

KINESIOLOGY & COACHING

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Effects of judo participation in children: a systematic review

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Abstract

Background and aim. Judo is a popular sport worldwide. It was created as a means for holistic education and it is regularly practiced by hundreds of thousands of youngsters. This systematic review is aimed at summarizing the evidence on the physical, physiological/motor and social/psychological effects of judo participation in children.

Methodology. The review was conducted according to the PRISMA-P protocol. The Cochrane Library, PubMed, PsycINFO, Scopus, SportDiscus, Web of Science, DOAJ, LILACS and SCIELO databases were consulted for document retrieval by using the terms “judo” and “child” and other related terms, and the snowballing technique was also used. The Newcastle-Ottawa Scale was used to assess the quality of the selected studies. The studied variables were study type and aims, sample, interventions and procedures, measurements and outcomes.

Results. Nine studies, all cohort studies, were selected for inclusion. Judo participation improved participants’ arms bone mineral and fitness in variables such as flexibility, muscular endurance or agility, and also avoided the increase of their subcutaneous fat levels, but did not prove to be superior to participation in other sports. On the contrary, judo participants showed higher levels of anger than their peers.

Conclusion. Research in this field is sorely lacking. Judo participation can be of help in achieving the World Health Organization’s suggested standards on physical activity for health, but special attention should be paid at the psychological outcomes of this participation as negative effects on anger have been reported.

Introduction

In their book *Judo: A Sport and a Way of Life*, Michel Brousse and David Matsumoto [1999] define contemporary judo as a “tremendous and dynamic combat sport that demands both physical prowess and great mental discipline” (p. 7), to add a few paragraphs later that

Judo is much more than the mere learning and application of combat techniques, however. In its totality, it is a wonderful system of physical, intellectual, and moral education. Judo has its own culture, systems, heritage, customs, and traditions. Moreover, the principles of gentleness are carried from the practice mats and into most students’ lives, in their interactions with

their friends, family, work colleagues, and even strangers. Judo gives its students a code of ethics, a way of living, and a way of being. (p. 8)

These contrasting images have been, undoubtedly, key elements to understand how judo has become one of the most practiced martial arts and combat sports in the world. Judo has nowadays a prominent sporting face, being an official Olympic sport since Munich 1972 Olympics, but it has been able to preserve its popular image as an educational method, as judo founder Jigoro Kano (1860-1938) desired it to be [Gutierrez-Garcia, Perez-Gutierrez and Svinth 2010]. According to Carratala and Carratala [1999], parents are the main agents in promoting their children’s sport participation, a fact that has been also observed by Kozdras [2014]. The reasons

these parents give for taking their children to judo classes are sport socialization, physical education, competition, self-control and education [Carratala and Carratala 1999]. Likewise, Sterkowicz-Przybycien and Lech [2006] and Sterkowicz-Przybycien, Klys and Almansba [2014] found that parents of children attending judo classes had a very positive image of judo's educational power:

Parents emphasized a variety of values of practicing judo, which concerned physical fitness and health (agility, coordination, strength, flexibility, form), and psychosocial traits (courage, respect, discipline, responsibility, regularity, persistence, prudence, diligence, concentration, sensitivity, independence, assertiveness, self-confidence, serenity). They also pointed to development of sports interest, cooperation in the peers' group, improvement in self-assessment, consistency, sense of duty and the need for competition. [Sterkowicz-Przybycien *et al.* 2014: 24]

In this study, most parents observed that their children had developed their skills (97.8%), learned to solve problems (78.3%), started conversations about training (78.3%), started physical exercises at home during leisure time (76.1%), were able to persuade others (69.6%), helped weaker people solve their problems (67.4%), had positive changes in their relation to physical activity (65.2%), waited for the training day (63.0%), improved their self-discipline (54.3%), were more excited with judo trainings than with other classes in the kindergarten (50.0%), changed their attitudes to the nearest community (47.8%), and had positive personality changes (e.g. were more kind-hearted, sensitive and courageous) (50.0%).

Of course, judo stakeholders strongly support the value of judo for the education of children and youths. At the international level, the most relevant initiative was taken in 2011 by the International Judo Federation (IJF) with the creation of the IJF Judo for Children Commission.

Judo is the most educational sport in the Olympic Program. Its principles are meant to educate children and youth, while developing personal skills and abilities that will contribute to the individual development of the young athletes. The sport's educational values are enclosed in its DNA. Judo is not only an Olympic sport, but also an educational tool. [...] In 2011, the IJF took the initiative to help federations worldwide to introduce more children to judo as a sport. The IJF is convinced that the values of judo will provide children with 'skills for life'. [...] THE TARGET – Our target is to struc-

turally introduce more children to the sport of judo. Moreover, the IJF will cooperate with its commission to keep up political pressure in order to ensure that judo will become a standard part of the physical training curriculum at (primary) schools worldwide. *Vision* – We see judo as an indispensable asset for children when growing up. *Mission* – Develop judo as a standard part of the physical training curriculum in schools worldwide. [International Judo Federation 2013]

According to the Commission's report for 2015-2017, up to 31 countries had been supported by the Commission and were active in developing specific programs of judo for children [IJF Judo for Children Commission 2017].

Despite popular and institutional conceptions, it seems scientific research on the effects of judo practice in children is scarce. Fukuda *et al.* [2011] published a literature review on the health benefits of practicing judo in children and adolescents. Although they used many references for their study, only three were specific to children. Indeed, most of the studies cited in this review were focused in older, high-level athletes, showing the long-term effects of high-intensity judo training. In the wider field of martial arts, there are several reviews addressing their global effects on health. Woodward's [2009] review provided few references specific to judo and children, while Cox's [1993], Pieter's [1994] and Burke *et al.*'s [2007] reviews and Bu *et al.*'s [2010] systematic review included several studies on judo but none of them specific to children. There are also several reviews on the psychological and/or social effects of participation in martial arts. Fuller's [1988] early review, and a later addendum by Columbus and Rice [1991], did not include any specific study on judo and children. Vertonghen and Theeboom's [2010] selected up to 27 studies for their review on the social-psychological outcomes of martial arts practice among youth, four of them being specific to judo. In the same vein, Gubbels *et al.*'s [2016] meta-analysis on externalizing behavior in juveniles included 12 studies, four of them specific to judo. Finally, Harwood *et al.*'s [2017] meta-analysis on martial arts and aggression in children and youths also included 12 studies, three of them focused on judo. In general, these reviews show that martial arts and combat sports practice can have positive effects on health, although evidence at the social/psychological level is particularly contradictory [see Vertonghen and Theeboom 2010; Gubbels *et al.* 2016].

The current interest on the effects of martial arts participation in children and youths can be framed in the global concern for children's health. This regards not only the physical but also the psychological and the social spheres. Following the World Health Organiza-

tion's [2012: 11] opinion on physical activity for health,

Scientifically-informed recommendations, with a global scope, on the benefits, type, amount, frequency, intensity, duration and total amount of the physical activity necessary for health benefits are key information for policy-makers wanting to address physical activity at population level and who are involved in the development of guidelines and policies at regional and national levels on prevention and control of NCDs [*i.e.*, Non-communicable Diseases].

Considering that these days thousands of children practice judo all around the globe, it is important for judo professionals and researchers to have easy access to scientific evidence on judo effects in children, even if research on the topic is still scarce. This would help in designing better judo programs and encouraging judo researchers to focus in judo programs aimed at children. Based on the above, the aim of the present systematic review was to summarize the evidence on the physical, physiological/motor and social/psychological effects of judo participation in children.

Material and Methods

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses Protocols (PRISMA-P) protocol [Moher, Shamseer, Clarke *et al.* 2015], and the review protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD42018090730.

Eligibility criteria

The object of study of this review was the studies focused on the effects of judo participation in children. Children were considered as those between two and twelve years-old (MeSH entry terms *Child* and *Child, Preschool*). Judo participation had to be developed in specific judo programs (sport clubs, sports camps, high performance centres, specific school programs, after-school sport programs, etc.), regardless of the duration of such programs. Finally, effects referred to changes in any physical, physiological/motor or social/psychological variable from baseline to the last follow-up. Studies on injuries were not under the scope of this review as they demand a specific systematic review approach [for information on this topic, see Pocecco, Ruedl, Stankovic *et al.* 2013].

On the basis of these definitions, studies including judo practitioners over twelve years-old were excluded, although these studies would be considered for inclusion

if they presented specific analyses of judo practitioners below thirteen years-old. Studies on children practicing judo as a content of school physical education (e.g. through a teaching unit focused on judo), or in multi-sport programs (in which judo was included), or in complementary interventions in addition to judo (e.g. tutoring, discussion groups, pharmacological treatment, etc.) were also excluded, as they cannot be considered to be specific to judo. Moreover, studies on learning one or several specific judo techniques [see e.g. Gomes, Franchini, Meira Jr *et al.* 2002, on the acquisition of the technique of *o-soto-gari*] or tactics were not considered for inclusion as this cannot be considered a judo program.

Following Grimes and Schulz's [2002] classification, original experimental studies (randomized controlled trials and non-randomized controlled trials) as well as observational, analytical studies (cohort studies) were eligible for inclusion, but not observational, analytical studies (case-control studies and cross-sectional studies) and observational, descriptive studies. Meta-analyses and reviews were excluded. Therefore, the existence of at least one control or comparator group was necessary for the study to be included in the review. Control(s)/comparator(s) could include groups of non-judo practitioners, regardless if they were sedentary, just attended to regular school physical education lessons or practiced any other sport(s). Comparison among different groups of judo participants (e.g. groups based on age, gender, performance level, type of guidance, etc.) were also accepted for inclusion.

The researchers' knowledge of languages made it possible to assess for inclusion studies published in English, French, German, Italian, Portuguese and Spanish. These studies should have been published in full-length (e.g., as papers, books or book chapters), therefore abstracts published in books of abstract or congress proceedings were excluded. Duplicated studies were excluded too. We did not consider any restriction regarding the publication date of the studies.

Information sources

The Cochrane Library, PubMed, PsycINFO, Scopus, SportDiscus, Web of Science (Science Citation Index – SCI, Social Science Citation Index – SSCI, Arts & Humanities Citation Index – A&HCI, Emerging Sources Citation Index – ESCI, Book Citation Index – Science – BKCI-S and Book Citation Index – Social Sciences & Humanities – BKCI-SSH) and the Directory of Open Access Journals (DOAJ) databases were consulted. Following Clark and Castro's [2002] recommendations regarding using wide strategies in locating relevant information to include in systematic reviews, complementary databases were also explored. These were the Literature in the Health Sciences in Latin America and the Caribbean (LILACS) and Scientific Electronic Library

Online (SCIELO) databases. Finally, we looked for studies to be assessed for inclusion in the reference sections of the studies potentially eligible for inclusion (*backward snowballing technique*) [Wohlin 2014].

Search strategy

The search strategy included the term “judo” (and related terms “judoka” and “judoist”) and several terms related to childhood, such as “child” (MeSH term), “kid”, “boy”, “girl” and “youth” (and related terms “childhood”, “young” and “youngster”). The search terms and the search strategies were adapted for each database, including where available truncation symbols (e.g., *) and database-specific filters to refine results (e.g., “publication language” filters or “reference type” filters). As suggested by McCutcheon [2009], free language terms were used in all databases and controlled language terms where used where possible (e.g., MeSH terms in PubMed). We built unique search strings for all databases where this option was available. For example, the search string for Scopus was:

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(TITLE-ABS-KEY (judo) OR TITLE-ABS-KEY (judo*)) AND (TITLE-ABS-KEY (child) OR TITLE-ABS-KEY (child*) OR TITLE-ABS-KEY (kid) OR TITLE-ABS-KEY (young) OR TITLE-ABS-KEY (young*) OR TITLE-ABS-KEY (youth) OR TITLE-ABS-KEY (boys) OR TITLE-ABS-KEY (girls)) AND (LIMIT-TO (LANGUAGE , “English”) OR LIMIT-TO (LANGUAGE , “French”) OR LIMIT-TO (LANGUAGE , “German”) OR LIMIT-TO (LANGUAGE , “Italian”) OR LIMIT-TO (LANGUAGE , “Spanish”) OR LIMIT-TO (LANGUAGE , “Portuguese”)) AND (EXCLUDE (DOCTYPE , “cp”) OR EXCLUDE (DOCTYPE , “le”) OR EXCLUDE (DOCTYPE , “no”))
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The database search was conducted from 12 to 17 March 2017. Specific citations alarms were set in all databases where this option was available, and for the rest all searches were re-run just before the final analyses. This allowed to include the newest studies in the review.

Study records and data items

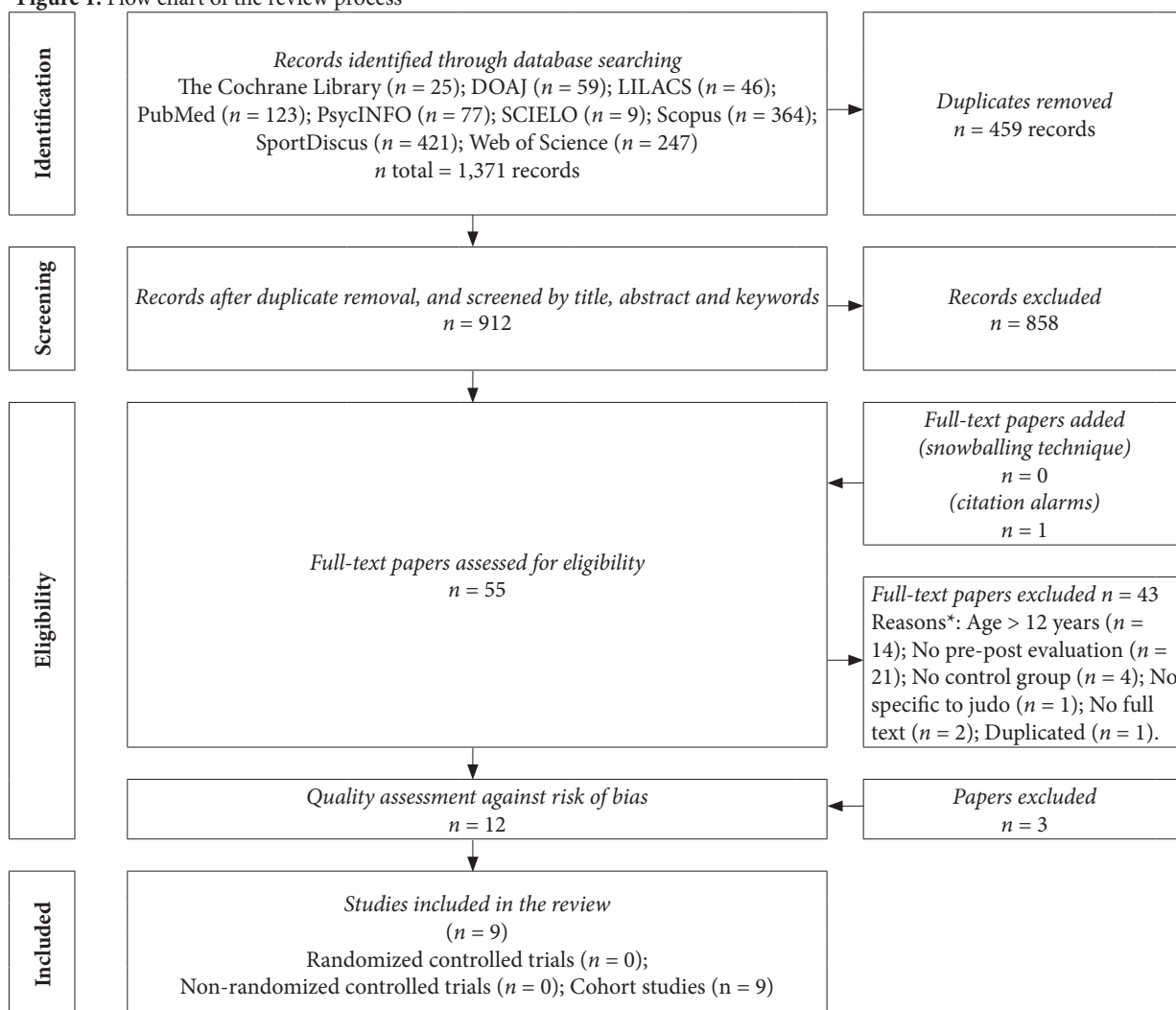
The selection process of the studies that were included in the review followed several steps: (1) Titles, abstracts and key-words for all documents retrieved from the selected databases ($n = 1,371$) were exported to EndNote (v.X6) reference manager software. Then, after eliminating the duplicated entries ($n = 459$), each of the remaining references ($n = 912$) was screened according to the basic data provided in the exported fields. (2) The full texts

of the potentially eligible studies ($n = 54$) were retrieved and assessed in-depth against eligibility criteria. During this phase, the references sections of these studies were screened but no new references to include in the review were found. (3) The quality of the selected studies ($n = 11$) was assessed through standard scales (see below the subsection “Risk of bias in individual studies”). (4) A standardised form was used for extracting and synthesizing data of the selected studies ($n = 8$), including the following variables: a) study type and aims, b) study sample, c) interventions and procedures, c) measurements, and d) outcomes (at the physical, physiological/motor or social/psychological levels). (5) Once the manuscript was submitted for the first time, citation alarms informed about the publication of several studies related to the topic, being one of them included in this review after going through the full selection process [Costa *et al.* 2018]. The number of studies finally included in this review was nine. It is important to note that Reynes and Lorant’s [2002a; 2002b; 2003; 2004] studies, are not duplicated but were part of the same study. All steps were performed independently by two members of the review team. A third member of the review team helped in resolving any disagreement between the two main reviewers. Figure 1 depicts the flow diagram of outcomes of the present review.

Assessment of risk of bias in individual studies

All selected studies were cohort studies. Following Zeng, Zhang, Kwong *et al.*’s [2015] recommendations, the Newcastle-Ottawa Scale (NOS) tool [Wells, Shea, O’Connell *et al.*] was used in order to assess the methodological quality of the 13 selected studies. This tool is composed of eight items for cohort studies and includes three dimensions (selection, comparability and outcome). Several response options are provided for each item. Those responses indicating the highest quality are awarded one (seven items) or two (one item) stars, allowing a range in the quality assessment of the studies between zero and nine stars. This tool has been criticized [Stang 2010] but it is currently and commonly used in research. For this reason, it must be used with caution, as it was the case for this review. In this regard, we used NOS items as a reference to detect evidences of risk of bias in the selected studies, and only studies presenting high risk of bias were excluded of the final analyses. We did not use the selected papers total scores (“stars”) as the only criterion for exclusion, as this kind of scoring system has been frequently criticized [Quigley, Thompson, Halfpenny *et al.* 2018].

Three studies [Borisenko, Loginov, Lubysheva 2015; Demiral 2011; Ioan, Petru, Lucian 2015] were excluded in this phase. Borisenko *et al.*’s [2015] paper was excluded mainly because it provides little information on the control group used for comparison and the tests applied for assessing participants’ coordination abilities. Demiral’s

Figure 1. Flow chart of the review process

* Only one reason for exclusion is provided for each study. Eligibility criteria were assessed sequentially as shown in the figure.

[2011] compared the development of motor abilities in two groups of young judoka after one year of training, but provides no information on the baseline equivalence of these groups and the training process (i.e., the treatment) followed by each, making it impossible to understand why differences were found. Finally, Ioan *et al.*'s [2015] study on the effects of specific speed training in young judoka does not provide basic data to assess the baseline equivalence of the experimental and control groups, such as number of participants in each group by gender, and some of those provided show relevant differences between groups (e.g., the average weight was 17% higher in the experimental group, 48.8kg vs. 41.7kg). Also this study does not provide information on the judo training followed by participants and the specific statistical data of inter- and intra-group comparisons.

Data synthesis

The findings of this review are presented in a narrative synthesis of the included studies, structured around stud-

ies design and studies outcomes. We also provide a table summarizing the main characteristics for each study.

Results

Table 1 summarizes the main characteristics of the selected studies. One paper aimed at studying the effects of judo participation at the physical level [Costa *et al.* 2018], four focused on both the physical and physiological/motor levels [Krstulovic, Kvesic, Nurkic 2010a; Krstulovic, Males, Zuvella *et al.* 2010b; Sekulic, Krstulovic, Katic *et al.* 2006; Walaszek, Sterkowicz, Chwala *et al.* 2017] and Reynes and Lorant's [2002a; 2002b; 2003; 2004] studies were focused on the psychological level, specifically on aggressiveness. Judo samples ranged from 12 to 41 children, of an average age of 5 to 10 years-old. All studies except Reynes and Lorant's [2003], Krstulovic *et al.*'s [2010a] and Costa *et al.*'s [2018] were specific to boys. Judo training ranged from 70-90 to 180 minutes per week, divided in two or three training

sessions. The smallest interval in which measurements were taken was three and six months [Walaszek *et al.* 2017], while the longest was one and two years [Reynes, Lorant 2003; 2004]. Studies focused on the physical level included basic anthropometric data (body weight and body height) [Krstulovic *et al.* 2010a; 2010b; Sekulic *et al.* 2006; Walaszek *et al.* 2017], the sum of two skinfolds [Sekulic *et al.* 2006; Krstulovic *et al.* 2010a; 2010b] and bone mineral density and content [Costa *et al.* 2018]. Three studies [Krstulovic *et al.* 2010a; 2010b; Sekulic *et al.* 2006] used the same battery of simple field tests to assess children's general fitness development: 10m obstacle course test (coordination), 4 x 1.98m shuttle run test (agility), maximal circumduction of both shoulders while holding a measuring stick and sit-and-reach test (flexibility), 20m dash (speed), standing long jump and distance overhand softball throw (explosive strength), flexed arm hang and 90-degree flexed-knee sit-ups in one minute (muscular endurance), and 3-minute running test (cardiovascular endurance). Walaszek *et al.* [2017] focused their assessments on body posture, balance, and lower limbs mechanical output by using more technologically complex assessment tools (i.e., photogrammetric assessment equipment, dynamometric platforms), except for balance in which the unipedal stance field test was used. Costa *et al.*'s [2018] used dual-energy X-ray absorpti-

ometry (DEXA) to assess participants' bone mineral content. Finally, Reynes and Lorant's [2002a; 2002b; 2003; 2004] studies, focused on aggression, used the Buss-Perry Aggression Questionnaire.

Physical level

Judo participation showed positive outcomes at the physical level. Children participating in judo, both males [Sekulic *et al.* 2006; Walaszek *et al.* 2017] and females [Krstulovic *et al.* 2010a], gained in weight and height similarly to their peers in the control group, who participated in supervised recreational team-games (free play) [Krstulovic *et al.* 2010a; Sekulic *et al.* 2006] or did not train in any sport [Walaszek *et al.* 2017]. Nevertheless, the judoka maintained their subcutaneous fat levels during the 9-month judo intervention, while controls significantly increased them on an average of 6% (females) and 10% (males) [Krstulovic *et al.* 2010a; Sekulic *et al.* 2006]. Differences between groups were found only in the post-test, with controls having higher subcutaneous fat levels. Similar results were also found in Krstulovic *et al.*'s [2010b] study, in which children practising judo, soccer or track and field were compared to children who just had regular school physical educational lessons. In this study, judo participants were heavier than their soc-

Table 1. Main characteristics of the selected studies on the effects of judo participation in children.

Reference	Focus	Sample size & groups	Interv. (length)	Variables	Outcomes
Reynes and Lorant 2002a	Soc/Psyc	55 boys CG, judo	1 year	Aggression	The judo group was more aggressive than the CG
Reynes and Lorant 2002b	Soc/Psyc	+9* boys Karate	1 year	Aggression	Judoka were more aggressive than karateka
Reynes and Lorant 2003	Soc/Psyc	60 (34 boys, 26 girls) CG, judo	2 years	Aggression	The judo boys were more aggressive than the CG. No differences for girls.
Reynes and Lorant 2004	Soc/Psyc	43 boys GC, judo, karate	2 years	Aggression	The judo group was more aggressive than the CG and the karate group
Sekulic <i>et al.</i> 2006	Physical Phys/Motor	98 boys CG, judo	9 months	Weight, height, skinfolds, 10 motor-tests	Judoka had better results in skinfolds, flexibility, agility, and muscular endurance.
Krstulovic <i>et al.</i> 2010a	Physical Phys/Motor	79 girls CG, judo	9 months	Weight, height, skinfolds, 10 motor-tests	Judoka had better results in skinfolds, flexibility, agility, and muscular endurance.
Krstulovic <i>et al.</i> 2010b	Physical Phys/Motor	202 boys CG, judo, soccer, track & field	9 months	Weight, height, skinfolds, 10 motor-tests	The sport groups got better results than the CG in several variables. Each sport group had specific improvements.
Walaszek <i>et al.</i> 2017	Physical Phys/Motor	24 boys CG, judo	6 months	Weight, height, BMI, posture, balance, legs mechanical output.	Judoka had positive changes in posture, balance and legs mechanical output. Not observed in the CG.
Costa <i>et al.</i> 2018	Physical	32 (boys and girls) CG, judo, Muay Thai	9 months	Bone mineral content and density	Increased in judo, even more in Muay Thai

All selected studies were cohort studies. Soc/Psyc= Social/Psychological; Phys/Motor= Physiological/Motor; CG = Control group. * Added a karate group to their previous study [Reynes and Lorant 2002a].

cer and track and field peers at the post-test, but this was not due to a higher increase in subcutaneous fat. Judo participants were also found to have higher increases in arms bone mineral density and content than controls (not participating in combat sports training) after nine months training [Costa *et al.* 2018]. In this study, Muay Thai participants achieved the highest global increases, especially for the improvements of legs bone mineral density and content.

Physiological/motor level

Positive outcomes were also found at the physiological/motor level. A nine-month interval led 7-year-old boys and girls to a general improvement of their fitness [Krstulovic *et al.* 2010a; 2010b; Sekulic *et al.* 2006], but judo participants achieved better results in tests assessing flexibility, agility and muscular endurance than their peers participating in supervised recreational team-games [Krstulovic *et al.* 2010a; Sekulic *et al.* 2006] or just attended to regular school physical educational lessons [Krstulovic *et al.* 2010b]. Compared to other sports (soccer and track and field), judo led to higher improvements in muscular endurance and flexibility but these were lower in speed and cardiovascular endurance with respect to soccer and track and field and also in explosive strength with respect to track and field [Krstulovic *et al.* 2010b]. Walaszek *et al.* [2017] found that a six-month judo intervention was beneficial to 5-6 year-old children, who gradually improved their balance, body posture and the force of their lower extremities muscles, while this gradual improvement did not happen in the group of non training peers.

Social/psychological level

Reynes and Lorant's [2002a; 2002b; 2003; 2004] studies found that one year of judo practice did not have any effect in the aggressiveness of 8-year old boys, but judoka were more aggressive than a group of their non training peers and a group of karate training peers. After two years, the group of non training boys had decreased their total aggression scores, while this did not happen in the judo and karate groups. Indeed, the judo group still showed more anger than the other two groups. Regarding girls, the small sample of 8-year old female judoka included in one of the selected studies [Reynes and Lorant 2003] showed no differences with respect to their non training peers, although judokas reduced their physical aggression and anger initial scores – these were the only aggressiveness variables measured in this study.

Discussion

This review aimed at summarizing the evidence on the effects of judo participation in children. On the basis of

the obtained results, it seems that research in this area is very scarce, as only nine studies meet the eligibility criteria to be included in the review. In the same vein, Fukuda *et al.* [2011: 61] stated that “Although long-term physiological benefits of judo training have been previously reported, the more immediate benefits for children and young adults are now being explored.” Despite thousands of children practicing judo all over the world, the fact is that nowadays judo research (and in general, combat sports research) is mainly focused in competitive judo [see e.g., Franchini 2014; Franchini, Del Vecchio, Matsushigue *et al.* 2011; Miarka, Julio, Del Vecchio *et al.* 2012; Ziv, Lidor 2013], which is also the key area of interest of the most prolific judo researchers [see Peset, Ferrer-Sapena, Villamon *et al.* 2013]. It would therefore be desirable for the development of judo programs for children that continuous and solid research in this field were conducted. This research could include ambits currently unexplored or under debate and development, such as the cognitive effects of judo participation [see: Diamond, Lee 2011; Mercer 2011; Strayhorn, Strayhorn 2011, for a debate on the effects of martial arts participation on the executive function development in children]. It also would allow assessing the effects of judo participation in children, and also how different judo interventions could lead to different outcomes.

Judo participation has shown to have positive effects on children's physical and motor development. Specifically, these benefits refer to the maintenance of subcutaneous fat levels and the improvement of arms bone mineral, body posture, balance, flexibility, agility, and muscular endurance. According to the World Health Organization's [2012: 20] guidelines on physical activity for health

1. Children and youth aged 5–17 should accumulate at least 60 minutes of moderate- to vigorous- intensity physical activity daily.
2. Amounts of physical activity greater than 60 minutes provide additional health benefits.
3. Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.

Following these guidelines, judo programs can be a good alternative to supplement the regular school physical education classes that children commonly take at this age. The selected studies included 3x45 min [Krstulovic *et al.* 2010a; 2010b; Sekulic *et al.* 2006], 2x35-45 min [Walaszek *et al.* 2017] and 2x90 min [Costa *et al.* 2018] of judo practice per week. Judo lessons were roughly composed of a generic part, including basic motor skills and physical conditioning exercises, and a specific part focused on judo fundamentals, basic skills, techniques and games. Costa *et al.*'s [2018] intervention regu-

larly included 30 minutes of fight simulation (*randori*) Judo is usually practiced in pairs, by applying throwing techniques (*nage waza*) that are performed in standing position, and grappling techniques (*katame waza*) that are done on the ground [Gutierrez-Garcia *et al.* 2010]. Muscle-strengthening actions, such as gripping, pulling, pushing or lifting, are therefore required, usually in complex combinations demanding significant levels of coordination and balance. These actions are positively related with energy expenditure and bone mineralization, which can explain children's improvements at the physical level. In addition, judo training includes the learning of falling techniques (*ukemi waza*), which may be of help for preventing fall-related injuries [Nauta, Knol, Adriaensens *et al.* 2013]. These judo programs must pay special attention to injury prevention during judo practice. Following Pocecco *et al.*'s review [2013a], the most common types of injuries in judo athletes from 5 to 17 years-old are contusions/abrasions (25-45%), fractures (28-31%) and sprains/strains (19-24%), mainly located in the shoulder/upper arm (19%), foot/ankle (16%) and elbow/lower arm (15%), and frequently derived from incorrect throwing and falling techniques or practicing with heavier opponents. These authors make several suggestions that could be of help in preventing judo related injuries in children, such as establishing minimum standards of qualification and experience for trainers and referees, preventing children from entering competition prematurely and focusing judo educational programs on goals of achievement instead of performance goals.

Nevertheless, judo has not proven to be a better alternative than other sports to improve children's physical and motor development. Sekulic *et al.* [2006] and Krstulovic *et al.* [2010a] showed that judo practice improved the children's physical fitness more than recreational sports games. These recreational sports games sessions were supervised but not methodologically designed as they were the judo sessions. In other words, not only the kind of sport was playing a role in these studies but also the methodology and type of guidance followed during the training sessions. When the methodological design of the sessions was controlled (i.e., it was similar) and different sports were compared, each of them improved the children's physical and motor development in specific beneficial ways, depending on the characteristics of each sport [Krstulovic *et al.* 2010b]. Likewise, Costa *et al.* [2018] found that Muay Thai participants had higher increases in bone mineral than judo participants, probably due to the impacts (kicks, punches, jumps) intrinsic to Muay Thai training. These authors hypothesized that judo falls (which are often performed during training) would induce significant increases in bone mineral. Interestingly this was not confirmed. In the authors' opinion this could be due to the great emphasis on performing proper/safe falling techniques during judo training (i.e., reducing the impact of the body onto the mat as much as possible).

Contrary to the positive effects found at the physical and physiological/motor levels, the general effects of judo participation in children at the social/psychological level are still unexplored. The specific studies included in this review, focused on aggression, showed judo participation leading to higher anger levels after two years. Although the first of these studies [Reynes, Lorant 2002a] characterized *dojos* (spaces for learning martial arts) participating in their study as "traditional" (i.e., they put forward attitudinal aspects such as respect or self-control, practiced meditation, etc.), these were not so traditional when compared to karate *dojos*, which made more use of meditation and *kata* (pre-arranged patterns of movements) [Reynes and Lorant 2004]. What Ver-tonghen and Theeboom [2010] name "type of guidance" (i.e., "traditional" or "modern" approaches to teaching martial arts, the second being more competitive and aggressive), may therefore play a key role in children's outcomes regarding anger, aggressiveness and violence management, as well as the participants' characteristics and their social context. Strayhorn and Strayhorn [2011: 310] critically stated that "In a world beset by violence, there is irony and pathos in hoping that our children will be improved by teaching punching, kicking, and tripping." In order to avoid or compensate the potential negative effects on aggression of a high contact sport such as judo, the judo instructor need to adhere and promote educational principles based on respect and self-control [Reynes, Lorant 2004].

Considered as a whole, the selected studies have some limitations, including study designs (no controlled trials were found), small samples sizes, loss of participants between pre- and post-tests, or lack of control of potentially relevant variables (such as eating habits, calcium intake, general life habits or other sport habits). Nevertheless, and taking into consideration (1) the complexity of longitudinal studies, including study design, data collection and analysis, missing data or attrition rates [Fitzmaurice, Davidian, Verbeke *et al.* 2008], and (2) the realm of sport participation in children, which is affected by high levels of drop out derived from factors such as lack of enjoyment, perceptions of competence, social pressures, competing priorities and physical factors (maturation and injuries) [Crane, Temple 2015], they can be regarded as valuable contributions that overcome the limitations of just one group, cross-sectional studies.

This review also has some limitations. As said, only studies published in English, French, German, Italian, Portuguese and Spanish were eligible for inclusion, as these were the languages the authors could work with. This means that studies published in the particular languages of many countries where judo is a popular sport (e.g., Japan, Korea, China, Poland, Russia, to name a few) were not included in the review. In the same line, although we explored a wide range of international data-

bases, we did not explore local databases (e.g., Russian Science Citation Index, KCI – Korean Journal Database) except for LILACS and SCIELO as these databases mostly include languages used by the authors. Finally, the strict eligibility criteria followed in this review could be also seen as a limitation. Research on the effects of judo participation in children dates back, at least, to the 1970s (see e.g., Portuondo and Landry [1974]), and there exist several studies on the topic that just make post-intervention assessment, do not have a control or comparator group or include children and adolescents in the studied samples without differentiation (see e.g., Drid, Ostojic, Maksimovic *et al.* [2009], Gleser, Margulies, Nyska *et al.* [1992], Miranda, Saraiva, Suetake *et al.* [2017]). Nevertheless, by establishing strict eligibility criteria we tried to specifically focus on children and avoid the strong limitations of these types of studies regarding causal attribution.

Conclusion

The present systematic review provides information on the effects of judo participation in children. It shows that research in this field is sorely lacking, as only nine studies met the established eligibility criteria. The available evidence shows that judo participation has beneficial effects in children's physical and physiological/motor development, and can be of help in achieving the World Health Organization's [2012] suggested standards on physical activity for health. In this regard, as other sports, judo has proven to be a good alternative to improve children's fitness. At the psychological level, special attention should be paid at the psychological outcomes of judo participation in children, as negative effects on anger have been reported. More research on the topic is needed. We encourage researchers to conduct multi-dimensional studies – e.g., at the anthropometric, motor, psychological, cognitive or social levels – in which judo participation outcomes could be globally assessed.

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Wpływ uczestnictwa w zajęciach judo na dzieci: przegląd systematyczny

Słowa kluczowe: aktywność sportowa, sporty walki, sporty walki, judo, dzieci, chłopcy, dziewczęta, efekty, przegląd systematyczny

Abstrakt

Tło i cel. Judo to sport popularny na całym świecie. Został stworzony, jako sposób holistycznej edukacji i jest regularnie praktykowany przez setki tysięcy młodych ludzi. Niniejszy przegląd systematyczny ma na celu podsumowanie dowodów na fizyczne, fizjologiczno-motoryczne i społeczno-psychologiczne skutki uczestnictwa w zajęciach judo dzieci.

Metody. Przegląd przeprowadzono zgodnie z protokołem PRISMA-P. Skorzystano także z zasobów Biblioteki Cochrane, PubMed, PsycINFO, Scopus, SportDiscus, Web of Science, DOAJ, LILACS i ScieLO posługując się wyszukiwaniem słów "judo" i "dziecko" oraz innych pokrewnych terminów, a także zastosowano technikę nielosowego doboru próby tzw. metody kuli śnieżnej. Do oceny jakości wybranych badań wykorzystano Skalę Newcastle-Ottawa. Badane zmienne obejmowały rodzaj i cele badania, dobór próby, interwencje i procedury, pomiary i wyniki.

Wyniki. W analizie uwzględniono dziewięć badań, były to wszystkie badania kohortowe. Uczestnictwo w treningach judo poprawiło kondycję kości ramiennej uczestników i sprawiło, że zmienne, takie jak elastyczność, wytrzymałość mięśni czy zręczność, również pozwoliły uniknąć wzrostu poziomu podskórnej tkanki tłuszczowej. Udział w zajęciach judo nie okazał się lepszy we wszystkich aspektach od udziału w innych sportach. Przeciwnie, adeptci judo wykazywali wyższy poziom gniewu niż ich rówieśnicy.

Wniosek. Ilość badań w omawianej dziedzinie jest niewystarczająca. Uczestnictwo w zajęciach judo może być pomocne w osiągnięciu zalecanych przez Światową Organizację Zdrowia standardów w zakresie aktywności fizycznej dla zdrowia, ale należy zwrócić szczególną uwagę na wyniki psychologiczne, gdyż odnotowano negatywny wpływ na stan emocjonalny ćwiczących (gniew).