of the foot at the moment of impact in the Mawashi Geri technique. They must be light, maintaining a dynamic balance between their body weight, height and fat percentage, in order to improve their performance in competition. While Devís (1995) cited by Valdés, Quetglas, Tabares and Ruíz (2020) consider that Karate-do is a Martial Art that interacts with society life, since it strengthens the physical and mental condition. It is present in the branch of culture, education and health and culture. Develops behavioral attitudes in the athlete. In addition, it develops flexibility in its structure and muscular-articular mobility in the technical elements.

Motor aspects involved in karate

It is of vital importance to know the aspects of the most important physical condition for the realization of this sport. De Herrera (2009) cited by Majumdar, Das and Mandal.⁹ Defines the physical condition the set of anatomical and physiological qualities that the person has that enables them to a greater or lesser degree to perform a motor test. In this way, the need to establish tests that allow us to measure these conditions is seen. Taking into account the physiological classification of the sport and the motor aspects that intervene in karate, it will be taken into account to evaluate the tests that will enter to identify the physical condition for the development of it. Wells or sit and reach test: According to Sanz (2002) cited by Valdés, Quetglas, Tabares and Ruíz¹⁵ refer to the flexibility in the lower back, and the elongation capacity of the hip extensor and flexor muscles on your knees. The angle of flexion of the knee of the support leg is what determines the speed and scope of the impact in the kicks, this depends on its flexibility. To achieve the maximum speed of the executing lower limb, the knee must be bent as much as possible and the heel must be pulled as much as possible towards the buttocks, thus increasing the acceleration space and contributing to the increase in speed, the criterion for which this option was selected. characteristic. It is important to note that the knee extension angle will not be the same. In the anthropometric and biomechanical study that is socialized, the athletes present greater flexibility in the left supporting leg. It is crucial to observe the biomechanical models of the Mawashi Geri technique. To take advantage of the acceleration space and obtain high speed values, the support knee must be fully extended to an angle of $\pm 180^\circ$.

Results

It was carried out with a sample made up of fourteen male karate fighters, and from different categories and in the adolescence stage. Anthropometric indicators of weight, height, body fat mass and

biomechanical indicators of the relative angles of the knee joint of the supporting leg are studied in karate fighters from the School of Sports Initiation School (EIDE) of Cienfuegos. With the objective of characterizing height and weight, mass of body fat from a somatotype, and biomechanics to improve the Mawashi-Geri technique of karate fighters from Cienfuegos. The study is retrospective, observational, descriptive, and longitudinal. The anthropometric profiles of the years 2020-2021 and 2021-2022 in the sport of Karate-do in Cienfuegos were analyzed.

Anthropometric indicators

It is observed that in height in 2021 the values revolve around 1.67 centimeter meters and in 2022, they oscillate around 1.70 centimeter meters. When applying the non-parametric hypothesis test (Wilcoxon), since height does not fit the normal distribution, these changes from one year to the next are evident. Pearson's linear correlation coefficient showed that the relationship between height and weight, both in 2021 and 2022, is strongly positive, so when height increases, weight also tends to increase. Regarding the linear relationship that exists between height and BMI, it is observed that there is a strong negative relationship, so when one indicator increases the other decreases. When analyzing the weight indicator, it is observed that in the athletes under study in 2021 it rotates around 55 kg and in 2022 around 60.5 kg. When applying the parametric test (T for related samples), it is observed that between the weight that the karate fighters had in 2021 and 2022 there were significant changes. In addition, Pearson's linear correlation coefficient showed that the relationship between weight and BMI is strongly positive. The BMI in the karate fighters under study in 2021 oscillates around 1.09 and in 2022 it revolves around 1.12, so it can be seen that there is an increase in BMI from one year to the next, but, when applying the test of non-parametric hypothesis (Wilcoxon), it is observed that the changes are not significant.

Biomechanical indicators

When analyzing the knee angle biomechanical indicator of the Mawashi Geri kick, it is observed that the angle of the left support leg in 2021 rotates around 129° and in 2022, it oscillates around 134°. While the angle of the right support leg in 2021 oscillates around 170° and in 2022, it rotates around 173°. When applying the hypothesis test (T for related samples), it is observed between one year and another that there were significant changes. Although the changes observed are in favor of the second moment, it is recommended that work should continue in order to improve flexibility in the athletes under study, since the angles of the knee must reach when kicking the Mawashi Geri in the range of $\pm 160^\circ$ to $\pm 180^\circ$ in relation to the support foot. When comparing the anthropometric indicators (height, weight, BMI) with the biomechanical (knee angle) it is observed that the Pearson linear correlation coefficient shows that the relationship is weak negative, so when one indicator increases the other decreases.²⁰⁻²¹

Conclusion

- I. Pearson's linear correlation coefficient showed that the relationship between height and weight, both in 2021 and 2022, is strongly positive, so when height increases, weight also tends to increase.
- II. Regarding the linear relationship between height and BMI, it is observed that there is a strong negative relationship, so that when one indicator increases the other decreases.
- III. When analyzing the knee angle biomechanical indicator of the Mawashi Geri kick, it is observed that the angle of the left

support leg in 2021 rotates around 129° and in 2022, it oscillates around 134°. While the angle of the right support leg in 2021 oscillates around 170° and in 2022, it rotates around 173°. Therefore, work must continue in order to improve flexibility in the athletes under study.

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Conflicts of interest

The autor declares there is no conflict of interest.

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