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Review

The effects of taekwondo practice on physical and cognitive variables in children and adolescents: a systematic review

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Abstract: Taekwondo can develop social responses, beliefs, values, attitudes, and cognitive experiences due to its characteristics and the diversity of frequency, intensity, time, and type of application. This can facilitate the achievement of results related to physical health and cognition in individuals in the formation phases. Thus, this study aimed to analyze the effects of taekwondo practice on physical and cognitive variables in children and adolescents. This systematic review followed the PRISMA recommendations and was registered in PROSPERO (CRD42021293609). The search was performed in the MEDLINE (via PubMed), Scopus, SPORTDiscus, and Web of Science databases. The search terms were related to the theme taekwondo, school, and students with the keywords grouped in a single Boolean phrase: "taekwondo AND school" OR "taekwondo AND students". Studies that analyzed the effects of taekwondo on health-related variables in children and adolescents of both sexes were included. The risk of bias in experimental and quasi-experimental studies was analyzed using the Cochrane Collaboration tool and the Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) tool, respectively. After using the selection criteria, 8 studies were included. Study interventions consisted of a minimum of 8 weeks and a maximum of 72 weeks. There was a total of 402 participants aged between 6 and 16 years, of which 75% were male. The protocols demonstrated improvement in cognitive performance, strength, flexibility, and balance after taekwondo intervention. We concluded that the practice of taekwondo was able to bring positive responses to physical and cognitive performance in children and adolescents.

Keywords: martial arts; students; child; adolescent; physical fitness; cognition.

1. Introduction

Childhood and youth are important stages of human development. The transition from adolescence to adulthood marks the biological, psychological, mental, and social evolution, being considered maturation, a process of morphological and physiological changes that occur during growth. This change to adulthood depends on how healthy this period is (Bayansalduz, 2014).

The level of physical activity can positively influence the health of individuals (Ruegsegger & Booth, 2018). On the other hand, physical inactivity in children and adolescents can represent a public health problem. An increase in this condition is observed with technological advances, excessive use of cell phones, tablets, and electronic games, which can lead to the development of diseases associated with a sedentary lifestyle, such as obesity, sleep problems, mental health impairment, changes in body composition, decrease in physical conditioning and school performance (Hoare et al., 2016). However, physical exercise can be a strategy for maintaining health and preventing the harmful effects inherent to a sedentary lifestyle in adolescence (Benassi et al., 2018).

Combat sport are among the different forms of physical exercise. Taekwondo is a Korean combat sport practiced in more than 200 countries and 5 continents. It consists of attack and defense movements with the hands and feet in combined techniques (forms) and in the fight itself (Matsoki) (Chen, 2022). Taekwondo participated as a demonstration sport at the Asian Games in Seoul in 1986, at the Olympic Games in Seoul in 1988, and the Olympic Games in Barcelona in 1992, but it was not until Sydney 2000 that it became an Olympic sport (Park & Kim, 2016; Pilz-Burstein et al., 2010).

The participation of taekwondo in these events allowed an increase in the number of practitioners, especially in the population of children and adolescents, as it is a combat sport that values respect, courtesy, and self-defense. Furthermore, it is a recommended modality to stimulate positive actions in adolescents, as it involves social responses, beliefs, values, attitudes, and cognitive experiences (Cho et al., 2018).

Therefore, taekwondo can develop these actions due to its characteristics and the diversity of frequency, intensity, time, and type of application. This can facilitate the achievement of results related to physical health and cognition in individuals in the formation phases (Cho et al., 2018; Seonwoo & Jeong, 2021). Hence, the following question was raised: What effects can taekwondo have on physical and cognitive variables in children and adolescents?

Thus, the present study aimed to analyze the effects of taekwondo practice on physical and cognitive variables in children and adolescents.

2. Materials and Methods

This study is characterized as a systematic literature review. The procedure for conducting this research followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria (Page et al., 2021) and was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under number CRD42021293609.

Search process — Two independent and experienced researchers conducted an electronic search without language or time filters, in January 2022, in the MEDLINE (via PubMed), Scopus, SPORTDiscus, and Web of Science databases. Any disagreements between the two researchers were solved through discussion or arbitration by a third researcher. The terms related to the theme were taekwondo, school, and students. Then, the terms were grouped into a single Boolean phrase as follows: PubMed: (((taekwondo[Title/Abstract]) AND (school[Title/Abstract])) OR (taekwondo[Title/Abstract])) AND students[Title/Abstract]); Web of Science: taekwondo (topic) AND school (topic) OR taekwondo (topic) and students (all fields); Scopus: (TITLE-ABS-KEY (*taekwondo*) AND TITLE-ABS-KEY (*school*) OR TITLE-ABS-KEY (*taekwondo*) AND TITLE-ABS-KEY (*students*)); SPORTDiscus: taekwondo (AB ABSTRACT) AND school (AB ABSTRACT) OR taekwondo (AB ABSTRACT) AND students (AB ABSTRACT).

Eligibility criteria — We included experimental and quasi-experimental studies, which analyzed the effects of taekwondo on health-related variables in children and adolescents of both sexes. We excluded studies that did not use taekwondo as the main intervention, articles published in congresses, systematic reviews, and meta-analyses.

Risk of bias assessment — The risk of bias was verified using the Risk Of Bias In Non-randomized Studies - of Interventions (ROBINS-I) tool, which contains seven elements for classification and is carried out in the pre-intervention, intervention, and post-intervention stages. This tool is used in non-randomized studies to evaluate interventions in the health field. Each domain must have the risk of bias classified as "high risk of bias", "severe risk of bias", "critical risk of bias", "moderate risk of bias", or "not informed" (Sterne et al., 2016).

The risk of bias in the experimental studies was analyzed using the Cochrane Collaboration tool, available at: <https://training.cochrane.org/handbook/>. The domains that analyze the risk of bias of randomized controlled trials (RCT) are as follows: 1) generation of the random sequence; 2) allocation concealment; 3) blinding of evaluators and participants; 4) blinding of outcome evaluators; 5) incomplete outcomes; 6) reports of selective outcomes; 7) report on other sources of bias. Each domain has the risk of bias classified as "high", "uncertain", or "low". The final score is assigned with the highest rating among the domains evaluated in each study (Carvalho et al., 2013).

In both tools, the evaluation was carried out by two independent researchers, and the divergences were analyzed by another researcher for consensus.

Data extraction — Data from the included publications were independently extracted by two researchers. Disagreements were solved in a consensus meeting with a third researcher. We analyzed the following variables: authors, year of publication, country, study population characteristics (age, sex, and sample size), and intervention data, including general and specific exercises, intervention duration (weeks), training volume (duration of the training session, in minutes, and training frequency, in times per week), evaluation and outcomes related to physical and cognitive variables.

3. Results

In total, 257 studies were found following the proposed research methodology (MEDLINE via PubMed = 22; Scopus = 81; SPORTDiscus = 52; Web of Science = 102). After using the selection criteria, 8 articles were included in this study (Figure 1).

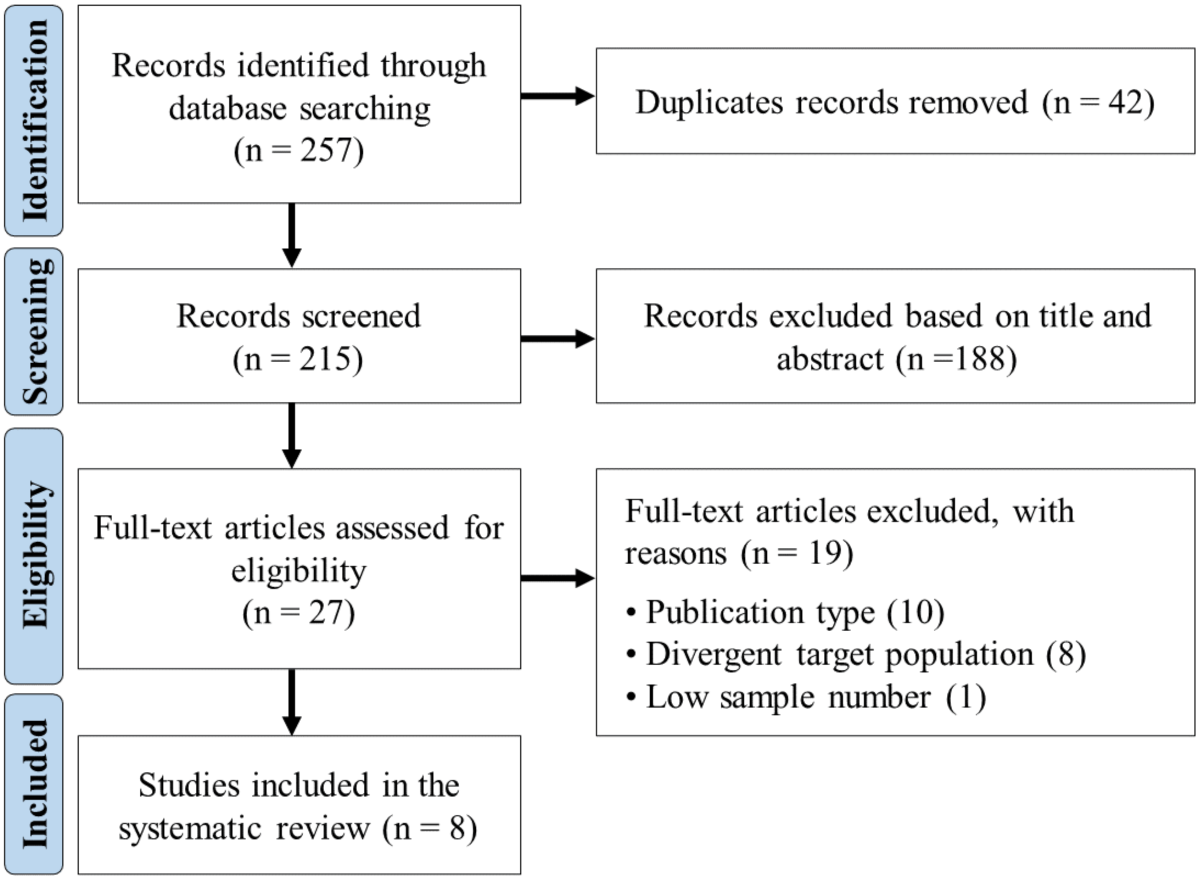

Figure 1. Study selection flow diagram.

Table 1 presents the risk of bias in four non-randomized studies (Cho et al., 2017; Lee & Kim, 2015; Mischenko et al., 2020; Yoon & Kim, 2009) assessed by the ROBINS-I tool. It was observed that the studies presented moderate risk in at least one evaluated bias.

Table 1. Risk of bias of the selected non-randomized studies.

Studies	1	2	3	4	5	6	7	Total
Cho et al., 2017	NI	Moderate	NI	NI	NI	NI	NI	Moderate
Lee & Kim, 2015	NI	NI	NI	NI	Moderate	NI	NI	Moderate
Mischenko et al., 2020	NI	NI	NI	NI	Moderate	NI	NI	Moderate
Yoon & Kim, 2009	NI	Moderate	NI	NI	Moderate	NI	NI	Moderate

1: Bias due to confounding; 2: Bias in the selection of participants into the study; 3: Bias in the classification of interventions; 4: Bias due to deviations from intended interventions; 5: Bias due to missing data; 6: Bias in measurement of outcomes; 7: Bias in the selection of the reported result; NI: not informed.

Table 2 shows the risk of bias of the included RCT (Kadri et al., 2019; Kim et al., 2011; Ma et al., 2018; Ouergui et al., 2021) assessed through the Cochrane Collaboration tool. The four studies were classified as having a low risk of bias.

Table 2. Risk of bias analysis for randomized studies (Cochrane Collaboration tool).

Studies	1	2	3	4	5	6	7	Total
Kadri et al., 2019	Low	Low	Low	Low	Low	Low	Low	Low
Kim et al., 2011	Low	Low	Low	Low	Low	Low	Low	Low
Ma et al., 2018	Low	Low	Low	Low	Low	Low	Low	Low
Ouergui et al., 2021	Low	Low	Low	Low	Low	Low	Low	Low

1: Randomization; 2: Allocation of randomization; 3: Blinding of participants; 4: Blinding of the evaluators; 5: Incomplete outcomes; 6: Report on selective outcome; 7: Other sources of bias.

Table 3 shows the sample characteristics of the included studies. The interventions had a total of 220 participants in the experimental group and 182 in the control group. The mean age of participants in both groups was 11.4 years. The mean number of participants was 26.8 and the total was 402 participants. Of the 8 included studies, 3 are from Korea (Cho et al., 2017; Lee & Kim, 2015; Yoon & Kim, 2009), the country of origin of taekwondo. Male participants appeared in 6 of the 8 studies, while female participants appeared in 3 studies, although 2 studies (Kim et al., 2011; Yoon & Kim, 2009) did not report the sex. The years of publication of the studies ranged from 2009 to 2021.

Table 3. Sample characterization.

Authors	Year	Country	Age: Mean ± SD (years)	Sex	Groups (n)
Cho et al.	2017	South Korea	EG: 11.4 ± 0.7 CG: 11.2 ± 0.8	M/F	EG: 17 CG: 18
Kadri et al.	2019	Tunisia	EG: 14.5 ± 3.5 CG: 14.2 ± 3.0	M/F	EG: 20 CG: 20
Kim et al.	2011	Canada	EG: 15.7 ± 0.4 CG: 15.9 ± 0.6	NI	EG: 21 CG: 10
Lee & Kim	2015	South Korea	EG: 8	M	EG: 55
Ma et al.	2018	China	EG: 7.4 ± 1.2 CG: 7.5 ± 1.2	M/F	EG: 51 CG: 94
Mischenko et al.	2020	Russia	EG: 7 CG: 7	M	EG: 12 CG: 12
Ouergui et al.	2021	Brazil	EG: 15 ± 1.0	M	EG: 24 CG: 8
Yoon & Kim	2009	South Korea	EG: 12.25 ± 0.44 CG: 12.15 ± 0.48	NI	EG: 20 CG: 20

SD: standard deviation; EG: experimental group; CG: control group; M: male; F: female; NI: not informed.

Table 4 presents the intervention characteristics and training volume of the studies. Seven studies had an experimental and a control group and one study (Lee & Kim, 2015) used only an experimental group. All participants in the control groups performed physical exercises, except for the study by Cho et al. (2017). Participants in the experimental groups performed specific taekwondo exercises. Training volume ranged from 8 weeks to 18 months, 45 to 120 minutes per training session, and 2 to 5 sessions per week. Only the study by Cho et al. (2017) reported the percentage of intervention intensity using heart rate as a physiological parameter, with values between 50–80% maximum heart rate.

Table 4. Study intervention data.

Study	Intervention	Duration (weeks)	VT
Cho et al., 2017	EG: taekwondo, 50-80% HRmax CG: did not perform physical exercises	16	70 min/session 5 ×/week
Kadri et al., 2019	EG: taekwondo CG: school Physical Education	72	50 min/session 2 ×/week
Kim et al., 2011	EG: taekwondo CG: school Physical Education	12	50 min/session 2 ×/week
Lee & Kim, 2015	EG: taekwondo	16	50 min/session 5 ×/week
Ma et al., 2018	EG: taekwondo CG: running	12	60 min/session 1 ×/week 60 min/session 5 ×/week
Mischenko et al., 2020	EG: taekwondo Kukkiwon CG: traditional taekwondo and trampoline-acrobatic training	32	45 min/session 3 ×/week
Ouergui et al., 2021	EG: specific taekwondo CG: conventional taekwondo	8	120 min/session 3 ×/week
Yoon & Kim, 2009	EG: taekwondo CG: free physical exercises	8	50 min/session

EG: experimental group; CG: control group; VT: volume of training; HRmax: maximum heart rate; min: minutes; ×/week: times a week; wtf: world taekwondo federation; NI: not informed.

Table 5 displays data on the evaluation and main results of the included studies. The evaluation variable was divided between 1 and 4 moments according to each study. Physical fitness and anthropometric characteristics appeared in most of the included studies. Variables such as muscle strength, cognitive function, and balance were also analyzed and showed significant post-intervention increases ($p<0.05$).

Table 5. Evaluation data and results of the included studies.

Study	Evaluation	Results
Cho et al., 2017	Cognitive function	EG: ↑ Color-word test; ↑ Self-confidence test; ↔ Word test; ↔ Color test; ↔ Self-regulatory efficacy test; ↔ Task difficulty preference test CG: no significant difference in the evaluated variables
	Body composition	EG: ↔ height; ↔ body mass; ↔ BMI CG: no significant difference in the evaluated variables
Kadri et al., 2019	Cognitive function	EG: ↑ Color block test; ↑ Color-word interference test; ↑ Word test CG: ↓ Color block test; ↓ Color-word interference test; ↓ Word test

Kim et al., 2011	Physical fitness	EG: ↑ Standing long jump; ↑ Sit and reach; ↔ Grip strength; ↑ Flexion 60º right; ↔ Flexion 60º left; ↑ Extension 180º right; ↔ Extension 180º left; ↑ Flexion 180º right; ↔ Flexion 180º left; ↔ Bent arm hang; ↔ 20-m multi-stage endurance run; ↔ VO_{2max} CG: no significant difference in the evaluated variables
	Body composition	EG: ↓ % body fat; ↓ fat body mass; ↔ lean body mass CG: no significant difference in the evaluated variables
Lee & Kim, 2015	Physical fitness *vs*. IGF-1 genetic polymorphism	EG (Homozygote): ↑ Hand grip strength; ↑ Standing on one foot while closing eyes EG (No carrier): ↑ Hand grip strength; ↑ Standing on one foot while closing eyes
	Body composition *vs*. IGF-1 genetic polymorphism	EG (Homozygote): ↑ thigh circumference
	Physiological markers *vs*. IGF-1 genetic polymorphism	EG (Heterozygote × non carrier): ↑ IGF-1; ↑ osteocalcin; ↓ glucose; ↔insulin; ↔HOMA-IR; ↔LDL; ↔ HDL EG (Homozygote × no carrier): ↔ IGF-1; ↔ osteocalcin; ↓ glucose; ↔ insulin; ↔ HOMA-IR; ↔ LDL; ↑ HDL EG (Heterozygote × Homozygote): ↔ IGF-1; ↔ osteocalcin; ↓ glucose; ↔ insulin; ↓ HOMA-IR; ↔ LDL; ↔ HDL
	Bone growth *vs*. IGF-1 genetic polymorphism	EG (No carrier): ↑ expected height
Ma et al., 2018	Demographic data	EG × CG: ↑ Habitual physical activity level, metabolic equivalent hours/week
	Skeletal development	EG × CG: ↓ Delay in skeletal development
	Body composition	EG × CG: ↔ height; ↔ body mass; ↔ BMI
	Physical fitness	EG × CG: ↑ movement assessment battery for children; ↔ eye-hand coordination; ↔ modified clinical test of sensory integration of balance
Mischenko et al., 2020	Physical fitness and motor coordination	EG: ↓ Running 30 m; ↓ Running 6 min; ↑ Push-ups from the knees; ↑ Abdominal crunch; ↑ Standing long jump; ↓ Shuttle run 3×8 m; ↑ Static balance on 1 leg (right and left); ↑ Leaning forward from a standing position; ↓ Statokinetic stability CG: ↑ Standing long jump; ↑ Leaning forward from a standing position, ↓ Shuttle run 3×8 m; ↑ Dynamic balance
	Technical readiness	EG: ↑ front kick; circular kick; ↑ direct hit; ↑ straight blow to three levels; ↑ straight blow to the middle level + front kick to the middle level + circular kick to the middle level CG: no significant difference in the evaluated variables
Ouergui et al., 2021	Physiological markers	EG × CG: ↑ HR; ↑ lactate; ↑ VO_{2max}
	Physical fitness	EG × CG: ↑ CR-10; ↑ agility
Yoon & Kim, 2009	Lower limb strength	EG × CG: ↑ ptEx right to 60º in 4–8 weeks; ↑ ptEx left at 60° at 0–4/4–8 weeks; ↑ ptFx right and left at 60° in 4–8 weeks; ↑ ptFx right to 180º in 0–4 weeks; ↑ ptFx left at 180° in 4–8 weeks; ↔ ptEx at 180° both sides in 0–4/4–8 weeks; ↔ ptFx right at 180° right at 4–8 weeks and left at 0–4 weeks; ↔ ptEx at 60° both sides in 0–4 weeks; ↔ ptEx right at 60° in 0–4 weeks

EG: experimental group; CG: control group; BMI: body mass index; ptEx: knee extension peak touch at angled speed 60 degrees/second; ptFx: knee flexion peak at angular speed 60 degrees/second; IGF-1: insulin-like growth factor type 1; HR: heart rate; CR-10: Borg's CR10 scales; VO_{2max}: maximum volume of oxygen; HOMA-IR: HOmeostatic Model Assessment for Insulin Resistance; LDL-C: low density lipoprotein-cholesterol; HDL-C: high density lipoprotein-cholesterol; TC: total cholesterol; TG: triglyceride; ↓ reduction; ↔ no change; ↑ increase.

4. Discussion

The present study aimed to analyze the effects of taekwondo practice on physical and cognitive variables in children and adolescents. Significant increases in muscle strength, cardiorespiratory fitness, and cognitive function were reported in the studies included in this systematic review.

The analysis of the 8 included studies showed that the practice of taekwondo in children and adolescents for a minimum of 8 weeks, 2 sessions with 45 minutes per week, can be effective in cognitive performance, strength, flexibility, and balance. Among the variables analyzed in this systematic review, five studies showed increases in post-intervention muscle strength (Kim et al., 2019; Kim et al., 2011; Lee & Kim, 2015; Mischenko et al., 2020; Yoon & Kim, 2019). The increase in muscle mass in the lower limbs was evidenced by Yoon and Kim (2009) and Kim et al. (2011) at different angles of movement.

Regarding body composition, Cho et al. (2017) and Ma et al. (2018) found no significant differences in height and body mass index (BMI) in the experimental and control groups after the intervention. However, the study conducted by Kim et al. (2011) showed a reduction in body fat, but no changes in body mass in the experimental group. There was no difference in the control group in the body fat percentage and body mass variables.

Corroborating Cho et al. (2017) and Ma et al. (2018), a study carried out by Formalioni et al. (2020) analyzed the anthropometric characteristics and physical performance of 45 taekwondo fighters with a mean age of 16.4 years and found that men had lower skinfold values when compared to women. Body mass and the sum of skin folds were used to assess body composition. Additionally, vertical jump, abdominal, pushups, handgrip isometric strength, flexibility, and Yo-Yo tests were used to assess physical fitness in both sexes.

Lee and Kim (2015) and Ma et al. (2018) analyzed body composition and bone growth. These studies found increases in height expectancy, reduced skeletal developmental delay, and increased total disability scores ($p<0.05$). In the study by Lee and Kim (2015), bone score, bone age, height difference, and bone age difference showed no differences ($p>0.05$) in the group that received the intervention. Ma et al. (2018) showed a reduction in skeletal development delay in the experimental group when compared to the control group ($p<0.05$). Height, body mass, and BMI showed no differences between groups.

Physical fitness was the most investigated variable in the studies included in this systematic review (Kim et al., 2011; Lee & Kim, 2015; Ma et al., 2018; Mischenko et al., 2020; Ouergui et al., 2021). Variables such as strength, speed, flexibility, motor coordination, and agility were analyzed. Kim et al. (2011) verified the horizontal jump and flexibility and found increases (p<0.05) in the results of the long jump and the sit and reach flexibility test in the comparison between pre- vs. post-intervention intragroup. Regarding the variable agility, Boutios et al. (2021) conducted a cross-sectional study that corroborates with the findings of Mischenko et al. (2020) and Ouergui et al. (2021). The authors (Boutios et al., 2021) analyzed whether the practice of taekwondo enhances visual reaction time, speed, and precision in the execution of technical movements such as kicks and anticipations in the performance of agility in 115 children (83 boys and 32 girls), who were divided into 3 groups (EG1: under 8 years old; EG2: under 10 years old; EG3: under 12 years old). The sample performed the ruler drop test, hexagon agility test, and target kick test. High-level athletes had better (p<0.05) scores on all tests than lower-level athletes.

Ma et al. (2018) observed improvements in motor coordination between groups (EG × CG) (p<0.05), while balance showed no change (p>0.05). Mischenko et al. (2020) found improvements in the reaction time variable (p<0.05) in the pre- *vs*. post-intervention in the experimental group. The study conducted by Bastik et al. (2012) found that the motor skill of 120 children with a mean age of 10 years, assessed through the locomotor test and the test of gross motor development - second edition (TGMD-II), did not show significant differences (p<0.05) among the sports taekwondo, swimming, table tennis, football, handball, and court tennis.

A randomized controlled trial conducted by Roh et al. (2020) evaluated 20 children who did not practice combat sports, with a mean age of 13 years, who received taekwondo as an intervention for 16 weeks, 5 times a week and 60 minutes per session. Changes in myokines were observed with increase (p<0.05) in brain-derived neurotrophic factor and decrease (p<0.05) of irisin. In body composition, there was a reduction (p<0.05) in body mass and BMI, an increase (p<0.05) in lower limb muscle strength with the leg strength, sit-and-reach, and Sargent jump tests. There were changes in oxidative stress biomarkers with reduction (p<0.05) of malondialdehyde and increase (p<0.05) of sodium. These results are similar to the findings of some studies included in our systematic review (Cho et al., 2017; Ma et al., 2018; Kim et al., 2019; Kim et al., 2011; Lee & Kim, 2015; Mischenko et al., 2020; Yoon & Kim, 2019).

The physiological markers insulin-like growth factor 1 (IGF-1), osteocalcin, glucose, insulin, HOmeostatic Model Assessment for Insulin Resistance (HOMA-IR), low density lipoprotein-cholesterol (LDL-C), high density lipoprotein-cholesterol (HDL-C), total cholesterol, and triglycerides were analyzed by Lee and Kim (2015). The authors found an increase in IGF-1 and osteocalcin (p<0.05) in the heterozygote group compared to the non-carrier. There was a reduction in glucose (p<0.05) in the heterozygote and homozygote groups when compared to the non-carrier group. HOME-IR reduced (p<0.05) in the homozygote group compared to the heterozygote group. HDL-C increased (p<0.05) in the homozygote group compared to the heterozygote group and in the non-carrier compared to the homozygote group. LDL-C, triglycerides, total cholesterol, and insulin showed no differences when comparing groups ($p>0.05$) (Lee & Kim, 2015).

Ouergui et al. (2021) evaluated the behavior of physiological parameters in different sizes of combat areas in meters (4×4 m, 6×6 m, 8×8 m). Lower values of perceived exertion were evidenced in the 8×8 m combat area in free combat. Lactate increases ($p<0.05$) were verified in the combat areas (4×4 m, 6×6 m, 8×8 m) compared to pre- and post-intervention. In the performance evaluation, increases in VO_{2max} were verified in both groups and increases in agility only in the 4×4 m group. There were no differences in lower limb potency in either group.

Two studies investigated cognitive function. Kadri et al. (2019) and Cho et al. (2017) applied specific taekwondo exercises with a frequency of 2 times a week and 5 times a week in the participants of the experimental groups, respectively. Both studies verified increases in cognitive function ($p<0.05$) in the experimental groups between pre- and post-intervention, using the color block test, color-word interference test, word test, and self-confidence. These tests consist of word reading, color reading, and color word reading where each part contains 100 items arranged in 5 columns and 20 rows.

Regarding the risk of bias in the studies, according to the ROBINS-I tool, the non-randomized studies (Cho et al., 2017; Lee & Kim, 2015; Mischenko et al., 2020; Yoon & Kim, 2009) were classified as "moderate risk" of bias in at least one evaluation criterion of the tool due to the lack of data on the results and/or how participants were allocated. Nevertheless, the randomized studies (Kadri et al., 2019; Kim et al., 2011; Ma et al., 2018; Ouergui et al., 2021) were evaluated using the Cochrane Collaboration tool and showed a low risk of bias.

A strong point found in the studies included in the present systematic review was the analysis of the physical fitness variable, which showed an increase in cardiovascular conditioning, increased motor coordination, balance, flexibility, and muscle strength. Another important factor was the use of specific taekwondo techniques involving warm-up, kicking movements, punches, forms, fighting techniques, and cool-down. On the other hand, the present study has some limitations that must be considered, such as the diversity of tests used to analyze the variables and the differences in the maturation levels and age group of the participants, which may interfere with the results found. Another limitation is the studies that did not randomize the sample. Therefore, the results should be interpreted with caution.

5. Conclusions

Taekwondo is an intervention that can bring positive responses in physical and cognitive variables, to promote an increase in physical and cognitive performance in children and adolescents. Improved cognitive function, increased muscle strength, improved body composition, increased motor coordination, and improved cardiorespiratory capacity appear as positive effects of taekwondo intervention in children and adolescents. These positive responses can contribute to the reduction of physical inactivity and associated non-communicable diseases in this population and can help control the health of children and adolescents, especially in the school environment.

Future research should investigate other changes in maturational levels (prepubertal, pubertal, and postpubertal), hemodynamic variables (recovery heart rate and maximal oxygen volume), behavioral (screen time) and mental (anxiety, stress, and depression) variables of physical exercise, especially taekwondo, in children and adolescents. It is important that future research compares the effects of taekwondo in the population studied with other combat sports, comparing the results.

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