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Original article

Biomechanical differences in the chigo-Chagüi kick with the front leg in female beginner and advanced taekwondo fighters

Diferencias biomecánicas en la patada chigo-Chagüi con pierna delantera entre taekwondocas principiantes y avanzados

Diferenças biomecânicas no pontapé chigo-Chagüi com a perna dianteira entre lutadores iniciantes e avançados de taekwondo

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ABSTRACT

The analysis of sports technique between different performance levels serves to establish methodological comparisons that contribute to the improvement of specialized motor performance, including eminently technical-tactical sports. In this sense, the objective of the research is to analyze the biomechanical differences between professional and amateur taekwondo athletes in the performance of the Chigo-Chagüi kick with front leg. Two independent groups were studied, 15 Beginner Athletes (DPRI in Spanish) and15 Professional or advanced Athletes (DPRO in Spanish); indicators of Speed, Flexion Angle and Center of Gravity were studied and a comparison was established. An initial angle of DPRO=28.4° and DPRI: 27.34° (p=0.309) and an impact angle of DPRI= 117.93º and DPRO=129.2º (p=0.001) and a final angle of DPRI=31.34º and DPRO=26.34º (p=0.057) were determined, with a kick execution time of DPRO=1312ms and DPRI=1462 ms (p=0.009), a maximum velocity of DPRO=6.86 m/s and DPRI=5.47 m/s (p=0.003) and an average acceleration of DPRO=48.35 m/s^2 and DPRI=36.55 m/s^2 (p=0.029), being the center of gravity for the impact point in Axis X with no significant differences (p=0.506) and in Axis Y with significant differences between independent groups (p=0.029). The differences between advanced and beginner athletes in the chigo-chagüi kick with front leg are usually remarkable in most of the indicators analyzed, being the level of the athlete an indicator that allows describing the technical deficiencies.

Keywords: Biomechanics; Taekwondo; Chigo-chagüi; Speed; Angle; Trajectory.

RESUMEN

El análisis de la técnica deportiva entre diferentes niveles de rendimiento sirve para establecer comparaciones metodológicas que tributan al perfeccionamiento del rendimiento motriz especializado, incluidos los deportes eminentemente técnico-tácticos. En tal sentido, el objetivo de la investigación es analizar las diferencias biomecánicas entre deportistas profesionales y amateurs de taekwondo en la realización de la patada Chigo-Chagüi con pierna delantera. Se estudiaron dos grupos independientes, Deportistas Principiantes (DPRI) 15 principiantes y Deportistas Profesionales (DPRO): 15 avanzados o profesionales), se estudiaron indicadores de Velocidad, Ángulo de Flexión y Centro de Gravedad y se estableció una comparación. Se determinó un ángulo inicial de DPRO =28,4° y DPRI: 27,34° (p=0.309) y un ángulo de impacto de DPRI= 117,93º y DPRO=129,2º (p=0.001) y un ángulo final de DPRI=31,34º y DPRO=26,34º (p=0.057), con un tiempo de ejecución de la patada de DPRO=1312ms y DPRI=1462 ms (p=0.009), una velocidad máxima de DPRO=6,86 m/s y DPRI=5,47 m/s (p=0.003) y una aceleración promedio de DPRO=48,35 m/s^2 y DPRI=36,55 m/s^2 (p=0.029), siendo el centro de gravedad para el punto de impacto en Eje X sin diferencias significativas (p=0.506) y en el Eje y con diferencias significativas entre grupos independientes (p=0.029). Las diferencias entre deportistas avanzados y principiantes en la patada chigo-chagüi con pierna delantera suelen ser notables en la mayoría de los indicadores analizados, siendo el nivel del atleta un indicador que permite describir las deficiencias técnicas.

Palabras clave: Biomecánica; Taekwondo; Chigo-chagüi; Velocidad; Ángulo; Trayectoria.

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RESUMO

A análise da técnica desportiva entre diversos níveis de desempenho serve para estabelecer comparações metodológicas que contribuirão para a melhoria do desempenho motor especializado, nomeadamente dos desportos eminentemente técnico-tácticos. Neste sentido, o propósito da investigação é analisar as diferenças biomecânicas entre os atletas profissionais e os iniciantes de taekwondo no desempenho do pontapé Chigo-Chagüi com a perna dianteira. Foram estudados dois grupos independentes, Atletas Principiantes (DPRI) 15 principiantes e Atletas Profissionais (DPRO): 15 avançados ou profissionais), foram estudados indicadores de Velocidade, Ângulo de Flexibilidade e Centro de Gravidade e foi estabelecida uma comparação. Um ângulo inicial do DPRO=28,4° e DPRI: 27,34° (p=0,309) e um ângulo de impacto do DPRI= 117,93º e DPRO=129,2º (p=0,001) e um ângulo final do DPRI=31,34º e DPRO=26,34º (p=0,057), com um tempo de pontapé de execução do DPRO=1312ms e DPRI=1462 ms (p=0,009), um tempo máximo de pontapé de execução do DPRO=1312ms e DPRI=1462 ms (p=0 009), uma velocidade máxima de DPRO=6,86 m/s e DPRI=5,47 m/s (p=0,003) e uma aceleração média de DPRO=48,35 m/s2 e DPRI=36,55 m/s2 (p=0,029), sendo o centro de gravidade para o ponto de colisão no Eixo X sem diferenças significativas (p=0,506) e no Eixo y com diferenças significativas entre grupos independentes (p=0,029). As diferenças entre atletas avançados e iniciantes no pontapé de chigo-Chagüi com a perna dianteira são geralmente notáveis na maioria dos indicadores analisados, sendo o nível do atleta um indicador que permite descrever as deficiências técnicas.

Palavras-chave: Biomecânica; Taekwondo; Chigo-Chagüi; Velocidade; Ângulo; Trajetória.

INTRODUCTION

Taekwondo is a combat sport, of Olympic character, (Kazemi, Waalen, Morgan, & White, 2006), it is based on the use of 80 % of kicks and only 20 % of marking in terms of fists within the combats and sports practices, its technique of execution of kicks is the fastest within the martial arts, being otherwise a sport of high reaction speed, (da Silva Santos, Loturco, & Franchini, 2018) for which reason, kicking techniques are highlighted as a priority in the theory and methodology applied to its training.

The chigo-chagüi technique or also called downward kick is one of the most dangerous and high impact techniques, since at the time of its execution the attacker must lift the knee and extend the foot in the direction of the opponent's face, dropping the sole of the foot on the opponent's face. According to its effectiveness in combat, it is a way to get 3 points or achieve a KO (Troya-Mogrovejo, 2013; WTF, 2020).

Biomechanics is a technique that provides an extensive source of data related to the physics of motor movements, widely explored from the mechanical point of view in direct relation to the efficient control of sports performance, being useful for the evaluation and understanding of human locomotion, being able to detect advantages and limitations of motor movement, (McGinnis, 2013; León, Calero, & Chávez, 2016; Granda, Loachamin, & Arla, 2016; Luigi T. Bercades & Willy Pieter, 2007) who lead to perfect essential components such as technique and technical-tactical performance.

The study of the biomechanical differences between beginners and advanced in the Chigo-Chagüi technique is directed to enhance certain magnitudes, including the reaction speed, (Swandana, Sugiharto, & Wahyu, 2021) since there are moments when the need to react quickly in milliseconds is an effective response to an elite or novice opponent to perform a kick in taekwondo, (Ervilha, Fernandes, Souza, & Hamill, 2020), which becomes essential in the actions of the athlete (Martinez & Escobar, 2017). Therefore, the transcendental importance of specialized training to improve speed, agility and quickness in taekwondo at any level, (Akhmad, Nugraha, & Sembiring, 2021) either through traditional models or comprehensive models of sports preparation (Tipán, *et al.,* 2017).

One of the most studied variables in biomechanics applied to sports performance is the center of gravity, which constitutes an advantageous position to keep the body balanced on a firm support base, (WTF, 2020; Loachamin, Mena, Durán, & Maqueira, 2017), where the center of gravity is correctly aligned and distributed on the feet when performing any technical action.

The trajectory of the movement and the angles of the joint are measures that allow the correction of many aspects such as location, a correct technical optimization, posture and the execution and effectiveness of the kick, (Marlene J Adrian & John M Cooper, 1995). This considers physical capabilities such as flexibility in the angles of the joints of the lower limbs, is a priority to perform the Chigo-Chagüi kick, being equally a fundamental direction of the sport under study, (Paramitha, Rosadi, Ramadhan, & Suwanta, 2020) as well as other variables such as maximum speed (Saransig, López, & Aldaz, 2021).

Given the possible existence of differences in the technical executions in taekwondo, according to the levels presented by athletes, the purpose of the research is to determine the biomechanical differences between beginners and advanced athletes in the chigo-chagüi kick with the front leg of taekwondo, hoping that the results obtained will provide professionals with reliable indicators in order to correct and enhance the training of the Chigo-Chagüi technique.

MATERIALS AND METHODS

A population of 30 athletes was studied, from them, 15 were beginner athletes and 15 were professional athletes from the DAIGORO Specialized Training Club, both men and women, in the city of Quito, Republic of Ecuador.

According to their training time, the athletes were classified into the following independent groups:

1. Beginner Athletes (DPRI): have a very short training time and have no more than one year of training experience. Total: 15 Athletes.

2. Professional Athletes (DPRO): have more than three years of training in the discipline and range from blue green belt to black belt (1dan), possessing an already perfected technique of the chigo-chagüi kicking technique with front leg.

For data analysis, the Kinovea program version 0.8.27 was used and for data tabulation and correlation, the SPSS V25 program was used, applying the Mann-Whitney U test (p= 0.05) since there was no normal distribution of the data.

The analysis was carried out with the tools provided by the Kinovea program. It was taken into account the following magnitudes:

1. Speed: it was measured at the exact moment when the Chigo-Chagüi kick movement starts, reaches its maximum point and descends until it reaches the initial position again.

2. Center of gravity: it was measured at the moment when the athlete reaches the point of maximum extension and height of the kick, after having performed the knee flexion and elevation phase; tools and a human model were selected to match the predetermined points with the athlete's joints.

3. Flexion angle: to measure it, an angle was inserted taking as vertex the coxofemoral joint and the ankle joint in the initial and final impact position.

To obtain the trajectory, a reference point was placed on the lateral malleolus of the foot when the athlete initiates the movement of the chigo-chagüi technique; the option *follow trajectory* was selected and the process ends when the athlete returns to his combat position. The graph that will be obtained will be a curvilinear line that allows the analysis of the motor movement.

RESULTS

Table 1 shows the results achieved by the professional athletes in the Chigo-Chagüi kick with front leg, where the angle in initial position (X1) presented an average of 28.4°, the angle of average position (X2) an average of 129.2°, the angle of final position an average of 26.33° (X3), the movement time with an average of 1312ms (milliseconds)(X4), the maximum trajectory velocity with an average of 6.85m/s (X5), the maximum trajectory acceleration with an average of 48.35m/s^2 (X6) and the center of gravity (X7) with a mean or average in the X-axis of 1.052° and in the Y-axis of 1.015° (Table 1).

Table 1. - Results of professional athletes in the Chigo-Chagüi kick

Results obtained with professional athletes in Chigo-Chagüi kicking								
Variables	x1*	x2*	x3*	x4*	x5*	x6*	x7*	
							x-axis	Axis and
Units of measure	Grades			ms	m/s	m/s²	m	m
Professionals								
Subject 1	26	122	21	1370	7,9520054	47,7908249	1,04	1,16
Subject 2	37	121	30	1470	7,7633309	45,9949760	1,02	0,88

Subject 3	28	137	28	1370	8,3799839	71,9481201	0,75	1,09
Subject 4	21	130	20	1470	6,3889542	44,8942490	1,12	1
Subject 5	25	126	28	1260	7,7771335	72,1054382	1,2	1,18
Subject 6	27	123	28	1230	6,1224294	29,4514942	1,01	0,89
Subject 7	32	123	23	1490	5,9234424	59,4702530	1,08	0,99
Subject 8	19	124	25	1290	5,6790342	35,7243691	0,91	0,67
Subject 9	18	139	24	1410	5,6038084	27,2886448	1,04	0,81
Subject 10	27	151	23	1220	7,3367081	42,8614197	0,93	1,36
Subject 11	37	120	33	1200	6,5113721	38,3708076	1,13	1,02
Subject 12	36	125	32	1210	6,8539529	60,6783943	1,1	1,03
Subject 13	38	132	24	1290	5,3236151	46,6719131	1,2	1
Subject 14	32	121	31	1170	7,1688623	59,8809013	1,12	1.01
Subject 15	23	144	25	1230	8,0869474	42,1889000	1,13	1,13
Average	28,4	129,2	26,3333333	1312	6,85810534	48,3547137	1,052	1,015

*** Legend:** X1 =Initial position angle; X2 =Median position angle; X3 =End position angle; X4=Time of movement; X5 =Maximum trajectory velocity; X6 =Maximum trajectory acceleration; X7 =Center of gravity

Table 2 evidences the results achieved by the beginner athletes in the Chigo-Chagüi kick with front leg, where the angle in initial position (X1) presented an average of 27.33°, the angle of average position (X2) an average of 117.93°, the angle of final position an average of 31.33° (X3), the movement time with an average of 1462ms (X4), the maximum trajectory velocity with an average of 5.47m/s (X5), the maximum trajectory acceleration with an average of 36.55m/s^2 (X6) and the center of gravity (X7) with an average in the Xaxis of 1.1° and in the Y-axis of °0.9427 (Table 2).

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Table 2. Results of the beginner athletes in the Chigo-Chagüi kick

Results obtained with beginner athletes in the Chigo-Chagüi kick								
Variables	x1*	x2*	x3*	x4*	x5*	x6*	x7*	
							xaxis	Axis and
Units of measure	Grades			ms	m/s	m/s².	m	m
Beginners								
Subject 1	30	113	24	1260	5,9490099	52,2936630	1,19	1,01
Subject 2	19	119	30	1580	4,9431925	27,0343895	1,04	0,88
Subject 3	19	126	28	1410	4,6461797	32,2793007	1,01	0,77
Subject 4	25	123	27	1530	7,6154737	44,7603989	1,05	1,16
Subject 5	27	113	23	1430	6,4576726	40,0948639	1,11	1,05
Subject 6	30	119	28	1330	5,9587684	42,4626503	1,01	0,98
Subject 7	28	95	28	1350	5,7971501	27,8600750	1,01	0,71
Subject 8	23	118	24	1280	4,6215472	43,5593300	1,02	0,95
Subject 9	31	127	44	1260	5,7102346	47,1356506	1,1	0,96
Subject 10	25	116	35	1770	3,2209926	11,8049402	1,19	0,78
Subject 11	34	120	34	1410	6,7457132	43,6903458	1,27	1,08
Subject 12	33	126	50	1780	6,3782377	33,8449135	1,21	0,95
Subject 13	26	115	31	1540	4,5216872	43,6743267	1,17	1,1
Subject 14	31	121	36	1570	4,5524931	20,2198334	1,07	0,87
Subject 15	29	118	28	1430	4,9847217	37,5628624	1,05	0,89
Average	27,3333	117,933	31,33	1462	5,47353828	36,55183625	1,1	0,9427

*** Legend** X1 =Start position angle; X2 =Middle position angle; X3 =End position angle; X4 =Time of movement; X5 = Maximum trajectory velocity; X6 = Maximum trajectory acceleration; X7 = Center of gravity; X8 = Maximum trajectory acceleration; X9 = Maximum trajectory acceleration; X9 = Maximum trajectory acceleration; X9 = Center of gravity

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Table 3 shows the angle of impact in the Chigo-Chagüi kick of professional and beginner athletes, where, in the former, the initial angle establishes an average of 28.4°, the angle of impact established an average of 129.2° and the final angle an average of 26.33°. The beginner athletes in the angle of impact in the Chigo-Chagüi kick establish for the initial angle a mean of 27.33°, the angle of impact a mean of 117.92° (showing that the angle of impact has a range of 95°-127°) and the final angle a mean of 31.33° (Table 3).

Table 3. - Results of professional athletes in the angle of impact in the Chigo-Chagüi kick

Professionals				Beginners			
	Initial Angle	Impact Angle	Final Angle		Initial Angle	Impact Angle	Final Angle
Subject 1	26	122	21	Subject 1	30	113	24
Subject 2	37	121	30	Subject 2	19	119	30
Subject 3	28	137	28	Subject 3	9	126	28
Subject 4	21	130	20	Subject 4	25	123	27
Subject 5	25	126	28	Subject 5	27	113	23
Subject 6	27	123	28	Subject 6	30	119	28
Subject 7	32	123	23	Subject 7	28	95	28
Subject 8	19	124	25	Subject 8	23	118	24
Subject 9	18	139	24	Subject 9	31	127	44
Subject 10	27	151	23	Subject 10	25	116	35
Subject 11	37	120	33	Subject 11	34	120	34
Subject 12	36	125	32	Subject 12	33	126	50
Subject 13	38	132	24	Subject 13	26	115	31
Subject 14	32	121	31	Subject 14	31	121	36
Subject 15	23	144	25	Subject 15	29	118	28
Average	28,40	129,20	26,33	Average	27,33	117,93	31,33

On the other hand, table 4 shows the results of the professional and beginner athletes in the movement time of the Chigo-Chagüi kick, establishing a mean or average in the professional athletes of 1312 ms, with a maximum value of 1490 ms and a minimum value of 1170 ms. On the other hand, in the beginner athletes a mean or average of 1385 ms was established, with a maximum value of 1780 ms and a minimum value of 1260 ms (Table 4).

Table 4. - Results of professional athletes in the movement time of the Chigo-Chagüi kick

Professionals		Beginners	
	Movement time		**Movement time**
Subject 1	1370	Subject 1	1260
Subject 2	1470	Subject 2	1580
Subject 3	1370	Subject 3	1410
Subject 4	1470	Subject 4	1530
Subject 5	1260	Subject 5	1430
Subject 6	1230	Subject 6	1330
Subject 7	1490	Subject 7	1350
Subject 8	1290	Subject 8	1280
Subject 9	1410	Subject 9	1260
Subject 10	1220	Subject 10	1770
Subject 11	1200	Subject 11	1410
Subject 12	1210	Subject 12	1780
Subject 13	1290	Subject 13	1540
Subject 14	1170	Subject 14	1570
Subject 15	1230	Subject 15	1430
Average	1312	Average	1385

Table 5 shows the results of the professional and beginner athletes in the maximum speed of the Chigo-Chagüi kick, establishing for the professionals an average of 6.8 6m/s, with a minimum value of 5.32361507 m/s and a maximum value of 8.3799839 m/s. While for the beginner athletes, a mean of 5.47 m/s was established, with a minimum value of 3.22099257 m/s and a maximum value of 7.61547375 m/s (Table 5).

Table 5. - Results of professional athletes in the maximum speed of the Chigo-Chagüi kick

Professionals		Beginners	
	Maximum speed		Maximum speed
Subject 1	7,9520054	Subject 1	5,9490099
Subject 2	7,7633309	Subject 2	4,9431925
Subject 3	8,3799839	Subject 3	4,6461797
Subject 4	6,3889542	Subject 4	7,6154738
Subject 5	7,7771335	Subject 5	6,4576726
Subject 6	6,1224294	Subject 6	5,9587684
Subject 7	5,9234424	Subject 7	5,7971501
Subject 8	5,6790342	Subject 8	4,6215472
Subject 9	5,6038084	Subject 9	5,7102346
Subject 10	7,3367081	Subject 10	3,2209926
Subject 11	6,5113721	Subject 11	6,7457132
Subject 12	6,8539529	Subject 12	6,3782377
Subject 13	5,3236151	Subject 13	4,5216872
Subject 14	7,1688623	Subject 14	4,5524931
Subject 15	8,0869474	Subject 15	4,9847217
Average	6,86	Average	5,47

In the case of professional athletes (Table 6), in the results of the maximum acceleration of the Chigo-Chagüi kick, an average of 48.35 m/s2 was obtained, while in the results of the beginner athletes an average of 36.55 m/s2 was obtained.

Table 6. - Results of professional athletes in the maximum acceleration of the ChigoChagüi kick

Professionals		Beginners	
	Maximum Acceleration		Maximum Acceleration
Subject 1	47,7908249	Subject 1	52,293663
Subject 2	45,994976	Subject 2	27,03439
Subject 3	71,9481201	Subject 3	32,279301
Subject 4	44,894249	Subject 4	44,760399

Subject 5	72,1054382	Subject 5	40,094864
Subject 6	29,4514942	Subject 6	42,46265
Subject 7	59,470253	Subject 7	27,860075
Subject 8	35,7243691	Subject 8	43,55933
Subject 9	27,2886448	Subject 9	47,135651
Subject 10	42,8614197	Subject 10	11,80494
Subject 11	38,3708076	Subject 11	43,690346
Subject 12	60,6783943	Subject 12	33,844914
Subject 13	46,6719131	Subject 13	43,674327
Subject 14	59,8809013	Subject 14	20,219833
Subject 15	42,1889	Subject 15	37,562862
Average	48,3547137	Average	36,551836

Table 7 shows the results of the beginner and professional athletes in the center of gravity as part of the point of impact of the Chigo-Chagüi kick, where the beginners obtain an average in the X-axis of 1.1° and an average in the Y-axis of 0.94° and the professionals obtain an average in the X-axis of 1.052° and in the Y-axis of 1.015°, taking into account that the coordinate system was located in the athlete's support foot (Table 7).

Table 7. - Results of professional athletes in the center of gravity at the point of impact of the Chigo-Chagüi kick

Beginners			Professionals		
	x-axis	Axis and		x-axis	Axis and
Subject 1	1,19	1,01	Subject 1	1,04	1,16
Subject 2	1,04	0,88	Subject 2	1,02	0,88
Subject 3	1,01	0,77	Subject 3	0,75	1,09
Subject 4	1,05	1,16	Subject 4	1,12	1
Subject 5	1,11	1,05	Subject 5	1,2	1,18
Subject 6	1,01	0,98	Subject 6	1,01	0,89
Subject 7	1,01	0,71	Subject 7	1,08	0,99
Subject 8	1,02	0,95	Subject 8	0,91	0,67
Subject 9	1,1	0,96	Subject 9	1,04	0,81
Subject 10	1,19	0,78	Subject 10	0,93	1,36
Subject 11	1,27	1,08	Subject 11	1,13	1,02

Subject 12	121	0,95	Subject 12	1,1	1,03
Subject 13	1,17	1,1	Subject 13	1,2	1
Subject 14	1,07	0,87	Subject 14	1,12	1.01
Subject 15	1,05	0,89	Subject 15	1,13	1,13
Average	1,1	0,942667	Average	1,052	1,015

DISCUSSION

It was determined that professional athletes have an average initial angle of 28.4° and beginner athletes have an average angle of 27.34°, which reflects that there is no greater variation in the angle of the initial position between the two groups. In addition, by means of the comparative calculation from the Mann-Whitney U test, it was determined that there were no significant differences (p=0.039), establishing a lower average range in the beginner athletes (13.87) than in the professional athletes (17.13).

The angle of impact of the beginner athletes averages 117.93º and the angle of the professional athletes is 129.2º, which reflects the existence of a greater variation in the angle of the impact position between both groups, in addition, by means of the comparative calculation from the Mann-Whitney U test, the existence of significant differences was determined (p=0.001), establishing a lower average range in the beginner athletes (10.23) than in the professional athletes (20.77).

In the final angle, it is observed that the beginner athletes have an average of 31, 34º and the average angle of the professional athletes is 26, 34º, determining that there is no greater variation in the angle of the final position between both groups, there is no significant difference (p=0.057), a lower average range is established in the professional athletes (18.53) than in the beginner athletes (12.47).

One of the aspects related to the angles and their description in degrees is the existing relationship with the physical capacity of flexibility, (Tacan, Werz, & Cevallos, 2021) a better joint amplitude could derive in a better muscular flexibility and, therefore, a greater probability of moving the lower limbs in taekwondo derives in an increase of sport performance in terms of kicking precision, as defined in Paramitha, Rosadi, Ramadhan, & Suwanta, (2020).

In the execution time, there was an average of 1312 ms in the professional athletes and an average of 1462 ms in the beginner athletes, which determined that there is a greater variation in kick execution time between both groups, there are significant differences (p=0.009) and a lower average range is established in the professional athletes (11,33) than in the beginner athletes (19,67), indicative that the professional athletes have a shorter execution time and, therefore, a better specific speed capacity.

It was determined that professional athletes have an average maximum speed of 6, 86m/s and beginner athletes have an average maximum speed of 5.47 m/s, which reflects that there is a greater variation in the maximum speed of the kick between both groups, determining significant differences (p=0.003) and the average range is lower in

beginner athletes (10,80) than in professionals (20,20), indicative of a better speed capacity of professional athletes, an aspect studied in other works such as (Saransig, López, &Aldaz, 2021).

The average acceleration of the professional or advanced athletes is 48, 35m/s^2, and the average acceleration of the beginner athletes was 36.55 m/s^2, which reflects the existence of a greater variation in the maximum acceleration of the kick between independent groups, which is significantly different (p=0.029) by establishing a lower average range in the beginner athletes (12.00) than in the professionals (19.00), indicating that the latter mentioned have a greater acceleration by having a better physical preparation.

The comparative calculation of the center of gravity in the coordinate axis (X) for the point of impact during the execution of the Chigo-Chagüi front leg kick between beginner and professional athletes did not determine significant differences (p=0.506), which establishes a lower average range in the professional athletes (14.43) than in the beginners (16.57). In the case of the comparative calculation of the center of gravity in the coordinate axis (Y), the point of impact during the execution of the Chigo-Chagüi kick, with front leg between beginner and professional athletes from the Mann-Whitney U test, determined significant differences (p=0.029), which establishes a lower average range in beginner athletes (12.00) than in professional athletes (19.00).

It is observed that the center of gravity in the X-coordinate axis in beginners is 1.1 and in the Y-coordinate axis is 0, 94 and in professionals, the X-coordinate axis is 1.052 and in the Y-coordinate axis is 1.015, which shows during the ascent phase until reaching the point of impact; the center of gravity tends to shift more towards the supporting foot and greater stability is obtained. On the other hand, during the ascent phase of the striking foot, the center of gravity tends to shift towards where the performing leg moves, which raises the center of gravity to some degree.

Professional athletes have greater experience in the execution of the kick, in addition to being more flexible to perform the Chigo-Chagüi kick with the front leg; therefore, their angle at the point of impact is greater compared to beginners, who have less flexibility, i.e., the blow is more precise and efficient, even managing to overcome the opponent's head, which would be a competitive advantage in combat (Paramitha, Rosadi, Ramadhan, & Suwanta, 2020).

The total execution time of the Chigo-Chagüi technique with the front leg is shorter in the professionals than in the beginners, given that they have automated the movement due to the time they have been training. Similarly, it is determined that the maximum speed in the professionals perfects the technical-tactical action of the kick, which provides an additional competitive advantage to the professionals. In acceleration, differences are also observed in the professionals, their acceleration was greater than that of the beginners, since they have to maximize the acceleration of the thigh, thus transmitting the force to the leg to achieve a stronger impact, since there is a direct relationship between acceleration or linear speed and force (Ojeda-Aravena, Azócar-Gallardo, Hérnandez-Mosqueira, & Herrera-Valenzuela, 2020).

Professional or advanced athletes have much more time of experience, in addition to a better technique, which has been perfected with their greater experience for the correct execution of the different kicks, as opposed to beginner athletes, who have less time of technical learning and, therefore, a lower technical and technical-tactical performance in terms of probabilities.

CONCLUSIONS

The differences between advanced and beginner athletes in the chigo-chagüi kick with front leg are usually remarkable in most of the indicators analyzed, being the level of the athlete an indicator that allows describing the technical deficiencies, as well as serving as a predictor to emphasize the biomechanical elements that affect the sport performance.

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REFERENCES

Akhmad, I., Nugraha, T., & Sembiring, P. (2021). Speed, Agility, and Quickness (SAQ) training of the circuit system: How does it affect kick speed and agility of junior taekwondo athletes?. Journal Sport Area, 6(2), 175-182. doi:10.25299/sportarea.2021.vol6(2).6433

da Silva Santos, J. F., Loturco, I., & Franchini, E. (2018). Relationship between frequency speed of kick test performance, optimal load, and anthropometric variables in black-belt taekwondo athletes. Ido Movement for Culture. Journal of Martial Arts Anthropology, 18(1), 39-44. doi:10.14589/ido.18.1.6

Ervilha, U. F., Fernandes, F. D., Souza, C. C., & Hamill, J. (2020). Reaction time and muscle activation patterns in elite and novice athletes performing a taekwondo kick. Sports biomechanics, 19(5), 665-677. doi:10.1080/14763141.2018.1515244

Granda, C. A., Loachamin, E. M., & Arla, S. M. (2016). Biomechanical analysis of the Taekwondo Ap-Chagui kick. Lecturas: Educación Física y Deportes, 21(218), 1-7. https://www.efdeportes.com/efd218/biomechanical-analysis-of-the-taekwondo.htm

Kazemi, M., Waalen, J., Morgan, C., & White, A. R. (2006). A profile of Olympic taekwondo competitors. Journal of sports science & medicine, 5(CSSI), 114. https://www.jssm.org/jssm-05-CSSI1-114.xml%3EFulltext

León, S., Calero, S., & Chávez, E. (2016). Morfología funcional y biomecánica deportiva (2E ed.). Quito, Ecuador: Editorial de la Universidad de las Fuerzas Armadas ESPE.

Loachamin, E. M., Mena, F. M., Durán, E. E., & Maqueira, G. d. (2017). Diferencias biomecánicas en la patada ap chagüi entre taekwondocas de cinturón blanco y negro. Revista Cubana de Investigaciones Biomédicas, 36(2), 159-168. http://scielo.sld.cu/scielo.php?pid=S0864-03002017000200013&script=sci_arttext&tlng=en

Luigi T. Bercades, & Willy Pieter. (2007). Un análisis biomecánico de la patada descendente modifi cada de taekwondo. Revista de Artes Marciales Asiáticas, 2(1), 28-39. http://revpubli.unileon.es/ojs/index.php/artesmarciales/article/view/282/239

Marlene J Adrian, & John M Cooper. (1995). Biomechanics of Human Movement. WCB. Brown a BenchmarkPub. Iowa: WCB Brown & Benchmark.

Martinez, C. A., & Escobar, Y. P. (2017). Sistema de ejercicios para el perfeccionamiento de la velocidad de ejecución simple y compleja en acciones ofensivas del taekwondo en atletas escolares de la EIDE provincia las Tunas. Revista Boletín Redipe, 6(1), 174-192. http://revista.redipe.org/index.php/1/article/view/187

McGinnis, P. M. (2013). Biomechanics of sport and exercise. Human Kinetics. New York: Human Kinetics.

Ojeda-Aravena, A. P., Azócar-Gallardo, J., Hérnandez-Mosqueira, C., & Herrera-Valenzuela, T. (2020). Relación entre la prueba de agilidad específica en taekwondo (tsat), la fuerza explosiva y la velocidad líneal en 5-m atletas de taekwondo de ambos sexos. Retos, 39, 84-89., 39, 84-89. doi:10.47197/retos.v0i39.78395

Paramitha, S. T., Rosadi, T. Y., Ramadhan, M. G., & Suwanta, D. M. (2020). The Influence of Flexibility Training on the Accuracy of the Dollyo Chagi Kick in Taekwondo Martial Arts. In 4th International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2019) (4th International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2019).21, págs. 317-320. Atlantis Press. https://www.atlantis-press.com/article/125934806.pdf

Saransig, D. D., López, A. P., & Aldaz, E. M. (2021). Diferencias biomecánicas en el taekwondo entre la categoría clasificado y novato realizando la patada mondolyo furyo chagui. Lecturas: Educación Física y Deportes, 26(276), 75-89. doi:10.46642/efd.v26i276.2918

Swandana, A., Sugiharto, S., & Wahyu, I. S. (2021). Development of Reaction Speed and Endurance Training Tools for Taekwondo Kick Speeds Using Pyongyo. Journal of Physical Education and Sports, 10(1), 8-16. https://journal.unnes.ac.id/sju/index.php/jpes/article/view/44385

Tacan, E. J., Werz, D. N., & Cevallos, E. C. (2021). Insistencia pasiva dinámica y contracción maximal: influencia en la flexibilidad del split en karate. PODIUM-Revista de Ciencia y Tecnología en la Cultura Física, 16(2), 1-13. http://podium.upr.edu.cu/index.php/podium/article/view/1084

Tipán, M. G., Quichimbla, H. V., Morales, C., Apolo, E. G., Aldaz, E. M., & Rojas, M. P. (2017). Integrated training vs traditional training in senior taekwondo practitioners. Lecturas: Educación Física y Deportes, 21(224), 1-16. https://efdeportes.com/efd224/integrated-training-in-senior-taekwondo.htm

WTF, W. T. (2020). Competition Rules & Interpretation. Seoul, Korea: World Taekwondo Federation. http://www.worldtaekwondo.org/viewer_pdf/external/pdfjs-2.1.266-dist/web

/viewer.html?file=http://www.worldtaekwondo.org/att_file/documents/WT%20Competition%20Rules_Interpretation%20(October%201,%202020).pdf

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The authors have participated in the writing of the work and analysis of the documents.