REVIEW ARTICLE

Physiological and psychological benefits of aikido training: a systematic review

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: The aikido is a philosophy and a Japanese art of self-defence, which is proposed to have several beneficial effects on mind and body. It is limited, but growing research on this topic. A summary of the empirical works could shed light on the anecdotally postulated benefits of aikido. This systematic literature review aims to summarise the current knowledge about the physiological and psychological benefits of aikido training.

Material & Methods: Databases including SPORTDiscuss, PsycINFO, PubMed, MEDLINE, and ScienceDirect were searched by following the PRISMA guidelines for systematic reviews. A total of 20 articles met the final inclusion criteria.

Results: The authors of the half of selected articles examined the physiological benefits (flexibility, wrist strength, functional efficiency, balance stability, scoliosis, and injuries) while the other half looked at psychological benefits of aikido training (mindfulness, self-control, self-esteem, health-related behaviour, mood profile, and goal orientation) but also on Type A behaviour, as aggressiveness and anger. In line with the analysed reports, the gist of these studies suggests that aikido training has positive benefits on both physiological and psychological measures, including flexibility, scoliosis, balance stability, mindfulness, anger control, and/or ego-orientation indeed. However, certain methodological concerns weaken the strength of the evidence.

Conclusions: The key message of this review is that the theoretically postulated benefits of aikido have started to emerge from both physiologically and psychologically oriented empirical research, which provide infrastructure, as well as the incentive, for future work in this currently underexplored field of study.

Keywords: affect • anger • budo • ego • exercise • health • pliability • posture • scoliosis

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Type A and Type B – in personality theory, there are two contrasting types: Type A is more competitive, outgoing, ambitious, impatient and/or aggressive; Type B is more relaxed personalities [27].

Budo (Budō) – originally a term denoting the "Way of the warrior", it is now used as a collective appellation for modern martial arts of ***kendō***, ***jūdō***, ***kyūdo*** and so on. The primary objective of these "martial ways" is self-perfection (***ningen-keisei***) [28].

Capoeira – ***noun*** a martial art and dance form, originally from Brazil that is used to promote physical fitness and grace of movement [29].

Mindfulness – state awareness of thoughts, emotions, and actions.

Pliability – elasticity, flexibility.

Scoliosis – a lateral curvature of the spine.

Stabilometry – the objective study of body sway during standing.

State anxiety – momentary worry, fear, or apprehension connected to a challenging situation.

Competitive state anxiety – ***noun*** a feeling of stress caused by competition, especially when the athlete does not feel able to meet the challenges [29].

INTRODUCTION

Aikido is a Japanese self-defence art (part of budo) invented in the early twentieth century and practised nowadays in 130 countries around the world. It is founder Morihei Ueshiba developed it after studying extensively several armed and unarmed systems of combat. Aikido is a fighting art, a method of self-defence, and philosophy, with the goal to *improve one's character according to the rules of nature* [1]. Its meaning can be interpreted as the way of spiritual harmony, where "ai" means harmony, connection, "ki" means spirit, life or cosmic energy, and "do" is a method, the pathway.

Basic practising aikido is typical in pairs, with the aim to defend oneself without causing harm to the attacker, instead to create a harmony of movements (no competitions are held in aikido). It is performed by blending with the motion of the attacker and redirecting the force of the attack, based on moving from the centre of the body in a calm and controlled way, with a heightened state of awareness, using circular and spherical movements [1-3]. Numerous positive physiological and psychological health effects of aikido could be proposed by its philosophy and the anecdotal statements of the art's practitioners, but empirical evidence is scarce in this field.

This systematic literature review aims to summarise the current knowledge about the physiological and psychological benefits of aikido training

MATERIAL AND METHODS

Protocol

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline [4] was followed, and the protocol was registered with PROSPERO international prospective registry of systematic reviews.

Search method

A literature search was carried out between March 2017 and June 2017. Four databases were searched: SPORTDiscuss, PsycINFO, PubMed, MEDLINE, and ScienceDirect. The search term was "aikido" in title, abstract, keyword using the Boolean operator "or". We did not downsize the search by using other terms to ensure that none of the possibly important works is missed. The search was restricted to articles in English language, academic journals, and articles with an abstract (without such distinctions, the independent database search resulted in 615 article).

Additional articles from other sources were identified through recommendations from aikido teachers and by examining the reference lists of the studies located via the database search.

Inclusion and exclusion criteria

Only empirical research examining the physiological and psychological outcome of aikido were included, with no restriction to age, gender, nationality, or health status of the studied sample. Reviews, meta-analyses, conference papers, case-studies, books, book chapters, and theses dissertations, were excluded. Further, studies in which aikido was not the independent variable, or the intervention was not a traditional (original) aikido training, were also excluded; similarly like studies focusing on the enhancement of training's efficacy, or detailed description of the techniques.

Study selection

After completing the searches, the located articles were screened for eligibility based on the inclusion and exclusion criteria. Articles deemed as eligible were subsequently further screened for relevancy by examining its full text in detail (Figure 1). In general two, but in some dubious cases, three of the authors have carefully evaluated the articles.

Quality assessment and risk of bias

Two reviewers independently assessed the risk of bias of the trials. Bias in the areas of participants selection, pre-selection, drop-out effect, possible third variables effect, selective outcome reporting, or other sources of bias was assessed.

Data extraction

Data were annotated into a database and verified by a second reviewer. Pre-specified data were collected for each study; these included general classifiable information about the objectives, sample, design, measurement tool, and findings.

Preliminary selection of articles

The search identified 152 records from databases and 10 through additional resources (Figure 1). After removing duplicates, 100 unique citations were screened for eligibility. The screening resulted in 30 articles that were reviewed one more time by reading their full texts. Two-thirds

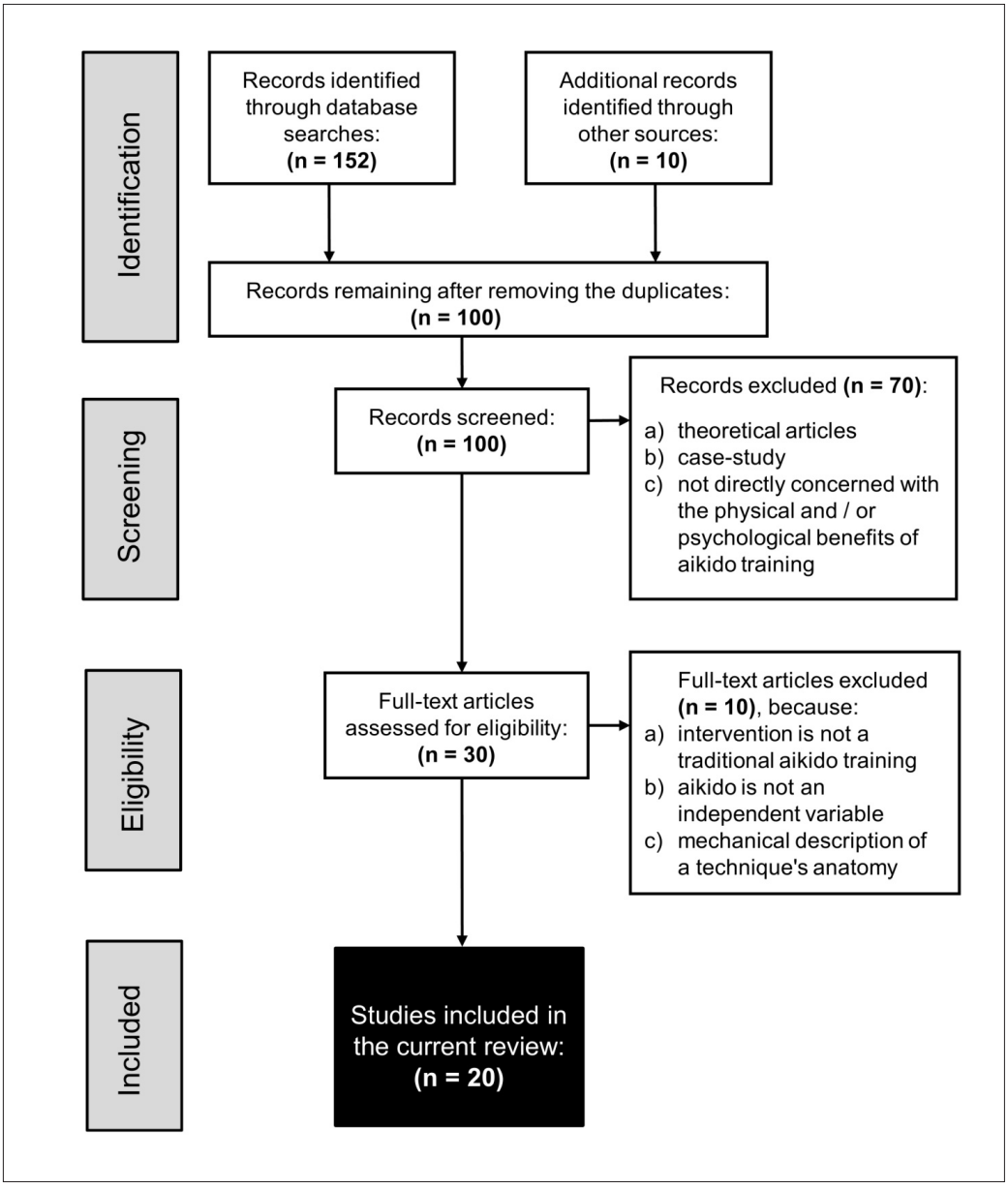

Figure 1. The selection of studies based on the PRISMA method [4].

(n = 20), published from 1987 to 2017, met the criteria for inclusion set for the review.

Criteria for presentation of the results of the review

For a more coherent analysis, we divided the eligible articles into two domains: 1) having a psychological focus and 2) having a physiological focus.

The publication year is an ordinal variable in the tables where the results of the review are presented. With at least two publications in a given year, the order variable is the alphabetical layout of the first author. The tables structure is also based on design and sample; measurement tool; findings.

RESULTS

Psychological effects of aikido training (Table 1)

Gernigon and Le Bars [5] studied children and adults practicing aikido or judo, while in the second, Vertonghen et al. [6] examined a large sample of youth to identify the mediating factors that could influence involvement in martial arts and

combat sports (MA&CS), such as aikido, kick-/Thai box, judo, and karate.

Among children, both studies showed that aikido practitioners are more task-oriented than those practising judo and Thai kickbox. While cause and effect relationship cannot be drawn from cross-sectional research, these results may prompt the hypothesis that aikido fosters task orientation in children, which is an advantageous goal orientation from many perspectives and in many aspects of human behaviour. In the study reported by Gernigon and Le Bars [5], results only prevailed in adults when comparing the different MA&CS styles. In the Vertonghen et al.'s [6] study the differences surfaced when comparing different styles, and when comparing only the advanced practitioners, the aikido group showed higher scores than the karate group and was less ego-oriented than Judo and Thai/kick group. Since these studies did not reveal differences in goal orientations at beginner levels, we could posit that not the choice of the MA&CS style was determined by the goal orientation of a child/youth, but maybe the different goal orientations were the results of the practiced MA&CS, thus further justifying the need for longitudinal studies that could establish causal relationships.

Regarding adult practitioners of aikido, the above findings with children seem only be partially justified. Gernigon and Le Bars' [5] results showed that experienced aikidoka was less task- and ego-oriented than beginner aikidoka and experienced judoka.

In another cross-sectional study by Pieter and Pieter [7], it was found that one hour before an aikido tournament no differences were evident in mood profiles of the winner and looser aikidoka. Therefore, successful aikidoka does not appear to use anger to psych-up themselves in competitions as found in other martial arts (tae kwon do, karate). This finding is in accord with aikido's teaching and philosophy. However, this research did not use a typical aikido practice in which there is no competition.

In Vertonghen et al.'s study [6] an analysis of the social background of the youth showed that aikido practitioners came from a more the privileged social classes than kick-/Thai boxers; so social background could affect the choice of martial arts, probably in function of the philosophy and contemporary social image of the given art. Vertonghen et al. [6] also examined the differences in psychosocial behaviour in various martial arts. They found that that kick-/Thai boxers showed more behavioural difficulties, conduct problems, and physical aggression than aikidoka, but there was no significant difference between the less experienced and advanced aikido practitioners.

These findings agree with Delva-Tauiliili's [8] intervention-based results which also found no change in children's aggressive behaviour, or self-control, due to a two and a half week daily aikido training. Similarly, a 10-week aikido training showed no significant impact on anger expression, anxiety, and self-esteem in beginner student practitioners [9].

Another research [10] also using a 10-week long intervention programme examined whether aikido and aerobic training affect Type A behaviour pattern of Type A individuals (college students). The results showed that aikido training did not influence Type A behaviour. Nevertheless, future study of the effects of discipline and self-control demanding aikido training on Type A behaviour, also known as *coronary-prone behaviour* [11] is warranted, since theoretically expectable benefits could lower the incidence of cardiovascular-related dysfunctions in people exhibiting this type of behaviour. However, the small sample sizes, lack of randomisation, and most importantly the short period of aikido training periods used in these studies could have masked the possible effects. Indeed, personality-linked behaviours need longer times of intervention to become detectable.

In a two-part study [12], a strong positive connection was disclosed between mindfulness and regular aikido training. In the first part of this research, a 9-month aikido training resulted in increased mindfulness as compared to the pre-training baseline and a control group. In the second part, the research employed a cross-sectional design with a larger sample in which the aikido group showed again higher scores of mindfulness than the control group; the effect was higher among advanced practitioners. Although the results of these works appear to be convincing, there are some limitations, such as the lack of randomization, relatively small sample size, and inequality of gender distribution, that render the findings rather tentative, thus begging for further systematically controlled work on the topic

which could yield more robust results on these benefits of aikido.

A study by Boguszewski et al. [13] revealed higher scores for aikido practitioners in health-related behaviours than a non-sport control group, but in comparison to capoeira, no differences were found. In light of the small and non-representative sample size of the study, it is possible that the results were simply due to the practising of a sport or physical activity. Thus, this work raises some valid questions for the future research in this area.

Our systematic search resulted in three qualitative inquiries. Two of them interviewed women practising aikido. The first was conceptualised within the postmodern feminist framework and aimed to explore women's experiences in long-term aikido training by studying those who trained for three or more years in the martial art [14]. The interview results indicated that "*participants through aikido learned to enjoy the full expression of physicality, to redefine and reconstruct behaviours which were once confined to the limited territories of the male or female genders, gained a framework to connect their own individual intellectual, physical and spiritual spheres and, through their empowerment, connect in a positive way to their communities*." [14, p.134]. The obvious limitations of this work are the use of a small sample size (12 women) and the interview method in which the author, who is also a trained aikidoka, shared her experience with the participants.

The second qualitative research, conducted by Halik and Kochan-Wójcik [15] explored the experience of corporeality among women who practice aikido. Corporality constructs have emerged in three areas: body, emotions, and interpersonal relationships. The former two were characterised by a functional dimension, whereas interpersonal

Table 1. Psychological aspects of aikido training (the ordinal variable is the year of publication).

Year Author [references]	Issues	Design and sample	Measurement tool	Findings
1987 Jasnoski et al. [10]	Pattern-A for those individuals at behavioural risk for developing coronary heart disease, i.e., young Type A individuals.	Quantitative intervention study (pre- and post-test), with the comparison group (aerobic), and control. Aikido (n =40♀); total (= 120♀); age M 19.25, range 17-31yrs); Type-A and Type-B subjects. Training: 10 weeks (twice/week)	1) Activity Subscale (TAS) of the Thurstone Temperament Schedule [30]; 2) Aerobic Capacity: Submaximal Astrand-Rhyming Bicycle Ergometer test [31]; 3) Workout Pulse Rates	Compared to the aerobic group, aikido practice did not decrease Type A behaviour and did not improve aerobic capacity.
1995 Delva-Tauiliili [8]	Aggressive behaviour. Self-control.	Quantitative intervention study (pre- and post-test), with control group: aikido (n = 21♂); total (n =42); age range 9-12yrs). Intervention: aikido training	1) Teacher's Self-control Rating Scale [32]; 2) Scale of Aggressive Behavior [8]	Negative findings: No differences due to aikido training.
1997 Foster [9]	Anger expression. Anxiety. Self-esteem.	Quantitative intervention study (pre- and post-test), with comparison group (karate, golf), aikido (n =20); total (n = 69 university students). Training: 10 weeks	1) Self-esteem Scale [33] 2) State-Trait Anxiety Inventory [34]; 3) State-Trait Anger Expression Inventory [35]	Negative findings: No differences due to aikido training.
2000 Gernigon & Le Bars [5]	Goal orientations in sport.	Quantitative cross-sectional questionnaire study, with comparison group (judo), children aikido (n = 24♂, 12♀); total (n =80); age M = 12.1 ±1.43; adults aikido (n =24♂, 19♀); total (n = 84); age M 28.5 ±8.30). Between group: beginners, experienced.	Perception of Success Questionnaire [36]	No gender differences. *Children*: aikidoka more task-oriented than judoka, experienced aikidoka less ego-oriented than beginners and experienced judokas. *Adults:* experienced aikidoka less task- and ego-oriented than beginners and experienced judokas.
2003 Noad & James [14]	Women's experiences in aikido	Qualitative exploratory study: aikido (n =12♀); age range 17-50yrs.	Semi-structured interview's (What does aikido mean to you?',What do you feel aikido is?',How would you describe aikido?') Analysed, and arranged under meta-themes (Coding, categories; two independent researchers checked the coding)	Five major themes emerged: female values in a masculine environment; empowerment and self-development; spirituality; social behaviour and intimacy; sport, martial arts and aikido.

Year Author [references]	Issues	Design and sample	Measurement tool	Findings
2006 Faggianelli & Lukoff [16]	The effect of aikido practice on psychotherapeutic work	Qualitative semi-structured interview study: aikido (n = 6♂, 2♀); no data on age, aikido training >7 yrs, psychotherapeutic work >5yrs).	Research approach based [37] narrative method and informed by [38] hermeneutic phenomenology. The Central question: In your experience, does the practice of Aikido inform or affect your practice of psychotherapy? If so, how and in what ways?'	Aikido practice had a high influence on the psychotherapeutic work (emerging under 8 themes)
2008 Pieter & Pieter [7]	Mood profile	Quantitative, cross-sectional study: aikido, black belt (n = 45♂) age M 30.51 ±8.06), (n = 17♀) age M 27.29 ±6.94). Between group: winners, losers.	Brunel Mood Scale ([39], question: 'How are you feeling right now?)	No difference in the mood profile of losers and winners. Women scored higher on tension, but lower on depression and fatigue. (Differences were found in depressed, and non-depressed males in mood scales).
2013 Lothes II. et al. [12]	Mindfulness	Quantitative, cross-sectional study with control: aikido (n = 111♂, n = 48♀); total (n =179). Between-group: kyu, dan holders Quantitative intervention study with control: aikido (n = 9♂, 3♀); total (n =32). Training: 9 months.	1) Mindfulness Skills [40]; 2) Mindfulness Attention Awareness Scale [41]	Positive findings: Aikido group scoring higher than control (in both settings), and dan holders higher dan kyu holders.
2014 Boguszewski et al. [13]	Health-related behaviour	Quantitative cross-sectional questionnaire study, with comparison group (capoeira) and control (non-sport): aikido (n = 32♂); total (n = 92, age range 18-40 yrs).	Health-Related Behaviour [42]	Aikido showed higher levels of health-related behaviour, (regarding subscales in healthy practices) than control. No significant difference between capoeira and aikido.
2014 Vertonghen et al. [6]	Goal orientation Physical aggression Social background Psychosocial behaviour	Quantitative cross-sectional questionnaire study, with comparison groups (judo, karate, kick-/Thai boxing); aikido (n =103); total (n = 477); age M 14.0 ±2.1; (n = 343♂,134♀). Between-group: less experienced, advanced.	1) Perception of Success Questionnaire [43] 2) Aggression Questionnaire [44] 3) Strengths and Difficulties Questionnaire [45] 4) Questions about the social background.	Aikido group more task and less ego-oriented than judo and kick-/Thai boxers, less psychosocial behaviour problems, and aggression and come from more privileged social categories than kick-/Thai boxers. Advanced aikido practitioners more task-oriented than beginners, and more task and less ego oriented than advanced practitioners of other martial arts.
2015 Halik & Kochan-Wójcik [15]	Corporeality	Qualitative cross-sectional, semi-structured interviews: aikido (n = 5♀); age range: 27-50yrs; aikido training >9 years.	Grounded theory framework. Interviews contained five areas [45] questions about participants, practising aikido, corporality, behaviour, the connection between practicing aikido and corporality.	Three emerging areas referring to the corporality construct: body, emotions and interpersonal contact.

relationships were linked to group affiliation. The women also exhibited a need for self-realisation, self-control, and persistence. The author concluded that women who practice aikido appear to focus on the functional aspects of their bodies and emotions through which they motivate themselves to gain an increased self-realisation while studying martial arts.

The third qualitative study identified in the review explored the effect of aikido training on the work of psychotherapists [16]. Its results indicated that aikido practice provides a deeper context and theoretical pathways in satisfying human relationships, and also yields strategies which help psychotherapists to be safe in a conflicting relationship while exploring their own emotional and psychological states. As such, aikido strategies work intra-psychically as well as interpersonally; it helps in achieving a harmonious and effective way of being in and being out of (viewing) therapy.

Physiological effects of aikido (Table 2)

Studies on healthy people

With a focus on injury, one study examined the possible injuries in aikido compared to other martial arts using a one-year retrospective cohort survey [17]. Aikido practice was associated with a higher risk of head/neck, upper extremity, and soft tissue injury compared with karate practitioners. By trying to determine significant predictors of a) injuries, b) of major injuries, and c) of multiple injuries by including predictors such as age, sex, rank, experience, frequency of training, and martial art style, the results revealed that martial art style was not a predictor for aikido, just for tae kwon do and karate. In considering the robustness of the findings, it should be noted that this study examined different martial arts groups that were not equal in size and the injuries were self-reported.

Five cross-sectional studies examined the physiological effects of aikido training in healthy participants. One conducted by Huang et al. [18], studied the flexibility of the upper extremities in aikido practitioners having five months of experience. Better flexibility, in all classes and ranges of motion, was disclosed in the aikido group compared to the lower-body sports and sedentary controls, and better than in the upper-body sports group, except shoulder flexion, lateral shoulder rotation, and wrist extension, when analysed separately. In spite of the optimistic results, the study has several limitations, including its cross-sectional design, and possible bias in the selection of the participants, which warrants the replication and the further examination of this work.

Vodicka et al. [19] also studied the upper extremities, namely the isokinetic strength of the wrist in male aikido practitioners. Results showed no significant differences between left and right hand, but by comparing to the findings of other studies the authors concluded, that aikidoka has weaker hand grip strength than other MA&CS athletes. Like with the bulk of the reviewed studies, the low sample size (refer to Table 2), and the differences in the methods compared to other studies (used as a comparison by the author), makes it is hard to draw firm conclusions and, hence, the replication of the study is necessary.

Another research assessed functional efficiency among man practising aikido and found that long-term aikido training results in better functional efficiency, which is in connection with a lower incidence of past injuries [20]. Due to the lack of a control group, one cannot confidently ascribe these result to the aikido's specific effects, because they may also be the positive side effects of improved coordination by regular training or physical activity. The subjective estimation of the Functional Movement Screen (refer to Table 2) test is a shortcoming of the research in addition to the lack of a control group. Therefore, its preliminary findings should be further investigated in future research.

Two investigations studied healthy postmenopausal women and found that eight years of aikido training was more beneficial than fitness training of equal length, or no training at all, in decreasing the psychophysiological costs of standing up and in increasing motor and cognitive efficiency [21, 22]. The authors concluded that aikido training decreases the cost of maintained vertical position and dependence of motor coordination on visual contribution. However, given the cross-sectional nature of the work, the relatively small sample size, and other possible mediating factors, these results may only be promising-tentative and, therefore, like the others warrant further empirical verification.

Studies of people with health ailments

Four studies examined participants with certain health dysfunction. Three [23-25] tested the effects of a one-school-year modified aikido intervention training program on boys prone to scoliosis in contrast to a conventional corrective exercise group and a regular physical education class control group. The results showed that the angle of lateral spinal curvature decreased in aikido group, while there were no changes in the corrective exercise group, and an increase was noticed in the control group. Aikido group's results also showed a reduction of pelvic anteversion angle (no change in the control group), but no change in α, β and γ spinal curvature angles in the sagittal plane were found (neither in control and comparison, except γ increase in the comparison group). In children with scoliosis, the angle of lateral spinal curvature decreased, similarly to the corrective exercise group, and it was more pronounced than in the control group. In non-scoliotic (just threatened) children the increased spinal angle was smaller in the aikido group than in the other two groups. Reduction in asymmetry values of the back pelvis spurs was only found in the aikido group. In children with asymmetry,

Year Author [references]	Issues	Design and sample	Measurement tool	Findings
2005 Zetaruk et al. [17]	Injuries	One year retrospective quantitative cross-sectional study with comparison groups (karate, taekwondo, kung fu, tai chi): aikido (n = 47); total (n = 263; no data on age and gender).	Survey: Personal data and injury data (checklist of injuries grouped by body region, required time off from training) [17]	Higher risks of head/neck injury, upper extremity injury, and soft tissue injury were noted int he aikido group compared to the karate group.
2006 Mroczkowski & Jaskólski, [23]	Lateral spine curvature	Quantitative, intervention with comparison (conventional corrective exercises) and control. Aikido (n =68♂); total (n = 202♂); age range 7-10yrs; with Grade I right- or left-sided scoliosis or threatened with scoliosis due to slanting pelvis in the frontal plane). Training: one school year.	Posturometric measurements (with "Posturometer-S" device, method [47] 1) angel of lateral spinal curvature in the frontal plane.	Positive findings: angle of lateral spinal curvature decreased most in aikido group
2007 Huang et al. [18]	Flexibility of the upper extremities.	Quantitative, cross-sectional, with control (sedentary) and comparison group (upper and lower body sports). Aikido (n = 12♂, 6♀); age: 18,4 ±0,2 yrs; total (n=67).	Standard measurement of joint motion with a ganiometer as based on [48]	Positive finding: Better flexibility seen in the aikido group compared to the other groups.
2007 Mroczkowski & Jaskólski [24]	Pelvis placement	Quantitative, intervention with comparison (conventional corrective exercises) and control. Aikido (n = 68♂; total (n = 202♂); age range:7-10yrs; with asymmetry of placement of back hip spurs with indication to apply heel pads on the side of pelvis lowering in the frontal plane, and children at whom the threat of slanting pelvis in the frontal plane due to scoliosis was recognized). Training: one school year.	Posturometric measurements (with "Posturometer-S" device, method: [47] 1) asymmetry of the back pelvis spur; 2) recommendation to apply heel pads.	Positive findings: Reduction in asymmetry values of the back pelvis spurs only in aikido group; Reduction of the recommendation of a pad`s usage.
2013 Boguszewski et al. [20]	Functional efficiency and injuries	Quantitative cross-sectional measurement Aikido (n = 32♂); age: M 25.5 ±5.9yrs. Between-group: age, length and number of training	1) Functional Movement Screen [49]; [50]; 2) Questionnaire about characterisations of the training, kinds and the number of injuries connected and not connected with sport [20]-	Positive finding: Higher FMS in those training longer (and in older participants) Higher FMS correlated with the lower level of injuries (both the sports ones and those not related to sport).
2013 Mroczkowski [25]	Spinal curvature in the sagittal plane moreover, anteversion angle of the pelvis	Quantitative, intervention with comparison (conventional corrective exercises) and control. Aikido (n = 68♂); age: M 8 yrs and 8 month; total (n = 211♂); with the first-degree scoliosis according to or with the risk of scoliosis due to the oblique alignment of the pelvis in the frontal plane). Training: one school year.	Posturometric measurements (with "Posturometer-S" device, method: [47] 1) alpha, beta and gamma angles of the spinal curvature in the sagittal plane 2) anteversion angle of the pelvis (not measured in the comparison group)	Aikido resulted in a reduction of pelvic anteversion angle (but no change in the control group) but did not affect α, βand γ spinal curvature angles in the sagittal plane (neither in control and comparison, except γ increase in the comparison group).
2015 Bazanova et al. [22]	Balance stability moreover, the role of visual activation in balance maintenance	Quantitative cross-sectional measurement with comparison (fitness) and control (sedentary). Aikido (n = 12♀); age: M 66 ±9yrs); total (n = 35).	Simultaneous stabilometry, EEG, and frontal EMG recording performed in sitting and standing up position in eyes closed and eyes open condition.	Positive findings: Smaller increase in the area of stabilogram and in the energy spent to maintain the balance when a change in the body position from sitting to standing (than in a sedentary group). Standing is accompanied by a decrease in visual activation, psycho-emotional tension, and an increase in the alpha-2 band power (compared to the other groups).

Year Author [references]	Issues	Design and sample	Measurement tool	Findings
2016 Vodicka et al. [19]	Isokinetic strength of the wrist	Quantitative cross-sectional measurement. Aikido (n =13♂); age: M 33.23 ±7.9yrs.	Cybex Humac Norm (Stoughton, MA, USA) at 120°, 180° and 240°/sec on both left and right wrists.	Negative findings: No significant difference in grip strength between the right and left hand (absolute or expressed regarding body mass). No Side x Movement x Angular / no Side x Velocity interaction for isokinetic wrist strength and no main effect for Side. There was a Movement x Angular velocity interaction.
2017 Bazanova et al. [21]	Balance stability moreover, the role of visual activation in balance maintenance and psychomotor task performance.	Quantitative cross-sectional measurement with comparison (fitness) and control (sedentary. Aikido (n = 12♀); age: M 65 ±6yrs; total (n = 35).	Simultaneous stabilometry, EEG, and frontal EMG recording performed in sitting and standing up position in eyes closed and eyes open condition. The recording was done at rest and while performing cognitive (Fluency of cognitive; [51] and finger motor [52] tasks.	Positive findings: Increased balance and fluency of movement paralleled by enhanced alpha-2 EEG and lower frontal EMG power in the aikido group.

Table 2. Physiological of aikido training (the ordinal variable is the year of publication).

at the beginning of the intervention aikido and physical education class groups showed improvement, and among children, without asymmetry, there was no difference between aikido and the other groups. In children with a recommendation for a pad`s use, the lowest percentage was found in aikido group. Among children with non-recommendations at the beginning of the intervention, the number of recommendations increased without any significant difference between aikido and the other two groups. The results of these studies appear to be both positive and promising, even though the modifications in aikido training, which could elicit such benefits, were insufficiently detailed.

Jasnoski's [10] already mentioned the study on Type A behaviour also found, that aikido training did not increase aerobic capacity. While aikido is not particularly an aerobic type of physical activity, such benefits may occur with long-term training. Therefore, the short intervention period could have masked any potential benefits of aikido on aerobic capacity.

DISCUSSION

Nine of the identified articles aimed to study the benefits of aikido training on a variety of physiological and health-related features, such as flexibility, wrist strength, functional efficiency, balance stability, scoliosis, and injuries [17-25]. The other eleven examined psychological variables, like mindfulness, aggressive behaviour, Type A behaviour, anger expression, self-control, self-esteem, health-related behaviour, mood profile, and goal orientation in sport [5-10, 12-14].

Apart from three [14-16], all studies were quantitative. Seven studies were intervention studies, most of which have used one or more control/comparison groups [8-10, 12, 23-25].

For the psychological assessments, questionnaires or interviews were used. For physiological measurements, exact indicators were taken like body posture, flexibility, aerobic capacity, functional movement screen, wrist strength, or stabilometry analyses. The studied samples differed in age, they were coming primarily from a healthy population, but people with health ailments were also examined (scoliosis or Type-A behaviour). The sample size of the studies varied as well, but typically relatively small samples were studied.

In summary, studies examining the psychological outcomes of aikido training vary in their focus. Instead of an established research path, the work in the field is scattered with diverse, but limited interest. Therefore, the findings of the here reviewed studies may be considered preliminary, or exploratory, projecting results that are rather tentative. In spite of the apparent shortcomings that generally characterise research on new areas/topics, the results of the reviewed studies are rather promising and certainly worth following up. Indeed, it

appears that aikido has a positive impact on mindfulness, on the reduction of one's ego-orientation and possibly on fostering the development of task-orientation, and also on anger-control in contest situations. The choice of aikido practice may be related to socio-economical status; children practising aikido appear to come from the higher social classes. These children show lower levels of physical aggression and social, behavioural problems than Thai kickboxers, a finding that could be linked to both MA&CS and/or social class. The untangling of these two is the subject of future, much needed, research in the field. While based on these preliminary studies, it may be unlikely that a short period of aikido training moulds self-control, aggressive or Type A behaviour, aikido seems to promote task-orientation and reduce ego-orientation compared to other martial arts, among children and adolescents, which could be of significant practical value. Further, a longer period of aikido training might have positive effects on psychotherapeutic work as shown in one of the studies, the outcome of which is valuable for those working in psychotherapy and possibly even in other helping professions. Aikido seems to have particularly beneficial effects for a woman by helping them to enjoy the full expression of physical self and focus on functional aspects of their bodies and emotions. While currently, we cannot draw firm conclusions from these few studies, their results are encouraging enough to warrant replication and expansion with more robust research methodologies. The exiting studies project a global image that aikido has positive psychological benefits, which is in accord with the anecdotal surmise revolving around this martial art.

In summing up the results of the physiological research on the benefits of aikido training, it is established that research in the field is unfocused and reflects sporadic interests. Nevertheless, like the studies examining the psychological outcomes, the work in this area is also promising. The preliminary findings that in comparison to Shotokan karateka, aikidoka seems to be at higher risk of head/neck, upper extremity and soft tissue injury, warrant urgent follow-up research as it as has immediate applied value in the health preservation of the aikido practitioner. In this context, the ration of the risk of injury should be measured up against the health benefits of this martial art. The finding that the length of aikido training is associated with better functional efficacy also has both theoretical and practical implication which are worth following up. Indeed, if only a five-month aikido training could result in the better flexibility of the upper extremities, then one can expect an increase in various task-related functional efficacies. The finding that compared to the inactive, or even fitness-practising women, the postmenopausal women involved in long-term aikido training decrease the cost of maintained vertical position and dependence of motor coordination on visual contribution is also noteworthy findings sending a promising message about the possible benefits of aikido training at an advanced age. From a therapeutic perspective, the finding that one school year long aikido training appears to be beneficial for boys with, or prone to, scoliosis has significant applied value for the affected population again. This bunch of positive findings, in spite of several methodological limitations, should motivate researchers to undertake focused research in examining the physical benefits of aikido, starting with the robust replication of some of the extant preliminary results.

Aikido training is believed to be a method of forging mind and body. This systematic review aimed to analyse the scientific research conducted on the physiological and psychological effects of aikido training. At this time research in this field is scarce; only 20 articles fulfilled the eligibility criteria for inclusion in the current review. The bulk of the reviewed studies seem to be preliminary or exploratory in nature, investigating a particular subject of interest to the researcher(s). However, the overall synthesis of projected by both physiologically and psychologically oriented empirical works are promising enough to encourage systematic and expanded follow up in future inquiries.

Aikido exercises emphasise the body and mind awareness, and in accord with research results, preliminary research shows positive effects on mindfulness. The peaceful atmosphere and serenity (without competition) as another basic aim of aikido seems partially demonstrated by the findings that aikido training reduces ego-orientation. These preliminary results warrant further investigations complemented with the studying of the effect of aikido on conflict (state anxiety or competitive state anxiety), coping strategies, spirituality, nature relatedness, body-awareness, psychological well-being, aggressiveness, and self-esteem. As stated in the physiological studies, future psychologically oriented works should also rely on longitudinal work, with at least one year intervention period, using a large enough sample size and adequate control groups. Cross,

martial arts comparisons, should be made with activities similar to aikido in physiological factors (like judo), and akin to mental or spiritual teachings (like thai chi) to exclude third factors effects.

CONCLUSIONS

There are several findings that merit future evaluations from a physiological perspective. It is likely that aikido training enhances the flexibility of the upper extremities in young adults, balance stability in postmenopausal women compared to other physical activities. Intervention studies of sufficient duration, the adequate control group, and random sampling, or at least randomisation, are necessary to confirm these findings. As shown in three studies, a longer aikido training is beneficial in the healing of scoliosis for boys, more than conventional corrective exercises. This promising result makes it important to broaden the investigations of aikido's effect on scoliosis among girls, and different age groups as well. Functional efficiency seems to grow with the time spent in aikido training as well. At least a year-long longitudinal studies, using active and inactive control groups, are needed to make reliable and causal connections between aikido training and functional efficiency. The investigation of the effects of long-term aikido practice on Type A behaviour pattern, and other cardiovascular functions, with a view on modifying the cardiovascular risk factors associated with this behaviour, again is important from a public health perspective, given that ischemic heart disease and stroke are the leading global causes of death [26].

LIMITATIONS

A first limitation is the strict delimitations used in the current work (only English, only peer-reviewed, only direct focus on traditional aikido). However, these delimitations were necessary to locate and examine the outcomes of the most robust and assumedly the most reliable studies in the field. The interventions and outcome measures are heterogeneous, making it impossible to compare effects through meta-analyses. Bias and quality of study are unclear in some of the studies, making it challenging to interpret outcomes with confidence. In spite of the limitations of the reviewed studies and this review, there is a clear take-home message that emerges from this work: The primarily anecdotally held beliefs about the benefits of aikido training appear to be substantiated by the results of scientific investigations on both physiological and psychological grounds.

HIGHLIGHTS

Empirical studies suggest that aikido training has both physiological and psychological benefits; empirical evidence associated with aikido training matches the anecdotal reports about this self-defence art; to date, the scholastic research on the benefits of aikido training lacks focus and has several methodological limitations; the promising preliminary results on aikido's benefits warrant future empirical effort the injury risk-health benefit of aikido training needs to be established.

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EDITORIAL NOTE

Both benefits of aikido training (physiological and psychological) are related to the expansion of all dimensions of health and survival ability (especially: self-defence aspect). The article Zsuzsanna Szabolcs et al. partially fills this gap in the sense of promoting health. Unfortunately, this careful, methodological review highlights the marginal contribution of dedicated publications of martial arts and self-defence art in global science space (which is associated with the ability to provide the latest scientific knowledge through prestigious electronic scientific journals [56]) as an attractive way to strengthen your health and personal safety throughout your life [57, 58].

Similar conclusions are drawn from previous judo articles review [59, 60]. On the one hand, doctoral and post-doctoral dissertations in Russia between 2000 and 2016 [56], on the other – publications from 1959 to 2017 (databases were accessed on July 31) available in the Web of Science [57]. The scientific knowledge of judo is dominating for the use of professional (Olympic) sport; the maximisation factor is exposed. Any maximisation of physical and mental effort is ultimately not healthy. On the contrary – sometimes deadly.

Aikido meets all criteria of the sport for all freed from the propaganda formula of professional sport, that is of winning and achieving new records (what in practice means encouraging fame and wealth while hiding the shameful truth about success often at the cost of losing health and even life). Aikido training, as a unique art of self-defence, is based on the principle *jita-kyoei* (mutual prosperity for self and others [58]), also optimising physiological and psychological benefits. This conclusion refers directly to *Czestochowa Declarations 2015: HMA against MMA* [59] and *Archives of Budo* mission [54, 55]. Therefore, in addition to this very valuable cognitive review, Szabolcs et al. we recommend available in *Web of Science* publications an eminent expert of Aikido, a professor Fumiaki Shishida from Waseda University in Japan [60-62]. Shishida in other articles available in global science space shows the relations between aikido and the other *budō arts* [63, 64] and also with regional and national martial arts [65,66].

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