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Effective techniques analysis in taekwondo: A systematic review
Análisis de las técnicas efectivas en Taekwondo: Revisión sistemática exploratoria
Análise de técnicas efetivas em Taekwondo: Revisão sistemática

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Abstract. The Korean martial art Taekwondo has been an official Olympic sport since the 2000 Sydney Olympics. Taekwondo is a full contact combat sport where the majority of successful techniques are powerful kicks, which are delivered by hitting the opponent's chest gear or the head. The aims of this research were: a) carry out a systematic review related to the effective techniques in Taekwondo, and b) know the must use techniques in taekwondo combat. The review was conducted according to the PRISMA-P protocol. The *Web of Science*, *Scopus* and *SPORTDiscus* electronics databases were explored for pertinent published studies according to the following keywords: "Taekwondo" and "Technique", published up to 31st August 2023. To boundary the search, four inclusion criteria were admitted: i) select only documents from scientific journals, ii) mention at least some of the techniques of Taekwondo (minimum 50 words), iii) journal documents published in English, Spanish and Portuguese, and iv) full text accessible or abstract availability. The sample consisted of 17 documents. In conclusion, the selected documents have allowed the identification and highlighting of different kinds of documents, which report the study of taekwondo associated with technique. The technique most studied in taekwondo is the round-house kick (Korean terminology: "*bandal chagui*" - kick to the chest gear or "*dollyo chagui*" - kick to the helmet gear).
Keywords: Performance, Martial art, PRISMA-P, Kicks.

Resumen. El arte marcial del Taekwondo ha sido oficialmente un deporte olímpico desde los Juegos Olímpicos de Sydney 2000. El taekwondo es un deporte de combate donde el éxito técnico se debe principalmente a la potencia de la patada dirigida a golpear el pecho o el protector de cabeza. Los objetivos de esta investigación científica fueron: a) realizar una revisión sistemática relacionada con las técnicas efectivas en Taekwondo, y b) conocer las técnicas de uso obligatorio en el combate de taekwondo. La revisión se realizó según el protocolo PRISMA-P. Se utilizaron bases de datos electrónicas como: *Web of Science*, *Scopus* y *SPORTDiscus*, para buscar estudios publicados según las siguientes palabras clave: "*Taekwondo*" y "*Técnica*" publicados hasta el 31 de agosto de 2023. Para limitar la búsqueda, se conocían bien cuatro criterios de inclusión: i) solo se eligieron cuidadosamente los artículos científicos, ii) mencionar al menos algunas de las características del taekwondo (mínimo 50 palabras), iii) estar redactado en Inglés, Español o Portugués; y iv) texto completo accesible o resumo. La muestra estuvo compuesta por 17 documentos. En conclusión, los documentos seleccionados han permitido identificar y resaltar diferentes tipos de documentos, que logran el estudio del taekwondo asociado a técnica. La técnica de taekwondo más estudiada es la patada circular (Terminología coreana: "*bandal chagui*" - patada al protector de pecho o "*dollyo chagui*" - patada al casco).
Palabra clave: Rendimiento, Arte Marcial, PRISMA-P, Golpeos.

Resumo. A arte marcial Taekwondo é oficialmente desporto Olímpico desde os Jogos Olímpicos de Sidney 2000. Taekwondo é um desporto de combate onde maioritariamente o sucesso técnico deve-se a potência do pontapé dirigido para acertar no protetor do peito ou cabeça. Os objetivos desta pesquisa científica foram: a) fazer uma revisão sistemática relacionada com as técnicas eficazes no Taekwondo, e b) conhecer as técnicas de uso obrigatório no combate de taekwondo. A revisão foi realizada de acordo com o protocolo PRISMA-P. Foram utilizadas as seguintes bases de dados: *Web of Science*, *Scopus* e *SPORTDiscus*, a fim de se pesquisar estudos publicados de acordo com as seguintes palavras-chave: "*Taekwondo*" e "*Técnica*", publicados até 31 de agosto de 2023. Para limitar a procura, foram estabelecidos quatro critérios de inclusão: i) foram eleitos cuidadosamente artigos científicos; ii) mencionar pelo menos uma das características do taekwondo (mínimo 50 palavras); iii) estar escrito em Inglês, Espanhol ou Português; e iv) texto completo ou resumo. A amostra foi composta por 17 documentos. Em conclusão, os documentos selecionados permitem identificar e ressalvar diferentes tipos de documentos, que reportam o estudo do taekwondo associado a técnica. A técnica de taekwondo mais estudada é o pontapé semi-circular (terminologia coreana: "*bandal chagui*" - pontapé ao protetor de peito ou "*dollyo chagui*" - pontapé ao capacete).
Palavras-chave: Desempenho, Arte Marcial, PRISMA-P, Golpes.

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Introduction

Taekwondo is a full-contact combat sport where the most successful techniques are powerful kicks, which are delivered by hitting the opponent's chest gear or head (Norjali Wazir et al., 2019; Liu et al., 2021). This martial art and combat sport originated in medieval or similar cultures, and today it is primarily a combat activity conditioned by safety rules (Sousa et al., 2022). This sport aims to develop self-defense through combat (Wasik & Shan, 2015). The Korean martial art Taekwondo has been an official Olympic sport since 2000 Sydney Olympics Games. Taekwondo is a renovated sport, focused on powerful and technical kicks (Moreira et al., 2018), through different movements such as acrobatics, jumping, and explosive techniques (Menescardi et al., 2020), to win the combat.

In accordance with González et al. (2011) the technical actions in taekwondo are performed by the arms (kwons) and legs (dari). There are two types of strikes: fist and foot attack, called, in this case, "chumok" and "chagui", respectively

(Gómez, 2005). In this way, the first attack (chumok) is only allowed to be made to the opponent's chest (Colmenero, 1993). Thus, the permitted fist techniques are: *Checho jirugui, Montong dollio jirugui and Montong jirugui*. The foot techniques allowed are: *An chagui, Ap chagui, Bakat chagui, Bandal chagui, Dollio chagui, Furio chagui* (included *mom dollio furio chagui* in this category)*, Miro chagui, Nako chagui* (included *mom dollio nako chagui* in this category)*, Neryo chagui, Tuit chagui and Yop chagui* (please see Annex 1). Falco et al. (2011) compare five of the most frequently used kicks in Taekwondo fights: the round kick, front leg axe kick, clench axe kick, jump spin back kick and jump spin hook kick to looked at the reaction time, execution time and total response time.

Taekwondo has traditionally focused on specific aspects athletes' overall technical and tactical skills, while ignoring other important issues such as identifying how successful athletes score points (Menescardi et al., 2019). In this line, Moreira et al. (2018) conducted that the skill of kicking start to contract specific muscles early and to perform the kicking phase with the gluteus muscle maximum more relaxed is associated a more efficient high "*dollyo chagi*" kick performance on the effect of impact and temporal aspects. On the other hand, Ojeda-Aravena et al. (2020) revealed that those techniques skills are related and are improved because the athletes' physiological performance is associated by explosive strength, agility, muscle stretch-shortening cycle and lineal velocity.

In martial art (taekwondo) kick velocity, differences in timing and speed between leg segments and the segmental kick velocity is associated with isometric and stretch indicators (Moreira et al., 2018). Casolino et al. (2012) concluded that the taekwondo athletes kick more frequently with the rear leg than front leg, and young athletes engaged more frequently in offensive actions. A higher frequency of offensive techniques (i.e., direct turning kick) occurred during the first and second rounds. In the other hand, there are differences between competitors regarding its experience, experts are faster than novice competitors in all distances and as execution distance increases, so do their differences for each three distances of kicking (Falco et al., 2009). In this line, Estevan et al. (2011) found that the medalists executed the roundhouse kick to the head with great impact force in a shorter execution time than did the no medalists when they kicked from any distance.

Between the technical and tactical moves, Gutiérrez-Santiago et al. (2020), scored highlighted the direct attack moves, in counterattack and for technical correction, being bandal, miro, and dolio chagui the most used techniques. To avoid the opponent's attack, the techniques most used are blocks, direct attack, indirect attack, anticipatory counterattack, and simultaneous counterattack (Menescardi et al., 2016). Direct attacks and simultaneous counterattacks were the most frequent action used in competition (Menescardi & Estevan, 2017). Considering the offensive actions counterattack is the most utilized technique and the mean of actions for assault and combat is higher during the third time, due to 95% of the combats are resolved in the third round (González-Prado et al., 2015). However, the winners show more defensive actions than non-winners (Tornello et al., 2014). In this line, tactical actions (attack, defense, and blocking), technical executions, kicking legs (forward/backwards and right/left) and overall technical efficiency must be constantly evaluated in competition to see their development and their relationship with the result obtained.

From a tactical point of view, the anticipatory counterattacks were the most effective for scoring one and three points, simultaneous counterattacks were the most effective for scoring two points, and indirect attacks were the most effective for scoring four points in male athletes (Menescardi et al., 2021). According to González-Prado et al. (2015), direct and anticipatory actions in the third round are more frequent than the earlier rounds. Instead of the increase in attack actions number from round 1 to 3 the value did not exceed 15 attacks per round, and the intensity of the match increased in the last round (Santos et al., 2011).

Considering the importance of the specific techniques or kicks in martial arts, and especially in taekwondo, this study aimed to carry out a systematic review related to the most used techniques in taekwondo. Also, the variables analysed in each study was identified to evaluate how they influence the performance of the athletes. In summary, this article provides as a support and tool for coaches to learn about the most commonly used techniques as well as their development and benefits, and, in this way, improve technical and methodological aspects.

Methods

Study Design

This research is placed within theoretical studies (Montero & León, 2007), through a systematic review of the literature, to identify the most current documents related to the topic. This process was carried out through a compilation of the notice articles (Ato et al., 2013), with the purpose of analyzing the related documents with taekwondo technique skills and verifying which techniques are most used in competition. This study followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) proposal (Page et al., 2021), with the following guidelines: i) definition of the objectives with explicit and reproducible methodology; ii) systematic search for evidence following eligibility criteria; iii) assessment of the validity of the findings; and iv) systematic presentation and synthesis of the characteristics and findings of the included studies. The study was developed under different steps to extract the results in the best way and established conclusions related to the topic (Moher et al., 2009).

Inclusion and exclusion criteria for scientific articles

To select and include the greatest number of documents, inclusion and exclusion criteria were established related to the topic (Table 1).

Search strategy

To search the documents, *Web of Science* (*WoS*), *SPORTDiscus* (*EBSCO*), and *SCOPUS (Elsevier)* databases were used. "Taekwondo" and "Technique" keywords were used to conduct the search in the different databases through the use of "AND" as a Boolean operator. A total of 677 documents were identified up to August 2023. Also, to select those documents related to the theme, the filter "Topic" was used in the databases, which means that only documents which contain the keywords in the title, abstract and keywords were included in the search. The search of the documents was carried out by two researchers (JLS and VHB), to reduce the bias of the results. Also, they developed the selection of the studies according to the inclusion and exclusion criteria. Finally, any disagreement was solved by third research (JMG). Figure 1 shows the flow diagram of the process.

Table 1.
Inclusion and exclusion criteria

Nº.	Inclusion criteria
1	Selected only document from scientific journal.
2	Mention at least some of the technique of Taekwondo (minimum 50 words).
3	Journal articles published in English, Spanish and Portuguese.
4	Complete text accessible or abstract availability.
	Exclusion criteria
5	To eliminate the article that only mentions the keywords introduced in the database.
6	To discard documents that refer generally taekwondo.
7	Exclude documents that cannot be referenced.

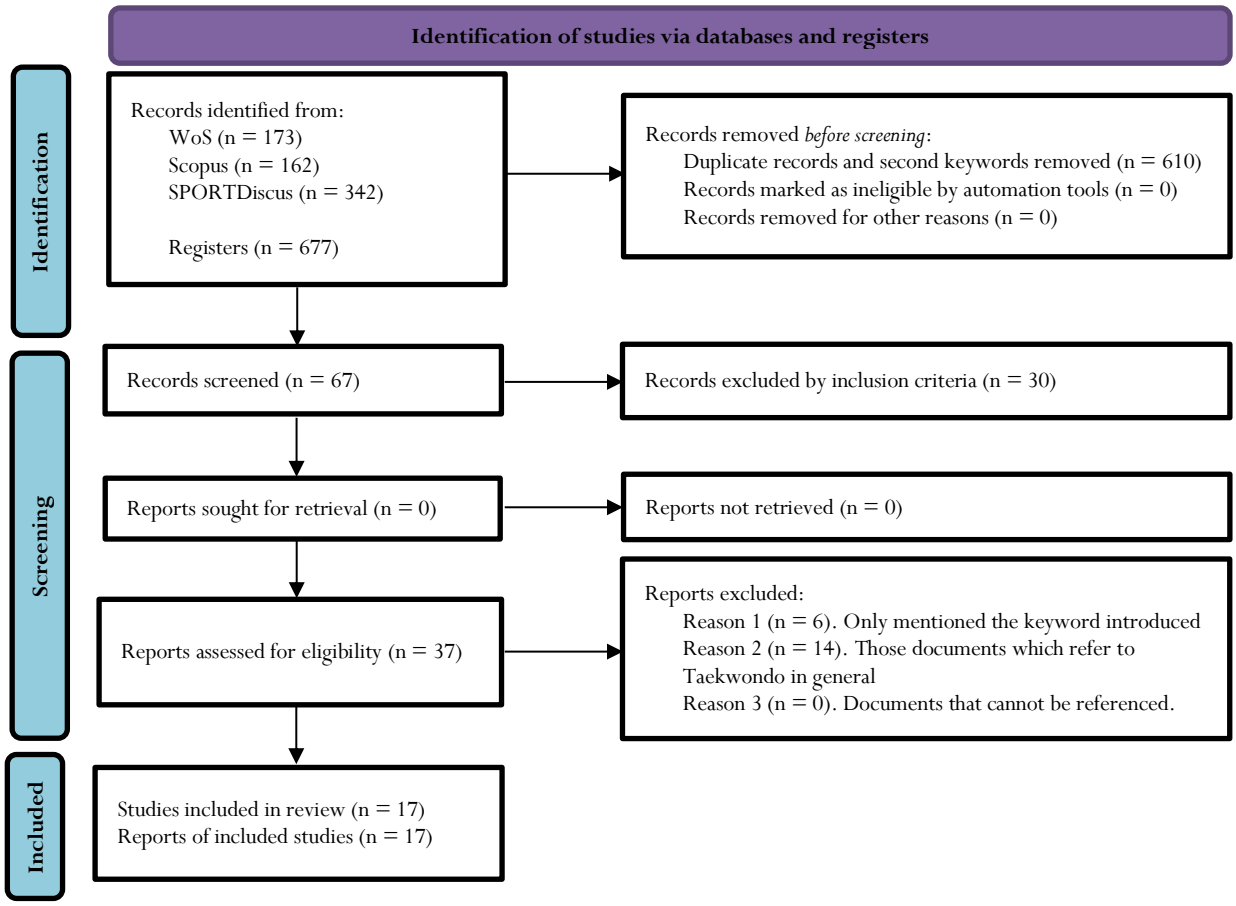

Figure 1. Flow chart of the search

Variable codification

The documents selected to be included in the study sample ($n = 17$), were classified according to different variables (Table 2). To increase the validity and reliability of the process, these variables have been used in previous studies related to the performance analyses in different sports, such as football (Alberto-Tienza et al., 2023), wheelchair basketball (Hernández-Beltrán, Mancha-Triguero et al., 2023), wheelchair tennis (Hernández-Beltrán, León et al., 2023), or football for blind people (Gamonales et al., 2018a).

Table 2.
Variables analysed

Variable	Acronym	Description
General variable	Title	Title of the scientific article.
	Author/s	First surname or scientific name of each author of the selected bibliographic reference.
	Year	Official year of publication.

	Main purpose	The aim of the study selected.
Specific variable	Databases	Electronic platform of the databases.
	Publisher Title	Mention the name of the journal editor.
	Type of document	Scientific journal document.
	Keywords	Terms included in the document.
	Design Type	Classification of documents according to the type of study following the Ato et al. (2013) proposal.
	Ethical Committee	Does the document present an ethical committee of the authors' university?
	Sample 1	Does the document describe the sample in detail?
	Sample 2	Number of participants/documents.
	Sport Science Discipline	Classification of documents according to Haag et al. (2016).
Thematic variables	Type of analyzed variables	Describes the analyzed variables.
	Techniques analysed	Briefly describe the analyzed techniques.
	Type of technique	Identify the type of techniques analyzed in the documents.
	Competition level	Mention of the competition.
Methodological quality of the documents variable	Quality of selected documents	Assessment the methodological quality of documents selected, according to the evaluation of observers/experts in the study subject.

Registration procedure

The procedure used is in accordance with Thomas et al. (2023), a correct planning is crucial to extract relevant articles and conclusions (Gamonales et al., 2018a). All the documents selected, for this research, comply with established inclusion criteria. The documents selected were classified in an Excel Spreadsheet to analyze them deeply, according to the variables established previously (Table 2). Finally, to evaluate each document regarding the methodological quality, Law et al. (1998) questionnaire was used. This questionnaire was carried out by different researchers unconnected to the study. Also, these evaluators were selected according to different inclusion criteria:

a) having a doctoral degree in Sport Science.

b) having extensive experience in sports and data analysis.

c) being a teacher of gymnastics and martial arts.

d) having knowledge and experience as a taekwondo fighter (minimum of 3 years).

After selecting the experts (n=4), a training and familiarization process was carried out to increase the reliability of the scores. This process was developed into 4 phases (Gamonales et al., 2018b): 1) Preparatory stage, 2) Selection stage of the coders, 3) Training stage of the observers and, 4) Reliability stage. In the final stage, an analysis of intra-observer reliability (p = 0.99), and inter-observer reliability (p = 0.94) was performed.

Finally, the documents were classified following Sarmento et al. (2018) proposal:

- Excellent methodological quality (A), scores upper than 75.00.
- Good methodological quality (B), scores between 51.00 and 74.99.
- Low methodological quality (C), scores lower than 50.99.

Statistical analysis

Reliability analysis was carried out through Multirater Kappa free (Randolph, 2005), to analyses the level of equally between the experts. Then, with the data, a descriptive analysis was carried out using the Keywords. The software used for the analysis was the Statistical Package for the Social Science (v27, 2021, IBM SPSS, Armonk, NY, USA). For the creation and visualization of the figures, Microsoft Excel (2006 version: Microsoft Corporation, Redmond, WA, USA) was used.

Results

Table 3 shows the documents selected and classified in chronological order according to the general and specific variables of each document. Table 4 shows the documents regarding the topic and methodological quality variables.

Table 3.
Selected documents related to the taekwondo techniques depending on the variables

ID	Title	Authors & Year	Main purpose	Database	Publisher Title	Type of document	Keywords	Design Type	Ethical Committee	Sample 1	Sample 2	Sport Science Discipline
1	Application Of Sports Biomechanics In The Technical Analysis Of Taekwondo Kicking	Yao (2023)	Apply a technical analysis of the taekwondo kick through a sports biomechanics approach.	WOS & Scopus	Revista Brasileira de Medicina do Esporte	Scientific article	Biomechanical Phenomena, Martial Arts, Athletes	Instrumental study	No present the Ethical Committee of the author's university.	Yes	30 Taekwondo athletes	Sports Biomechanics
2	Design and Validation of an Instrument for Technical Performance Indicators of the Kick (Chagi) Technique in Taekwondo	Sousa et al. (2022)	The main aim of this study was to develop an Observation System for Technical Performance Indicators-Chagi	WOS & Scopus	Applied Science	Scientific article	Taekwondo, technique, validation, observational methodology	Instrumental study	Yes	Yes	19 Taekwondo expert coaches	Sports Biomechanics
3	Kinematic and kinetic demands on better round-	Huang et al. (2022)	The aim of this study was to investigate the differences in the	WOS, SPORTDiscus & Scopus	Sports Biomechnics	Scientific article	Taekwondo, electronic body protec-	Quasi-experimental	Yes	Yes	18 Taekwondo athletes	Sports Biomechanics

	house kick performances		biomechanical characteristics between the roundhouse kicks with higher and lower impact magnitude using an electronic body protector.				tor, Roundhouse kick, Kicking technique, Segment velocity					
4	Contributions of body segments to the toe velocity during taekwondo roundhouse kick	Jung & Park, (2022)	To investigate the effects of various footwork techniques on biomechanical contributions of body segments to toe velocity during roundhouse kicks.	WOS & Scopus	Applied Science	Scientific article	Motion analysis, biomechanics, combat sports, footwork	Quasi-experimental	Yes	Yes	10 Taekwondo athletes	Sports Biomechanics
5	Relationship between the specific agility test in taekwondo (tsat), explosive strength and 5-m linear speed in taekwondo athletes of both sexes	Ojeda-Aravena et al. (2021)	The purpose of this study was to examine the association between the TSAT test, explosive strength, and 5-M line speed. Through a correlational design, 14 competitors of both sexes who regularly compete.	WOS, SPORTDiscus & Scopus	Retos-Nuevas Tendencias en Educación Física, Deporte y Recreación	Scientific article	Combat sports, change of direction, physical performance, strength	Quasi-experimental	No present the Ethical Committee of the author's university.	Yes	14 taekwondo athletes of both sexes.	Sport & Exercise Physiology
6	The Associations of Vitamin D Status with Athletic Performance and Blood-borne Markers in Adolescent Athletes: A Cross-Sectional Study	Seo et. al. (2019)	The purpose of this study was to examine the associations of vitamin D status with athletic performance and blood-borne markers in adolescent athletes.	WOS & Scopus	International Journal of Environmental Research and Public Health	Scientific article	25-hydroxivitamin D, exercise performance, stress-to-recovery status, adolescent athletes	Cross-sectional study	No present the Ethical Committee of the author's university.	Yes	47 taekwondo athletes, aged 15-18 years old.	Sport & Exercise Medicine
7	Cortisol predicts performance during competition: preliminary results of a field study with elite adolescent taekwondo athletes	Lautenbach & Lobinger (2018)	The aim of the study was to investigate cortisol relation to outcome, performance and whether cortisol can predict performance during a competition.	WOS, SPORTDiscus & Scopus	Applied Psychophysiology and Biofeedback	Scientific article	Elite athletes, Competition data, Performance prediction, Regression	Quasi-experimental	Present the Ethical Committee of the author's university.	Yes	Twenty taekwondo combatants (13 males; M-age = 15).	Sport & Exercise Physiology
8	Relationships of the expertise level of taekwondo athletes with electromyographic, kinematic and ground reaction force performance indicators during the dollyo chagui kick	Moreira et al. (2018)	The aim of the study is knowledge about kinematic and neuromuscular indicators of the dollyo chagui executed by elite and sub elite taekwondo athletes. Biomechanical measures included angular and linear velocities of leg and pelvis, ground reaction force, premotor time, reaction time, kicking time and contraction index of EMG activation of 8 leg muscles, obtained through the analysis of this kick.	WOS, SPORTDiscus & Scopus	Archives of Budo	Scientific article	Biomechanics, Co-contraction, Reaction time, Velocity	Quasi-experimental	Present the Ethical Committee of the author's university.	Yes	14 black belt taekwondo athletes (7 elite, 23.6 +/- 2.1 years old; and 7 sub elite, 22.4 +/- 1.3 years old).	Kinanthropometry
9	Postural stability assessment in elite taekwondo athletes: comparative study between different age groups	Beslija et al. (2017)	The main aim of this investigation was to characterize the postural stability profile in elite Croatian male and female Taekwondo athletes. The second aim was to compare postural stability in frontal	WOS	Acta Kinesiologica	Scientific article	Balance, Selection, Stabilization	Quasi-experimental	No present the Ethical Committee of the author's university.	Yes	121 Taekwondo athletes. Seniors (N=38), Juniors (N=40) and Cadets (N=43).	Motor behavior: motor development, motor control and learn.

			and sagittal plane in Taekwondo athletes of different age groups.									
10	Effects of gradual weight loss on anaerobic capacity and muscle strength in elite taekwondo ITF athletes	Bakonska-Pacon et al. (2017)	The aim of this study was the effects of a 6-week gradual weight loss program on anaerobic capacity, body composition and muscle strength of taekwondo athletes.	WOS & SPORTDiscus	Archives of Budo	Scientific article	Balanced diet, Body composition, Muscle balance, Training workloads, Water balance, Wingate test	Quasi-experimental	Present the Ethical Committee of the author's university.	Yes	18 Practicing Taekwondo Second Dan (9 men & 9 women).	Sport & Exercise Physiology
11	Selected dimensions of the self-esteem and a kinematic effect of the intentional target at taekwondo athletes	Ortenburger et al. (2016)	The aim of this paper is the new knowledge concerning: the role of an intentionally indicated target in front kick kinematics, and the impact of selected aspects of the feeling of personal competence on kicking kinematics.	WOS	Archives of Budo Science of Martial Arts and Extreme Sports	Scientific article	Front kick, Kicks kinematics, Martial arts, Movement kinematic, Performance, Psychological facto, Sense of personal competence, Velocity.	Experimental design	Present the Ethical Committee of the author's university.	Yes	6 Women Training (International Taekwon-do Federation).	Kinanthropometry
12	Segmental kick velocity is correlated with kick specific and non-specific strength performance in a proximodistal sequence	Moreira et al. (2015)	The purpose of this study was to answer the question if kick velocity is correlated with kick specific and nonspecific strength performance, in a proximodistal sequence.	WOS & Scopus	Archives of Budo	Scientific article	Ballistic velocity, Explosive strength, Martial arts, sport Performance, Vertical jump.	Experimental design	Present the Ethical Committee of the author's university.	Yes	6 Male black-belt taekwondo athletes (20.5 +/- 4.3 years).	Sport & Exercise Physiology
13	Talent detection in taekwondo: which factors are associated with the longitudinal competitive success?	Moreira et al. (2014)	The aim of this study is answer the question which factors are associated with the longitudinal competitive success of TKD young athletes over five competitive years (2008 to 2012).	WOS, SPORTDiscus & Scopus	Archives of Budo	Scientific article	Anthropometry, Biomechanical variables, Body composition (DEXA), Indicators, WTF Taekwondo.	Experimental design	Present the Ethical Committee of the author's university.	Yes	6 Taekwondo athletes (13.06 +/- 1.07 years), who trained three to six hours per week, for more than three years.	Sport & Exercise Physiology
14	Physiological and psychological performance of taekwondo athletes is more affected by rapid than by gradual weight reduction	Yang et al. (2014)	The purpose of this study was the knowledge about the effects of Rapid Weight Reduce and Gradual Weight Reduce in Taekwondo athletes on physiological and psychological changes and performance with the sport specific investigation.	WOS, SPORTDiscus & Scopus	Archives of Budo	Scientific article	Creatinine, Creatine kinase, Electrolytes, Kick-frequency, Urea, Weight loss	Experimental design	Present the Ethical Committee of the author's university.	Yes	10 Well-trained male Taekwondo athletes.	Sport & Exercise Physiology
15	Anaerobic evaluation of taekwondo athletes	Sant'Ana et al. (2014)	This study proposes a method for evaluation of the anaerobic power and capacity during a specific Taekwondo anaerobic test (TAT).	Scopus	International Sport Medicine Journal	Scientific article	Taekwondo, Anaerobic test, Muscular power, Performance	Descriptive study	No present the Ethical Committee of the author's university.	Yes	10 Males Taekwondo athletes (age 25 ± 3 yrs.).	Sport & Exercise Medicine
16	Concept and procedure for measuring anaerobic motricity in Taekwondo	Paunescu et al. (2013)	The aim of this study is trying to identify the adequate solution by simultaneously considering two criteria: the attribute of significance of the motricity investigation and the feature of practicality	Scopus	Applied Mechanics and Materials	Scientific article	Maximal anaerobic power, Myotest PRO device, Sports performance in Taekwondo	Experimental design	No present the Ethical Committee of the author's university.	Yes	14 Practicing Taekwondo (average age of 23 +/-2 years).	Sport & Exercise Medicine

17	Technical and Tactical Analysis of Youth Taekwondo Performance	Casolino et al. (2012)	This study aimed to analyze the technical and tactical aspects of young athletes during official taekwondo competitions.	WOS & Scopus	Journal of Strength and Conditioning Research	Scientific article	Match analysis, Technical indicators, Youth taekwondo athletes	Experimental design	Present the Ethical Committee of the author's university.	Yes	59 Youth Taekwondo athletes (43 boys & 16 girls).	Pedagogy of Sport

Sample 1 – The sample was detailed described; Sample 2 – Number of the participants/documents

Table 4.
Specific variables analysed

ID	Type of analyzed variable	Analyzed technique	Type of technique	Quality of selected documents
1	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.	The movements included technical kicks and the collection of motion trajectories when hitting the target.	Offensive technique	A
2	Take off the foot, Knee lift, Start of leg extension; Contact movement; Start of leg flexion; Thigh extension	Taekwondo kick skill process	Chagui	A
3	Peak linear velocity of shank, foot velocity level	Kinematics data of the kicking leg.	Offensive technique	A
4	The Roundhouse Kick without Footwork, Roundhouse Kicks with Angle-Change Types of Footwork (One-Foot Backstep), Roundhouse Kicks with Distance-Change Types of Footwork (Backstep with Both Feet)	Leg Techniques (kicks)	Roundhouse kick	A
5	Male and female taekwondo athletes, age, height, weight, experience, explosive strength, squat jump, countermovement jump, 5-m linear speed, taekwondo-specific agility test.	No analyze any taekwondo technique.	No analyze any type of technique.	A
6	Male adolescent taekwondo athletes, age, height, weight, training experience, Physique and Skeletal Maturation, Body Composition and Bone Mineral Density, Serum 25-hydroxyvitamin D and Blood-borne Markers, Athletic Performance.	No analyze any taekwondo technique.	No analyze any type of technique.	A
7	Male and female taekwondo athletes, body mass index, age, cortisol, performance measure, salivary sample.	No analyze any taekwondo technique.	No analyze any type of technique.	A
8	Black belt taekwondo athletes, age, weight, height, biomechanical measures.	Dollio chagui kick technique	Defensive technique	A
9	Taekwondo athletes, range center of force X, range center of force Y, force, area of sway, sway distance, speed of sway.	No analyze any taekwondo technique.	No analyze any type of technique.	A
10	Man and Women Taekwondo athletes, anaerobic capacity, maximum power, time to maximum power, total work, fatigue index, body composition, concentration of lactate, muscle torque of the lower extremities in isokinetic condition.	No analyze any taekwondo technique.	No analyze any type of technique.	A
11	Women taekwondo athletes, age, body mass, height, Kinematic measures, psychological measures ability to initiate demanding activity, stamina in continuing activities.	Leg Techniques (kicks)	Offensive technique	A
12	Black belt taekwondo athletes, Age, Weight, Height, Kick velocity, Isometric strength indicators, Leg press evaluation, Counter movement jump, kick ground reaction force.	Leg Techniques (kicks)	Offensive technique	A
13	Taekwondo athletes, age, weight, height, skinfolds (biceps, triceps, subscapular, supraspinatus, suprailiac, abdominal, medial germinal and frontal thigh), body composition, bone maturation, reaction time, movement time, agility coefficient (bandal chagui), counter movement and squat jump, competitive ranking.	No analyze any taekwondo technique.	No analyze any type of technique.	A
14	Male taekwondo athletes, weight classes, at least 10 years practice, blood sample, body weight, body water, body fat, squat jumps, countermovement jumps, lactate production rate, kick frequency, psychological mood state.	No analyze any taekwondo technique.	No analyze any type of technique.	A
15	Male taekwondo athletes, Age, Body mass, Height, Percentage body fat, Time of practice, Number of kicking cycle, Mean kick time, Best kicking time, Highest impact, Mean impact), Fatigue index, Peak post-test blood lactate, Muscular power during a counter movement jump.	Bandal chagui	No analyze any type of technique.	A
16	Practicing Taekwondo, Age, Height, Weight, Quality of jumping, Height jump, Power, Strength, and velocity.	No analyze any taekwondo technique.	No analyze any type of technique.	A
17	Youth athletes, Age range, Weight category range, Typology of action, match outcome, Kicking leg, Match period, Kicks technique (backward slide turning kick, anticipated turning kick, direct turning kick, switched feet turning kick, back kick, shuffled kick, jumping fake turning kick, 360° turning kick).	Leg Techniques (kicks)	Offensive technique	A

Table 5.
Keywords grouped

Group	Description
Taekwondo	Competition area, Combat sport, Martial arts, WTF Taekwondo
Technical & Tactical	Chance of direction, Front kick, kicks kinematics, Kick frequency, Kicks technique, Roundhouse kicks, Footwork
Performance	Physical performance, Exercise performance, Performance prediction, Performance, Sport performance, Sports performance in Taekwondo
Physical ability	Strength, Reaction time, Velocity, Training workloads
Health care	25-hydroxivitamin D, Balance, Balanced diet, Body composition, Water balance, Body composition (DEXA), Creatinine, Creatine kinase, Electrolytes, Urea
Biomechanics	Biomechanics, Movement kinematic, Anthropometry, Biomechanical variables
Athletes	Adolescent athletes, Elite athletes, Youth taekwondo athletes
Physiological test	Wingate test, Anaerobic test, Vertical jump test

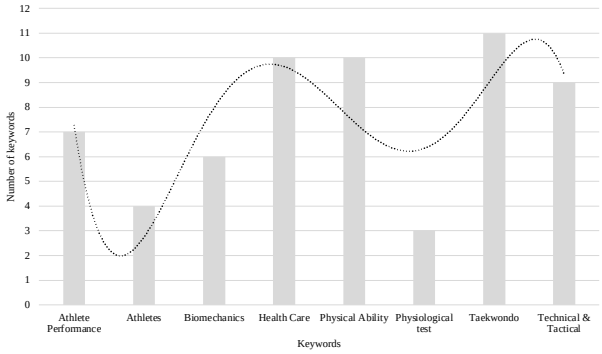

Figure 2. Most used keyword

Figure 2 shows the main keywords used in articles from different scientific journals. The keywords' *Physical ability* and *Health care* were referenced tenfold, and

Taekwondo and *Performance* were the most used in the selected documents.

To reduce the number of terms, some of keywords were grouped by semantic field (Table 5). Also, to improve the understanding of the results, only keywords with an occurrence equal to or upper 3 were included in the analyses.

Discussion

This study aimed to conduct an original systematic review that brings up to date the state of the most important and significant documents on subject of techniques in taekwondo data analysis, following the methodological processes pronounced in the literature. The goal of this systematic review was to do a systematic review related to the effective techniques in Taekwondo and analyse the most used techniques in taekwondo combat.

In terms of databases, most of the documents have been identified in several databases, with WOS identifying the highest number of studies (n = 15), followed by Scopus (n = 14). WOS is one of the databases with the highest number of indexed documents, and it is estimated that 95-99% of the studies indexed in WOS are found in Scopus (Singh et al., 2021). Therefore, WOS is one of the databases that should always be included in literature reviews, with the aim of identifying the largest number of documents related to the study objective. On the other hand, according to the year of publication, 2014 and 2022, are the year with the highest number of documents published (n = 3). This fact shows the concern from the beginning on the part of researchers to analyse taekwondo techniques for performance analysis (Menescardi et al., 2019). Finally, according to the journal in which the study has been published, "Archives of Budo" is the one with the highest number of papers (n = 5), followed by Applied Science (n = 2). This fact indicates that a correct identification and selection of journals for the publication of the documents should be carried out, and, in this way, the documents should be published in specialized journals related to the subject, with the aim of obtaining a higher impact index in the scientific community. According to Benito-Peinado et al. (2007), the review allows to focus the objective of the investigation because it helps to find unresolved questions from previous studies.

Depending on the type of design used, there is a great variety among the studies identified, such as instrumental studies (Yao, 2023; Sousa et al. 2022), descriptive studies (Sant'Ana et al., 2014), quasi-experimental studies (Bešlija et al., 2017; Bakonska-Pacon et al., 2017), experimental studies (Ortenburger et al., 2016) using a cross-sectional approach (Seo et al., 2019). Analyzing a subject from different typologies of study and methodological approaches will allow us to know to a large extent all the factors that influence the performance of athletes from different points of view and analysis, drawing relevant conclusions.

All selected documents show the discrete/interval quantitative variable (age), continuous quantitative variable (such as height, weight, number of kicks, body mass, etc.), nominal qualitative variable (such as gender, time of practice, competitive ranking, etc.) and categorical variable (taekwondo athlete). Depending on the techniques analysed, most of the documents focused on the analysis of offensive actions, to analyze the movements during the kick phase, as well as the trajectory and impact zone (Yao, 2023), or the kick technique (Ortenburger et al., 2016) through the Roundhouse kick (Jung & Park, 2022). Estevan et al. (2010) concluded that among the kicks performed in the fighting, are the circular kick to the chest or Bandal chagui, with 27% of the total points in the fighting and 10% of the knockouts. The roundhouse kick executed by the front leg, requires less time than the that of the back leg, it might be more effective in fast attacking legal area to score point during competition, and, on the other hand, this kick executed by the back leg generates greater momentum, which would make the opponent more difficult to block and thus create new chances to further attack (Kong et al., 2000). To close they concluded, also, that maximum linear velocity of the roundhouse kick executed by the back leg was greater than the front leg by 39.46% and 61.78% for the ankle and knee respectively. In taekwondo competition, Luk et al. (2001) pointed out a high percentage of the back leg and roundhouse kicking and kicking actions to the trunk was the dominant target.

The roundhouse kick is famous, powerful, and most frequently attack in Taekwondo (Thibordee & Prasartwuth, 2014), that's why most athletes intently perform this kick for scoring in competition. Finally, a physical target will function as a stimulus, affecting the motor control of athletes (Wasik & Shan, 2015).

In relation to the methodological quality, it should be noted that all the documents present an Excellent quality, with a score above 75 points (Sarmento et al., 2018). The documents were evaluated by a total of 4 experts in the subject matter under study, whose intra- and inter-observer reliability was analysed, obtaining a value of p = 0.99, and p = 0.94, respectively (Ibáñez et al., 2019; Antúnez et al., 2021). To obtain reliable values, it is recommended to increase the number of experts, as well as to establish inclusion criteria. In addition, new evaluation tools with a wider range of questions should be designed and validated to analyse the most relevant aspects of the research to a large extent.

The main limitation of the study was the rare number of documents related to taekwondo techniques, which made the process of extracting results and establishing conclusions difficult. As a strength, this study is a primary systematic review of the literature which analyzes the most used techniques in taekwondo, and this provides coaches, sportsmen, and researchers with information for quantifying and measuring the performance. In this line, for future research, it is recommended to carry out deeper searches using different terms and develop tests for measuring the g-force of the impacts and kicks or for visualization of the direction and impact zone of the kicks.

Conclusions

The present literature review method has allowed the identification and highlighting of different kinds of documents, which report the study of taekwondo associated with techniques. The selected document report taekwondo techniques skills are scarce ($n = 13$), most are found in the WOS database ($n = 11$), were published predominantly in the year 2014, and all documents are scientific articles. Furthermost of the selected documents are related to Fundamental Academic Discipline in Sports Science and some of them can be cataloged as multidisciplinary.

The must-study taekwondo technique is roundhouse kick (Korean terminology: "*bandal chagui*" or "*dollyo chagui*" - kick to the chest or to the helmet gear). These techniques are effective and must use techniques in a taekwondo combat. The analysis of the most used techniques during competitions serves as a support and tool for coaches to know the most used strokes and, in this way, improve technical and methodological aspects during training to improve performance and results in competitions.

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Informed consent of study participants

The review study was conducted in accordance with the ethical provisions of the Declaration of Helsinki (2013), and in compliance with the guidelines of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016.

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Annex 1

An-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head opponent. At the moment before contact, there is an extension and internal movement of the contact leg, and the contact, with the target, is made with internal part of the foot contact. This movement occurs with a simultaneous external rotation of the contact leg (up to 90º).

Ap-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head or trunk to opponent. At the moment before contact, there is a leg and foot extension, and a simultaneous external rotation of the support leg on the tiptoe or on the sole foot (up to 90º). The contact with the target is made with the distal plantar tip of the metatarsal bones of the foot.

Bakkat-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head opponent. At the moment before contact, there are an extension and external movement of the contact leg, and the contact, with the target, is made by external part of the foot. This movement occurs with a simultaneous external rotation of the contact leg (up to 90º).

Dollyo-chagui is a Taekwondo kicking technique, which involves a semi-circular upward kick from the beginning of the movement to the moment of contact with the target (upper zone - head). At the moment before contact, there are extension and internal rotation of the contact leg, foot flexion, and a simultaneous external rotation of the support leg on tiptoe or on the sole foot (up to 180º). The contact of the foot area with the target, is made with the distal area of the sole, i.e., the distal plantar tip of the metatarsal bones of the foot.

Bandal-chagui is a Taekwondo kicking technique, which involves a semi-circular upward kick from the beginning of the movement to the moment of contact with the target (middle zone - trunk). At the moment before contact, there are an extension and an internal rotation of the contact leg, foot extension, and a simultaneous external rotation of the support leg on tiptoe or on the sole foot (up to 180º). The impact is made with the instep of the contact foot.

Furio-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head opponent. At the moment before contact, there are a leg and foot extension, and the contact is made with the plantar of the foot in a descend and oblique trajectory. This movement occurs with a simultaneous external rotation of the support leg (up to 180º).

Mom dollio furio-chagui is a Taekwondo kicking technique, which involves a support leg internal rotation (up to 180º). At the moment before contact, there are a leg and foot extension, and the contact is made with the plantar of the foot in a descend and oblique trajectory. This movement occurs with a simultaneous internal rotation of the support leg (up to 360º).

Miro-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head opponent. At the moment before contact, there is a leg extension and foot flexion, and a simultaneous external rotation of the support leg on the tiptoe or on the sole foot (up to 90º). The contact with the target is made with the distal plantar zone of the foot.

Nako-chagui is a Taekwondo kicking technique, which involves a nonlinear movement with the attack leg. The movement start with a support leg external rotation (up to 90º). At the moment before contact, there are a leg extension and foot flexion, and the contact is made with the heel in a horizontal trajectory. This movement occurs with a simultaneous and continuous external rotation of the support leg (up to 180º).

Mondollio nako-chagui is a Taekwondo kicking technique, which involves a support leg internal rotation (up to 180º). At the moment before contact, there are a leg and foot extension, and the contact is made with the heel in a horizontal trajectory. The movement occur with a simultaneous and continuous internal rotation of the support leg (up to 360º).

Neryo-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the head opponent. At the moment before contact, there are a leg and foot extension, and the contact is made with the plantar or heel of the foot in a descend trajectory. This movement occurs with a simultaneous external rotation of the support leg (up to 180º).

Tuit-chagui is a Taekwondo kicking technique, which involves a linear and direct kick to the trunk or head opponent. At the moment before contact, there is a leg extension and foot flexion. The contact with the target is made with the heel.

Yop-chagui is a Taekwondo kicking technique, which involves a nonlinear movement with the attack leg. The movement start with a support leg external rotation (up to 90º). At the moment before contact, there are a leg extension and foot flexion, and the contact is made with the heel in a direct, horizontal or ascendent trajectory. This movement occurs with a simultaneous and continuous external rotation of the support leg (up to 180º). All the kick techniques start in Taekwondo combat position. The athletes are in a standing position with one foot in front and the other behind. The kicks start with knee up and leg flexion. The kicks start-up in the sagittal plane and finish in the transverse plane.