APPLICATION OF SPORTS BIOMECHANICS IN THE TECHNICAL ANALYSIS OF TAEKWONDO KICKING

APLICAÇÃO DA BIOMECÂNICA ESPORTIVA NA ANÁLISE TÉCNICA DO CHUTE NO TAEKWONDO

APLICACIÓN DE LA BIOMECÁNICA DEPORTIVA EN EL ANÁLISIS TÉCNICO DE LAS PATADAS DE TAEKWONDO

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ABSTRACT

Introduction: With the gradual improvement of the theoretical system of sports biomechanics and the high requirements of Taekwondo development, the scientific research of Taekwondo is no longer restricted to a monothematic perspective; sports biomechanics is a combination of the complex forms of movement and body changes in the sport, a discipline that combines the principles of mechanics and biology for research. This discipline, allied to the study of sport, contributes to the correct understanding, training, and mastery of movement techniques. Objective: Apply a technical analysis of the taekwondo kick through a sports biomechanics approach. Methods: Using a three-dimensional kinematic motion capture system, volunteers of 58kg, 68kg, 80kg, and three other weight classes, in a total of 30 athletes, participated in this research. The movements included technical kicks and the collection of motion trajectories when hitting the target. Results: There were significant differences in the angle, angular velocity, torque, action time, displacement, and velocity of the lower limb joints of the three weight classes ($P<0.05$). Conclusion: The higher the athlete's weight, the lower the body agility; although the striking distance is relatively long, the impact on movement speed is relatively minor. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Biomechanical Phenomena; Martial Arts; Athletes.

RESUMO

Introdução: Com a melhoria gradual do sistema teórico da biomecânica esportiva e os altos requisitos do desenvolvimento do Taekwondo, a pesquisa científica do Taekwondo deixou de restringir-se a uma perspectiva monotemática, a biomecânica esportiva é uma combinação das complexas formas de movimento e alterações corporais no esporte, disciplina que combina os princípios da mecânica e da biologia para a pesquisa. Essa disciplina, aliada ao estudo esportivo, contribui para a correta compreensão, formação e domínio das técnicas de movimento. Objetivo: Aplicação a análise técnica do chute no taekwondo pela abordagem biomecânica esportiva. Métodos: Utilizando um sistema tridimensional de captura de movimento cinemático, voluntários de 58 kg, 68kg, 80 kg e outras três classes de peso, num total de 30 atletas, participaram dessa pesquisa. Os movimentos incluíram chutes técnicos e a coleta das trajetórias de movimento ao acertar o alvo. Resultados: Houveram diferenças significativas no ângulo, velocidade angular, torque, tempo de ação, deslocamento e velocidade das articulações dos membros inferiores das três classes de peso ($P<0,05$). Conclusão: Quanto maior o peso do atleta, menor a agilidade do corpo, embora a distância de batida seja relativamente longa, o impacto na velocidade do movimento é relativamente menor. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

***Descritores*:** *Fenômenos Biomecânicos; Artes Marciais; Atletas.*

RESUMEN

Introducción: Con la mejora gradual del sistema teórico de la biomecánica deportiva y las altas exigencias del desarrollo del taekwondo, la investigación científica del taekwondo ya no se limita a una perspectiva monotemática, la biomecánica deportiva es una combinación de las complejas formas de movimiento y cambios corporales en el deporte, una disciplina que combina los principios de la mecánica y la biología para la investigación. Esta disciplina, aliada al estudio deportivo, contribuye a la correcta comprensión, entrenamiento y dominio de las técnicas de movimiento. Objetivo: Aplicar el análisis técnico de la patada de taekwondo mediante el enfoque biomecánico deportivo. Métodos: Utilizando un sistema de captura de movimiento cinemático tridimensional, participaron en esta investigación voluntarios de 58kg, 68kg, 80kg y otras tres clases de peso, en un total de 30 atletas. Los movimientos incluían patadas técnicas y la recogida de las trayectorias de los movimientos al golpear el objetivo. Resultados: Hubo diferencias significativas en el ángulo, la velocidad angular, el par, el tiempo de acción, el desplazamiento y la velocidad de las articulaciones de los miembros inferiores de las tres clases de peso ($P<0,05$). Conclusión: Cuanto mayor es el peso del atleta, menor es la agilidad corporal, aunque la distancia de golpeo es relativamente larga, el impacto en la velocidad de movimiento es relativamente menor. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

***Descriptores*:** *Fenómenos Biomecánicos; Artes Marciales; Atletas.*

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INTRODUCTION

Taekwondo is a hand-to-hand fighting sport that mainly kicks the legs, supplemented by punches, and uses both hands and feet, technology is one of the main factors that determine the performance of Taekwondo competition.[1] In the past 20 years, the Chinese Taekwondo team has won a total of 7 gold medals in the Olympic Games, and each session has a gold medal, which has a certain level of competition, however, the development of Taekwondo in my country is relatively late, and there are still problems such as incomplete development of the competitive level and low professionalism of the coaches. Coupled with the continuous development of taekwondo competition rules and equipment, it drives athletes to continuously improve and innovate their sports technology, therefore, it is particularly important to study the skills of Chinese taekwondo athletes.[2] With the gradual improvement of the theoretical system of sports biomechanics and the high requirements of the development of Taekwondo, the research of Taekwondo is no longer limited to a single subject perspective, sports biomechanics is a combination of the complex movement forms and changing laws of the human body in sports, a discipline that combines the principles of mechanics and biology for research, this discipline, combined with the study of sports, contributes to the correct understanding, formation and mastery of movement techniques. At present, the application of sports biomechanics in taekwondo is gradually enriched, the author through the bibliography method, this paper expounds the application status of sports biomechanics in the technical analysis of taekwondo movements, and understands the basic situation of its application in taekwondo.

METHOD

Research object

According to the weight class set in the Taekwondo World Championships, a number of outstanding Korean taekwondo athletes in three weight classes, 58 kg, 68 kg, and 80 kg, were selected as test subjects.[3] Before the test, all the subjects did not perform high-intensity training within 24 hours, and there was no intentional increase or decrease of body weight and no movement injury of lower limb joints within 3 months, and their physical condition and exercise ability were normal. The basic information of the subjects is shown in Table 1.

Experimental method

The technical and tactical effective score statistics of the 2020 Taekwondo World Championships quarter-final, semi-final and final video. The statistical objects are all the techniques used by both players in the game.[4] The recording method adopts the direct labeling method, and all the video observation videos in the study are selected from the official website of the World Taekwondo Association, directly play and watch through the YouTube video player on the official website, and use the excel 2010 version to record and organize the statistical indicators. According to the game time and number given by the official website, find the video of the statistical game to watch and record. If there are difficulties in technical use and score recording, use 0.5 times or 0.25 times to play at slow speed for more accurate records. In order to ensure the validity of data statistics, all recorded video data were completed by a three-person team, and the average of the statistical results was taken as the analysis data.[5] Statistical indicators: Leg technique: horizontal kicking technique, downward splitting technique, side kicking technique, back kicking technique, whirlwind kicking technique, backspin kicking technique, double-flying technique, hooking technique; Fist: Straight Punch Technique; Foul Behaviors: Falling to the ground, out of bounds, grabbing or pushing, hitting the lower body, raising the knee and controlling the leg, passive play, punching to the head, bad behavior, infraction.

Table 1. List of basic information of subjects.

Group	n	Age	height(cm)	body weight(kg)
58kg	10	20.2±0.5	172.5±2.4	54.7±2. 8
68 kg	10	21.1±0.4	178.4±2.4	64.6±3.1
80 kg	10	18.8±0.8	185.4±2.6	75.3±3.2

Data Analysis

According to the content of this research, statistics and analysis of the 2020 Taekwondo World Championships video, use Microsoft Excel 2010 for recording and processing, and the chart required for the thesis production, provide data support for this study. SPSS 24.0 was used for comparative analysis of the obtained data, and the test schemes used were independent sample T test and single factor sample test, check for significant differences.

There is no need for a code of ethics for this type of study.

RESULTS

As shown in Table 2, the total effective score of small-level athletes in different time periods showed a continuous downward trend, and the P value between groups was 0.048 < 0.05 after SPSS test, there is a significant difference, and the cross-test of the samples between groups found that, there is a significant difference between the total effective score in the final period and the previous two innings, the P values were 0. 031, 0. 024 < 0. 05, and there was no significant difference between the two groups in the first two rounds. Combining the scores of each score, it can be seen that, with the passage of time, the effective score of 1-point score in different time periods of small-level athletes shows a trend of "falling first, then rising; The effective score of 2 points decreased obviously; the effective scores of 3 points and 4 points showed a trend of first increasing and then decreasing.

As can be seen from Table 2, the effective score characteristics of small-level athletes in different time periods show that with the passage of time, the effective score continues to decline, in particular, the score dropped significantly in the final period, which was different from the previous two games. Combining with Figure 1, it can be seen that the effective score of the small-level athletes in the first round is mainly 2 points and 3 points, accounted for 72.27% of the total score, with 1 point as a supplement; The effective score of the second game is mainly 3 points, accounting for 20% of the total score, supplemented by 1 point and 2 points; The effective score in the third game is still dominated by 3 points, accounting for 48.53% of the total score, supplemented by 1 point and 2 points; Therefore, it can be seen from the scoring rate that 3 points are dominant in the effective score of small-level athletes, and 1 point and 2 points are supplemented.[6] By reviewing relevant literature and observing videos, it is found that tactics, score status and physical fitness status are the main reasons for the significant decrease in the effective scores of small-level athletes in different periods.

The men's middle weight class includes: 63kg, -68kg and -74kg, the athletes in this class are all-round athletes, the body shape such as height

Table 2. Comparative analysis of effective scores of small-level athletes in different periods.

period	Score	1 point	2 points	3 points	4 points	5points
first round	Score	36	67-	78'	4	00 '0
	Proportion (%)	17.32	34.66	36.62	1. 98	0
second game	Score	52	35*	90	6	00 '0
	Proportion (%)	26.42	18.35	49.00	3.23	0
third game	Score	35	30*	59	4	00 '0
	Proportion (%)	25.47	21.06	50.35	3.94	0
	F value	0.289	2.451	2.766	-	-
	P value	0. 713.	0.033	0.034	-	-

and weight has no obvious characteristics, and the competition is not dominated by proud skills, nor does it show obvious shortcomings. Effective scoring characteristics of middle-level athletes at different time periods, it shows that with the passage of time, the effective score first increases and then decreases, after testing, there was no significant difference between groups at different time periods, and there was no significant difference in each score between different time periods. Combining with Figure 2, it can be seen that the effective score of the middle-level athletes in the first round is mainly 2 points, and 1 point and 3 points are supplementary; The effective score of the second game is still dominated by 2 points, supplemented by 1 point and 3 points; In the third game, 1 point and 2 points are the main points, and the remaining points are supplemented. Therefore, it can be seen from the scoring rate that 2 points are dominant in the effective score of intermediate-level athletes, and 1 point and 3 points are supplemented.

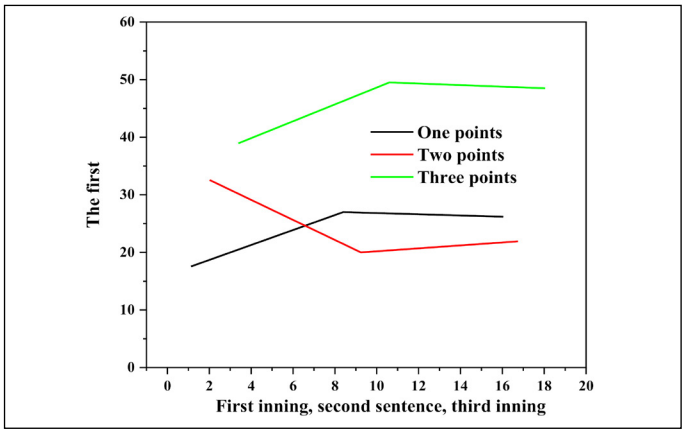

Figure 1. Comparison of the scoring rates of small-level athletes in different time periods.

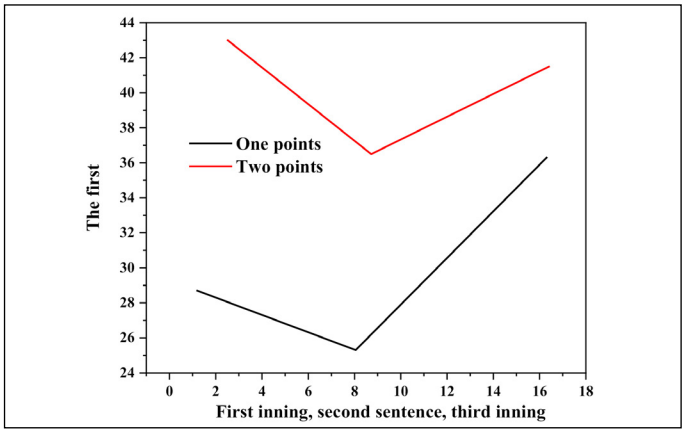

Figure 2. Comparison of the scoring rate of each score of middle-level athletes in different time periods.

DISCUSSION

The research is based on the characteristics of the horizontal kick technique combined with the principle of whiplash, using the theoretical knowledge of kinematics and physiology and the author's training practice accumulation, the biomechanical characteristics of horizontal kick technical movements of athletes of different weight classes were discussed, and the relationship between weight class differences and movement speed was found.[7] Through the test results, it was found that there were significant differences in the biomechanical characteristics of the horizontal kick technical movements of athletes of different weight classes. During the starting period of the horizontal kick technique, the athlete's torso and supporting legs first rotated around the vertical axis, and the overall rotation range was 58 kg >68kg>80 kg. The lower the weight of the athlete, the greater the rotation around the axis. Some studies suggest that, the rotation of the trunk and lower limb joints around the axis conforms to the anatomical structure of the human body, the supporting leg must be abducted first, which is conducive to the completion of the attacking leg movement. Observing the movement trajectory of the attacking leg movement, it is found that starting from the preparation moment of the technical movement, the flexion and extension, adduction and abduction, internal rotation and external rotation of each joint of the attacking leg were completely similar to those of the supporting leg, the overall performance was 58 kg > 68 kg > 80 kg. There is also a movement phenomenon in which the smaller the weight level is, the larger the rotation around the axis is. Some studies suggest that the flexion of the knee directly affects the speed of action during the hitting period.[8]

CONCLUSION

The difference in weight of elite taekwondo athletes due to different weight classes, the impact on the movement speed of the horizontal kick technique is more significant. When the coaches formulate training plans or conduct special training, according to the differences in the characteristics of the horizontal kick technical movements of athletes of different weight classes, as well as the degree of influence on the movement speed, combined with the technical action characteristics of the horizontal kick and the principle of the whipping action, aiming at the individual differences in the athlete's own sensitivity, improve the body's agility and standardize the horizontal kick technical action, according to the training principle of small load and fast speed, the strength of muscle fibers is enhanced and the contraction speed of muscle fibers is stimulated, in order to comprehensively improve the speed of the horizontal kick technique.

The author declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: The author made significant individual contributions to this manuscript. YY: writing, data analysis, article review and intellectual concept of the article.

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