

REVIEW ARTICLE

Judo-based exercise programs to improve health outcomes in middle-aged and older adults with no judo experience: A scoping review

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Received: 29 April 2022

Revised: 22 October 2022

Accepted: 26 December 2022

The practice of judo appears to impact positively on physical performance, muscle strength and flexibility in older people, while also benefiting bone mineral density in middle-aged adults. This scoping review aimed to map the range, scope and type of relevant studies conducted to examine the safety, feasibility and effects of judo interventions on various health-related outcomes designed for middle-aged and older adults (≥ 45 years) with no previous experience in judo. Six databases as well as gray literature were searched using a developed search strategy. Two independent reviewers screened the titles and abstracts, as well as full-texts of relevant articles using data extraction tools developed for the purpose of this study. Fifteen original studies were included, comprising 648 participants (mean age 45–77.8 years). All 15 studies reported significant positive results of ≥ 1 health-related outcome. Quality of life and bone mineral density seemed to improve only after longer interventions (≥ 9 or ≥ 12 months, respectively), while results regarding fear of falling and physical activity levels were mixed. Five studies showed improvements in fear of falling while four studies reported no change. Similarly, two studies showed improvements in physical activity, while another study showed no change. Five studies reported on safety and deemed their intervention to be safe (no adverse events), with two studies confirming feasibility. Findings suggest that judo interventions can positively impact health-related outcomes in middle-aged and older adults. However, studies had small sample sizes and more research is needed to confirm these findings. *Geriatr Gerontol Int* 2023; 23: 163–178.

Keywords: elderly, falls, healthy aging, judo, middle-aged.

Introduction

The population is aging globally.¹ Older adults are more prone to geriatric syndromes, including declines in strength and physical function,² resulting in an increased risk of falls and fall-related injuries.^{2–4} Thus, it is increasingly important to develop strategies

to promote healthy aging and prevent physical function decline to manage the rising number of falls.^{5,6}

Multicomponent exercises including strength, balance, aerobic and flexibility are beneficial in improving physical function and balance,^{7–11} thus benefiting falls prevention.^{7,8,12}

More recently, there has been increasing interest in martial arts as a multicomponent exercise.¹³ Judo, in particular, has gained popularity across the globe focusing not only on balance and strength, but also specific safe landing techniques (*ukemi*) that teach adults how to land safely when falling.^{14,15} *Ukemi* (breakfalls) are unique to judo, and it has been suggested that teaching *ukemi* might be a favorable strategy for reducing falls and consequential injuries in adults with no judo experience.¹⁶

Only a few studies thus far have been conducted in middle-aged and older adults with no judo experience. In older adults (≥ 60 years), judo interventions significantly improved physical performance,^{17,18} balance,¹⁸ strength,¹⁹ gait performance,²⁰ flexibility¹⁹ and safe falling techniques.^{17,18,21,22} In middle-aged populations (≥ 45 years), judo interventions increased bone mineral density (BMD) in females receiving medical treatment for osteoporosis.^{23–26}

Considering the potential benefits of judo for middle-aged and older adults with no judo experience, and given that the topic has not yet been extensively studied, a scoping review approach was chosen to provide an overview of the current literature. Understanding the feasibility, safety and effects of judo in middle-aged and older adults not previously exposed to judo, might help to inform the development of safe and feasible judo interventions to improve health-related outcomes such as reduced falls and falls-related consequences.

This scoping review therefore aimed to map the range, scope and type of relevant studies conducted to examine the safety, feasibility and effects of judo interventions on various health-related outcomes in middle-aged and older adults with no judo experience.

Methods

This scoping review was conducted following the Joanna Briggs Institute (JBI) framework for scoping reviews²⁷ and has been registered with the Open Science Framework Registry (Registration DOI: [10.17605/OSF.IO/NA2ET](https://doi.org/10.17605/OSF.IO/NA2ET)). The findings are presented according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) checklist.²⁸

Relevant definitions

Age classification

The definition of middle-age varies across the literature ranging from 40 to 59 years.^{29–33} In this scoping review, middle-aged adults have been defined as individuals aged between 45 and 59 years, while older adults were defined as individuals aged ≥ 60 years.³⁴

Health-related outcomes

Health-related outcomes were defined as any objective or subjective measures of deficits, impairments, disability, injuries, disease or illness (i.e., symptoms, falls, anxiety/depression, physical performance, cognitive status, well-being and quality of life [QoL]). Any safety and feasibility outcomes, such as adverse events and adherence were also of interest.

Interventions

Any judo intervention designed to improve health-related outcomes in middle-aged and older adults.

Eligibility criteria

Population

This scoping review included studies involving middle-aged and older adults aged ≥ 45 years (or mean age of ≥ 45 years) with no experience in judo.

Inclusion criteria

- Studies documenting the safety, feasibility and effects of judo interventions for middle-aged and older adults.
- Studies exploring adults' experiences and perspectives on judo interventions designed for middle-aged and older adults with no experience in judo.
- Studies summarizing evidence on the safety, feasibility and effects of judo interventions for middle-aged and older adults.

Setting

This review considered research studies across various settings including community and healthcare such as hospital, rehabilitation and nursing homes/residential aged care.

Type of studies

This scoping review considered any quantitative, qualitative, mixed methods and observational studies. Reviews were also included. Conference papers and commentaries were excluded.

Exclusion criteria

- Studies focusing on children, adolescence and young adults aged < 45 years (or mean age of < 45 years).
- Studies examining judo interventions for judo professionals/athletes or people with experience in judo.
- Studies focusing on other, non-health or feasibility-related outcomes.

Search strategy

The search strategy aimed to identify articles in the English language since 2000 as a preliminary search revealed that studies conducted before 2000 focused on judo athletes or participants with judo experience. The search was conducted on December 16, 2021 and has been updated until acceptance for publication. Studies not published in English were included if authors could provide an English version on request.

The search strategy involved a three-step process. First, a limited search was conducted of two databases (i.e., Medline and Embase). Text words and index terms found in articles retrieved from this initial search were used to develop a more comprehensive search strategy with the help of a health sciences academic librarian using Medical Subject Heading (MeSH) terms and search terms (File S1).

Secondly, the identified MeSH and search terms were entered into six electronic databases including Ovid search interfaces such as Medline, Embase, Emcare and PsycInfo, as well as other electronic databases such as SportDiscus and Scopus. The same keywords were entered into Google Scholar to identify gray literature. Only the first 100 hits (as sorted by relevance by Google) were screened as further screening was deemed unlikely to identify significantly more relevant articles.³⁵ All duplicates were removed.

Thirdly, the reference lists of all included articles were searched for additional studies after the full-text reviews were completed.

Study selection

To identify relevant research articles, a two-step screening process was used. First, titles and abstracts of articles from the search were screened using a Title Abstract Screening Tool (File S2) developed by authors to ensure articles meet the minimum inclusion criteria. A full-text review was then conducted for all articles not excluded based on title and abstract, or where any criteria was not stated or unclear, to confirm eligibility. Additional articles identified from the reference lists of included articles followed the same two-step screening process to determine eligibility. Both screening steps were conducted by two independent reviewers (UC and LA) with any disagreements being resolved through discussion with a third

reviewer (ADJ). The search and screening process is displayed in a PRISMA flow diagram (Fig. 1).³⁶

Data extraction

Data from relevant articles were extracted using a Full Text Data Extraction Tool developed by authors according to the aims of this scoping review (File S3).

Data extracted included authors, year of publication, source of origin/country, study setting, study type, sample size, population age, gender and health status, intervention characteristics (i.e., type, duration, frequency and intensity), outcome measures and key findings.

Both forms, the Title Abstract and Full Text Data Extraction Tool, were tested by the reviewers using two studies. No disagreements arose between the reviewers.

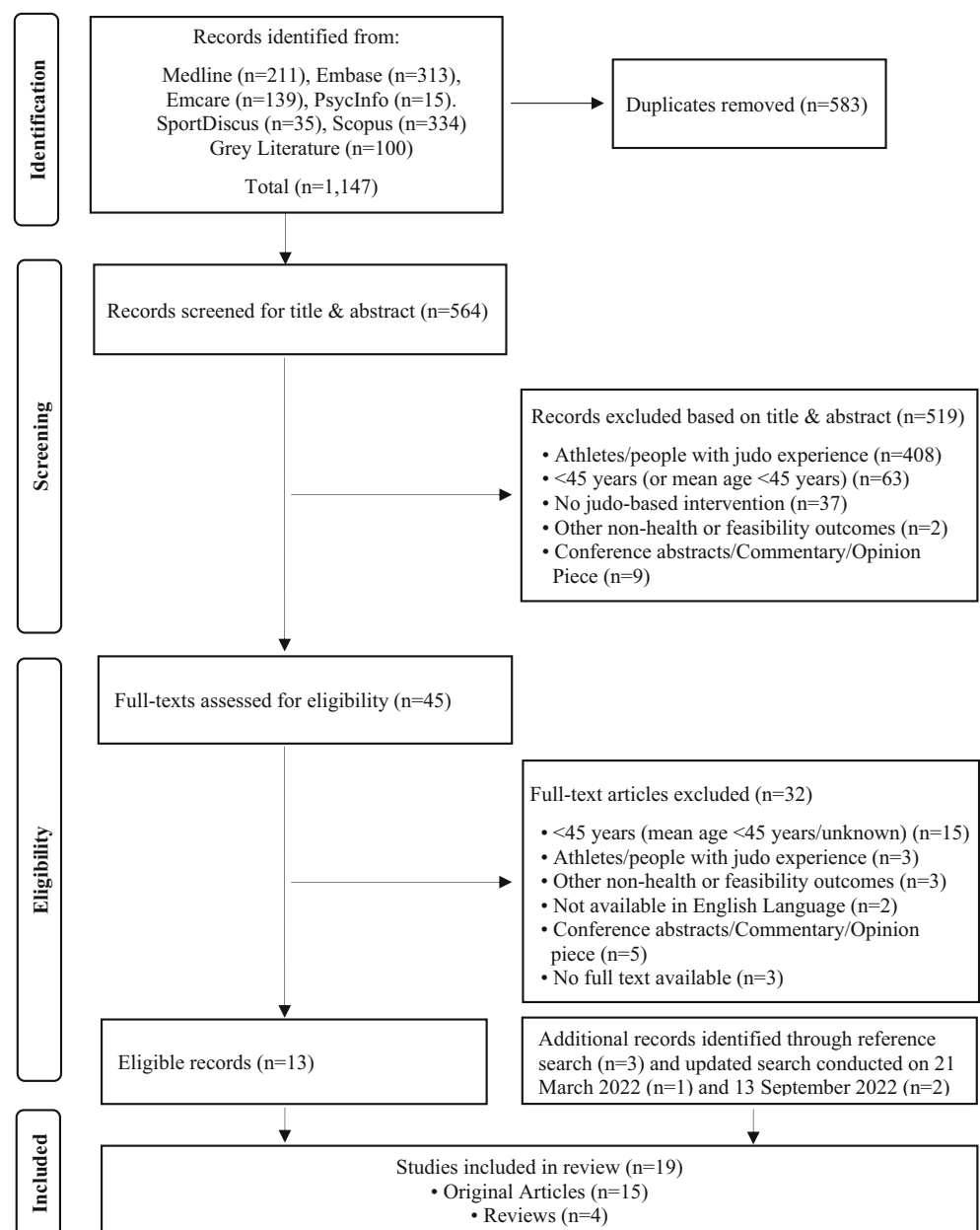


Figure 1 PRISMA flowchart of study selection and inclusion process.³⁶

Data management

References retrieved from the electronic databases were managed with EndNote 20[®] software. The EndNote 20[®] software enabled easy identification and removal of duplicates, classification of articles to be included or excluded, and efficient management of relevant full-text articles.

Presentation of the data

The findings are presented in a table format followed by a narrative summary of the results.

Results

Search and selection of articles

The original search conducted on December 16, 2021 returned 1147 records. After removing duplicates ($n = 583$) and screening the title and abstract, 45 articles were considered for full-text review. Twenty-seven full-text articles were excluded due to not meeting the eligibility criteria, three full-texts could not be obtained and two full-texts were not available in English. Three additional articles were identified from secondary reference searching^{22,24,25} and three articles^{18,37,38} have been identified via an updated search conducted on March 21, 2022 and September 13, 2022, resulting in a total of 19 relevant articles (Fig. 1).

The 19 relevant articles consisted of 15 original studies and four systematic reviews.^{13,37–39} The four systematic reviews comprised a total of 61 studies; however, only seven studies^{19,20,22–25,40} were relevant for this scoping review. All seven of these studies had been identified via the original search ($n = 4$) or secondary reference searching ($n = 3$). Therefore, 15 articles (including the seven studies from the four eligible systematic reviews) were included in this scoping review (Table 1).

Study characteristics

Six research groups conducted the studies between 2010 and 2022. Four studies each were conducted in Sweden^{17,18,41,42} and Brazil,^{23–26} three in Italy,^{19–21} two in Spain,^{40,43} and one each in Japan¹⁴ and the Netherlands.²²

Study type

Three studies were randomized controlled trials (RCT) allocating study participants randomly into intervention and control groups with two studies being labeled as an experimental study,^{23,25} and one study being a clinical trial.²⁶ Nine studies were non-randomized quasi-experimental studies,^{19–22,24,40–43} including five non-equivalent studies^{19,20,24,40,42} and four pre-post studies.^{21,22,41,43} One study each was a feasibility study,¹⁷ an initial RCT,¹⁸ and an observational study.¹⁴

Eight studies included a control group^{19,20,23–26,40,42} while six studies had a single intervention group.^{14,17,21,22,41,43} Two studies^{24,26} compared judo interventions with other interventions, such as resistance training, water aerobics and karate, in addition to a control group. One study began as a RCT initially,¹⁸ however, due to COVID-19 disruptions, on restarting the trial, both groups (i.e., control and intervention) received the judo intervention.

Recruitment source

The most common recruitment source was local television and radio,^{23–26} followed by workplaces^{17,41,42} and community

associations.^{18,20,21} Two studies used posters^{23,25} and healthcare settings (i.e., hospital and physiotherapists).^{14,17} Two studies used social media for recruitment,^{17,18} while three studies did not provide information on their recruitment source.^{19,40,43}

Participants

In total, 648 participants were included in the 15 studies. The mean age ranged from 45 to 77.8 years. Five studies included females only,^{23–26,43} while two studies^{17,42} did not report on gender.

Four studies focused on middle-aged participants (mean age 49.8–60.5 years; $n = 121$),^{23–26} including females only (100%) with sample sizes ranging from 18 to 50. All participants received medical treatment for osteoporosis or osteopenia with no history of fractures, and were in good physical and mental health according to a medical professional.^{23–26} Seven studies focused on older participants (mean age 63–77.8 years; $n = 241$),^{17–22,40} including 43%–76% females with sample sizes ranging from 19 to 79, while four studies focused on a mix of middle-aged and older adults (mean age 45–71.5 years; $n = 286$)^{14,41–43} including 60%–100% females with sample sizes ranging from 12 to 142.

Two studies recruited older⁴⁰ and mixed-aged⁴³ pre-frail participants based on the Frailty Trait Scale with no diagnosed illnesses that would prevent participants from exercising.^{40,43} One study included older adults with good mental and physical health based on the 12-item Short Form Health Survey (SF-12v2) (≥ 50 th percentile) and low falls risk (≥ 41 Berg Balance Scale).¹⁹ Two studies recruited older participants who were mobile,^{17,18} while one study each recruited older participants with no medical issues,²⁰ able to walk at least 15 min without a walking aid,²² or who provided medical certification for non-competitive physical activity (PA).²¹ One study included mixed-aged participants with low and high movement ability based on the 36-item Short-Form Health Survey (SF-36) (low mobility: ≤ 23 ; high mobility: ≥ 24).¹⁴ One study did not provide details on participants' health,⁴¹ while two studies excluded older¹⁸ and mixed-aged⁴² participants with uncontrolled high blood pressure or retinal detachment.

Study settings

Nine studies provided details on the study setting. Four studies were conducted in judo clubs,^{18,23–25} two in the workplace,^{41,42} and one at a local sports activity center for seniors.²² Two studies were conducted in mixed settings^{14,17} including a judo club, healthcare center and workplace,¹⁷ and the other study was conducted in a judo club and participants' homes.¹⁴

Intervention characteristics

Type

All 15 studies included *ukemi*. Ten studies^{14,19–21,23–26,40,43} conducted judo-specific interventions focusing on judo-specific movements and postures, while five studies^{17,18,22,41,42} conducted judo-based exercise programs incorporating balance, strength and mobility (Table 2).

Judo-specific interventions in middle-aged participants included repetitive practice of throwing (*uchi-komi*), practice of actual throwing (*nage-ai*), attack-defense (*kakri-geiko*), alternate projections (*yaku-soku-geiko*), turning the body (*tai-sabaki*) and training of unbalancing (*kuzushi*).^{23–26} In older participants, ground techniques (*ne-waza*), standing techniques (*tachi-waza*) and sequences of judo-specific movements (*kata*) were used.^{19–21,40} Lateral falls (*yoko-ukemi*), back falls (*ushiro-ukemi*), as well as

Table 1 Overview of included studies

Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
Brazilian Research Group Interventions								
1 Borba-Pinheiro et al., 2010 ²⁴ (Brazil) [†]	Community (judo club)	Quasi-experimental study (non-equivalent)	<i>n</i> = 35	Middle-aged	35 (100%)	Judo (<i>judo-specific</i>)	Bone mineral density (DXA)	↑ Bone mineral density
				Mean 52.2 Post-menopausal with osteopenia/osteoporosis		12 months 3×/week, alternate days, 60 min/session	Quality of life (OPAQ) Balance (Static Balance with Visual Control Test)	↑ Quality of life ↑ Balance
				Water aerobics, <i>n</i> = 8		RPE 12–16		
				Control, <i>n</i> = 7		Supervised		
2 Borba-Pinheiro et al., 2012 ²³ (Brazil) [†]	Community (judo club)	Experimental study	<i>n</i> = 18	Middle-aged	18 (100%)	Adapted judo training (<i>judo-specific</i>)	Bone mineral density (DXA)	↑ Lumbar bone mineral density
				Mean 52.2		12 months divided into 6 bimonthly cycles	Quality of life (OPAQ)	↑ Quality of life
				Post-menopausal with osteopenia/osteoporosis		3×/week on alternate days, 60 min/session	Balance (Static Balance with Visual Control Test)	↑ Balance
				Intervention, <i>n</i> = 11				
				Control, <i>n</i> = 7				
						RPE 11–16		
						Supervised		
3 Borba-Pinheiro et al., 2013 ²⁵ (Brazil) [†]	Community (judo club)	Experimental study	<i>n</i> = 18	Middle-aged	18 (100%)	Adapted judo training (<i>judo-specific</i>)	Bone mineral density (DXA)	↑ BMD in first year, maintained in second year
				Mean 52.2		24 months		
				Post-menopausal with osteopenia/osteoporosis		3×/week on alternate days, 60 min/session		
				Intervention, <i>n</i> = 11				
				Control, <i>n</i> = 7				
						RPE 11–16		
						Supervised		
4 Borba-Pinheiro et al., 2016 ²⁶ (Brazil)	Not stated	Clinical trial	<i>n</i> = 50	Middle-aged	50 (100%)	Adapted judo training (<i>judo-specific</i>)	Bone mineral density (DXA)	↑ Bone mineral density
						RPE 11–16		
						Supervised		
						Adapted judo training (<i>judo-specific</i>)		

(Continues)

Table 1 Continued

Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
Japanese Research Group Sakiyama <i>et al.</i> , 2021 ¹⁴ (Japan)	Community (judo club and home)	Observational study	Judo, <i>n</i> = 17	Mean 56.6		12 months divided into 6 bimonthly cycles	Functional autonomy (GDLAM Autonomy Index)	↑ Functional autonomy
			Karate, <i>n</i> = 17	Post-menopausal with osteopenia/osteoporosis		3×/week on alternate days, 60 min/session	Quality of life (OPAQ)	↑ Quality of life
			Control, <i>n</i> = 16			RPE 11–16	Muscle strength (10MR)	↑ Muscle strength
						Supervised		
Swedish Research Group Arkkukangas <i>et al.</i> , 2020 ⁴¹ (Sweden)	Community (workplace)	Quasi-experimental study (pre-post)	<i>n</i> = 53	Mixed-aged	46 (87%)	Judo exercise program (<i>judo-specific</i>)	Quality of life (SF-36)	↑ Quality of life—mental component scores in high mobility group
			Low mobility group, <i>n</i> = 14	Mean 71 (45–83)		Taught for 3 years 8 months, observed for 9 months		↑ Quality of life—physical functioning, social functioning and physical component score in low mobility group
			High mobility group, <i>n</i> = 39 (based on SF-36 scores)	Healthy		1×/month, 60 min/session		
						Instructed to practice independently at home at least 2×/week		
Interventions <12 months						Supervised once a month, all other times unsupervised	Safety and feasibility of intervention	Confirms safety and feasibility of intervention
			<i>n</i> = 79	Mixed-aged	48 (60%)	Judo-inspired exercise program (<i>judo-based</i>)	Falls confidence (FES-S)	↑ Falls confidence

(Continues)

Table 1 Continued

Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
7 Arkkukangas <i>et al.</i> , 2021 ⁴² (Sweden)	Community (workplace)	Quasi-experimental study (non-equivalent)	<i>n</i> = 142	Mean 45 (18–68)	95 (67%)	10 weeks	Physical performance (SPPB)	↑ Physical performance
				Healthy		1×/week, 50 min/session	Balance (Mini-BESTest)	↑ Balance
						Supervised	Safe falling techniques (Developed Test)	↑ Safe Fall Techniques
							Physical activity levels (Frändin & Grimby Activity Scale)	↑ Physical activity levels
				Mixed-aged		Judo-inspired exercise program (<i>judo-based</i>)	Falls confidence (FES-S)	No adverse events - Falls confidence
				Mean 47 (18–68)		10 weeks	Physical performance (SPPB)	↑ Physical performance
				Healthy		1×/week, 50 min/session High-intensity judo-inspired exercises/games, simple gymnastics Supervised	Balance (Mini-BESTest) Safe falling techniques (Developed Test) Physical activity levels (Frändin & Grimby Activity Scale)	↑ Balance ↑ Safe falling techniques - Physical activity levels
8 Arkkukangas <i>et al.</i> , 2020 ¹⁷ (Sweden)	Community (healthcare center, judo club, workplace)	Feasibility study	<i>n</i> = 28	Older age	Not stated	Judo-inspired exercise program (<i>judo-based</i>)	Falls confidence (FES-S)	No adverse events - Falls confidence
				Mean		10–16 weeks	Physical performance (SPPB)	↑ Physical performance
				Workplace 63		1×/week, 45–60 min/session	Safe falling technique (Developed Test)	↑ Safe fall techniques
				Judo club 71 Healthcare 74 (60–88)		Supervised	Feasibility and acceptance of intervention	Confirms feasibility and acceptance of intervention for active older adults
				Healthy				

(Continues)

Table 1 Continued

	Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
9	Arkkukangas <i>et al.</i> , 2022 ¹⁸ (Sweden)	Community (judo club)	Initial randomized controlled trial	Initial <i>n</i> = 199	Older age	Initial 158 (79%)	Judo-inspired exercise program (judo-based)	Falls confidence (FES-S)	↑ Falls confidence
				Intervention, <i>n</i> = 100	Initial mean 72.4	Post-disruption not stated	12 weeks	Physical performance (SPPB)	↑ Physical performance
				Control, <i>n</i> = 99	Healthy		1×/week, 50–60 min/ session Supervised	Balance (Mini-BESTest)	↑ Balance
				Post-disruption intervention <i>n</i> = 79	Post-disruption not stated			Safe falling techniques (Strömquist Bååthe Falling Technique Test)	↑ Safe falling techniques
								Physical activity levels (Frändin & Grimby Activity Scale)	↑ Physical activity levels
								Self-rated health (EQVAS)	↑ Health condition
								Quality of life (EQ-5D-3L)	- Quality of life
Italian Research Group									
10	Ciaconini <i>et al.</i> , 2021 ²¹ (Italy)	Not stated	Quasi-experimental study (pre-post)	<i>n</i> = 19	Older age	9 (47%)	Judo training (judo-specific)	Fear of falling (VAS-FOF)	- Fear of falling
					Mean 68.9		16 weeks	Training enjoyment (VAS)	- Training enjoyment
					Healthy		2×/week, 60 min/ session RPE low to moderate (values not stated)	Motivation (MPAM-R and SRQ-E)	↑ Motivation
							Supervised	Falls performance (developed test)	↑ Falls performance
11	Ciaconini <i>et al.</i> , 2020 ²⁰ (Italy) [‡]	Not stated	Quasi-experimental study (non-equivalent)	<i>n</i> = 30	Older age	13 (43%)	Judo training (judo-specific)	Step length (10-m Optojump Photocell System)	↑ Step length
				Intervention, <i>n</i> = 16	Mean 69.3 (60–75)		15 weeks	Gait cycle time (10-m Optojump Photocell System)	↓ Gait cycle time
				Control, <i>n</i> = 14	Healthy, physically inactive		2×/week, 60 min/ session Supervised	Gait speed (10-m Optojump Photocell System)	↑ Gait speed
								Gait cadence (10-m Optojump Photocell System)	↑ Gait cadence

(Continues)

Table 1 Continued

	Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
12	Ciaconini <i>et al.</i> , 2019 ¹⁹ (Italy) ^{§§,†}	Not stated	Quasi-experimental study (non-equivalent)	<i>n</i> = 30 Intervention, <i>n</i> = 19 Control, <i>n</i> = 21	Older age Mean 69.7 (64–77) Healthy, low falls risk (41–56 points on BBS)	18 (45%)	Judo training (<i>judo-specific</i>) 16 weeks 2×/week, 60 min/session RPE used (outcomes not stated) Supervised	Anthropometric assessment (BMI, hip and waist circumference) Flexibility (back scratch, chair sit-and-reach test) Strength (30 s chair stand, arm dynamometer) Body dissatisfaction (BIDA) Quality of life (SF-12v2) Fear of falling (FES-I)	↓ Waist circumference - Hip circumference, BMI ↑ Flexibility ↑ Muscle Strength ↓ Body dissatisfaction - Quality of life - Fear of falling
Dutch Research Group									
13	Groen <i>et al.</i> , 2010 ²² (The Netherlands) [†]	Community (local sports activities for seniors)	Quasi-experimental study (pre-post)	<i>n</i> = 25	Older age Mean 69.5 (60–81) Healthy	19 (76%)	Nijmegen Falls Prevention Program (<i>judo-based</i>) 5 weeks 1×/week, 45 min/session Supervised	Falls performance (developed test using a 6-camera 3D motion analysis system) Hip impact force (1.2 m × 1.2 m force plate covered by judo mats) Fear of falling (VAS)	↑ Falls performance ↓ Hip impact force ↓ Fear of falling
Spanish Research Group									
14	Toronjo-Hornillo <i>et al.</i> , 2018 ⁴³ (Spain)	Not stated	Quasi-experimental study (pre-post)	<i>n</i> = 12	Mixed-aged Mean 71.5 (57–83) Healthy	12 (100%)	Adapted utilitarian judo (<i>judo-specific</i>) 8 weeks 2×/week, 60 min/session Supervised	Fear of falling (FES-I)	↓ Fear of falling

(Continues)

Table 1 Continued

Author, year (country)	Study setting	Study type	Sample size, <i>n</i>	Age, mean (range) and health status	Women, <i>N</i> (%)	Intervention characteristics (type, duration, frequency, intensity)	Outcome measures	Key findings
15 Campos-Mesa <i>et al.</i> , 2020 ⁴⁰ (Spain) [†]	Not stated	Quasi-experimental study (non-equivalent)	<i>n</i> = 30	Older age	26 (87%)	Adapted utilitarian judo (<i>judo-specific</i>)	Fear of falling (FES-I)	↓ Fear of falling
			Intervention, <i>n</i> = 19 Control, <i>n</i> = 11	Mean 72.6 (F) Mean 76.0 (M) (65–85) Healthy		6 weeks 2×/week, 60 min/session Supervised		

[†]Relevant article from Systematic Review.³⁹[‡]Relevant article from Systematic Review.¹³[§]Relevant article from Systematic Review.³⁷[¶]Relevant article from Systematic Review.³⁸

↑, Significant increase; ↓, no significant change; ↓, significant decrease; 10MR, ten maximal repetitions; BBS, Berg's Balance Scale; BIDA, Body Image Dimensional Assessment; BMI, body mass index; DXA, dual-energy X-ray absorptiometry; EQ-5D-3L, European Quality of Life 5 Dimensions 3 Levels; EQVAS, Euro Quality of Life Visual Analog Scale; F, female; FES-I, Falls Efficacy Scale- International; FES-S, Falls Efficacy Scale-Swedish Version; GD/LAM Autonomy Index, Group of Development Latin-America for Maturity Autonomy Index; M, male; Mini-BESTest, Mini-Balance Evaluation Systems Test; MPAM-R, Motives for Physical Activity Measure-Revised; OPAQ, Osteoporosis Assessment Questionnaire; RPE, Rate of Perceived Exertion (based on Borg Scale); SF-12v2, 12-item Short Form Health Survey Version 2; SF-36, 36-item Short Form Health Survey; SF-36v2, 36-item Short Form Health Survey Version 2; SPPB, Short Physical Performance Battery; SRQ-E, Exercise Self-Regulation Questionnaire; VAS, visual analog scale.

Table 2 Details of judo interventions

Author, year (country)		Details of judo intervention
Judo-specific		
1	Borba-Pinheiro <i>et al.</i> , 2010 ²⁴ (Brazil)	<ul style="list-style-type: none"> Greeting, stretches, fitness, breakfalls (<i>ukemi</i>), repetition of techniques (<i>uchi-komi</i>), training kimono grip changes, attack-defense (<i>kakari-geiko</i>), alternate projections (<i>yaku-soku-geiko</i>), stretches and final greetings
2	Borba-Pinheiro <i>et al.</i> , 2012 ²³ (Brazil)	<ul style="list-style-type: none"> Initial: greetings, muscle stretching
3	Borba-Pinheiro <i>et al.</i> , 2013 ²⁵ (Brazil)	<ul style="list-style-type: none"> Physical conditioning: running, crawling and short jumps
4	Borba-Pinheiro <i>et al.</i> , 2016 ²⁶ (Brazil)	<ul style="list-style-type: none"> Techniques: breakfalls (<i>ukemi</i>), repetition drill training of throwing techniques (<i>uchi-komi</i>), training of unbalancing (<i>kuzushi</i>), training with turning of the body (<i>tai-sabaki</i>), throwing training (<i>nage-ai</i>) During <i>nage-ai</i>, teachers and judo athletes aged 15–20 years were thrown Repetition drills included 6–12 repetitions
5	Sakuyama <i>et al.</i> , 2021 ¹⁴ (Japan)	<ul style="list-style-type: none"> Basics taught: breakfalls (<i>ukemi</i>), throwing techniques (<i>nage-waza</i>), ground techniques Judo breakfalls (<i>ukemi</i>): cradle motion, backward and sideways, <i>uchite</i> (motion of the hand hitting the mat)
6	Ciaccioni <i>et al.</i> , 2019 ¹⁹ (Italy)	<ul style="list-style-type: none"> Warm up: light activities and gentle routines of judo postures, movements and techniques performed at slow speed (i.e., rolling over, squatting, bending) Judo: ground technique (<i>ne-waza</i>), standing techniques (<i>tachi-waza</i>), sequences of specific movements (<i>kata</i>), judo falling techniques (<i>ukemi</i>)
7	Ciaccioni <i>et al.</i> , 2020 ²⁰ (Italy)	<ul style="list-style-type: none"> Cool down: judo <i>kata</i> focused on stretching and relaxation Ground techniques (<i>ne-waza</i>) performed in pairs
8	Ciaccioni <i>et al.</i> , 2021 ²¹ (Italy)	<ul style="list-style-type: none"> Same as Ciaccioni <i>et al.</i> (2020)²⁰ In addition: breakfalls (<i>ukemi</i>) backwards, sideways (left and right), forward with and without roll
9	Campos-Mesa <i>et al.</i> , 2020 ⁴⁰ (Spain)	<ul style="list-style-type: none"> Falls training: specific exercises to assimilate safe and protected ways of falling
10	Toronjo-Hornillo <i>et al.</i> , 2018 ⁴³ (Spain)	<ul style="list-style-type: none"> Breakfalls (<i>ukemi</i>): <i>Yoko-ukemi</i> (lateral falls) and <i>ushiro-ukemi</i> (back falls) and rising from the ground
Judo-based		
11	Arkkukangas <i>et al.</i> , 2020 ⁴¹ (Sweden)	<ul style="list-style-type: none"> Warm up, balance, coordination, breakfall training, strength, cool down
12	Arkkukangas <i>et al.</i> , 2020 ¹⁷ (Sweden)	<ul style="list-style-type: none"> Breakfalls (<i>ukemi</i>): backwards, sideways (left and right), forward with and without roll Exercises performed in pairs (a common practice in Judo)
13	Arkkukangas <i>et al.</i> , 2021 ⁴² (Sweden)	<ul style="list-style-type: none"> Progression in 3 blocks: <ol style="list-style-type: none"> Basic falling techniques (<i>ukemi</i>) from sitting/kneeling positions, strength, body awareness, mobility, getting up and down from floor Continue with falling techniques (<i>ukemi</i>), increased load in strength exercises, balance, coordination, greater range of motion Advanced/challenging falling techniques (<i>ukemi</i>) from standing positions, develop power (strength and speed), challenging balance^{18,42} High-intensity games (i.e., rolling, crawling),⁴² progressive exercise challenges¹⁸
14	Arkkukangas <i>et al.</i> , 2022 ¹⁸ (Sweden)	<ul style="list-style-type: none"> Falls training identical to Nijmegen Falls Prevention Program⁵³ Performed on judo mats, fall is changed into a rolling movement, arm is used to break the fall after hip impact 2-part training: <ol style="list-style-type: none"> Obstacle course mimicking daily activities targeting balance, gait, coordination Walking exercises, martial arts-derived forward, backward and sideways falling techniques The 3 most important martial arts techniques were rolling movement, head protection by neck flexion, and use of the arm to stop rolling movement In forward falls, trunk flexion and rotation enabled participants to roll over the scapula of the ipsilateral shoulder and diagonally across the back to the contralateral hip region In sideways falls, participants rolled over the ipsilateral hip to the scapula of the ipsilateral shoulder; this was achieved by flexion, lateral flexion and trunk rotation Both sideways and forward fall exercises started in sitting position
15	Groen <i>et al.</i> , 2010 ²² (The Netherlands)	<ul style="list-style-type: none"> Falls training identical to Nijmegen Falls Prevention Program⁵³ Performed on judo mats, fall is changed into a rolling movement, arm is used to break the fall after hip impact 2-part training: <ol style="list-style-type: none"> Obstacle course mimicking daily activities targeting balance, gait, coordination Walking exercises, martial arts-derived forward, backward and sideways falling techniques The 3 most important martial arts techniques were rolling movement, head protection by neck flexion, and use of the arm to stop rolling movement In forward falls, trunk flexion and rotation enabled participants to roll over the scapula of the ipsilateral shoulder and diagonally across the back to the contralateral hip region In sideways falls, participants rolled over the ipsilateral hip to the scapula of the ipsilateral shoulder; this was achieved by flexion, lateral flexion and trunk rotation Both sideways and forward fall exercises started in sitting position

throwing (*nage-waza*) and ground techniques were used in mixed-aged participants.^{14,43}

Judo-based exercise programs included balance, mobility (i.e., getting up and down from the ground), and strength.^{17,18,22,41,42}

One study, including older participants, used an obstacle course comprising balance and gait exercises,²² while three other studies, including older¹⁷ and mixed-aged participants,^{41,42} used power exercises (i.e., strength and

speed) and high-intensity games in addition to balance, strength and mobility.^{17,41,42}

None of the studies reported to modify the intervention in response to participants' health or physical limitations. However, two studies adjusted their intensity according to participants' progress.^{40,43}

Supervision

All 15 studies were supervised, however, only four provided details.^{14,17,18,41}

One study conducting a judo-specific intervention in mixed-aged participants had a supervised session once a month and participants practiced independently at home at least twice a week.¹⁴

Three studies^{17,18,41} conducted judo-based interventions in older^{17,18} and mixed-aged participants⁴¹ with two studies having two instructors allocated to either groups of seven to 11 participants,¹⁷ or of unknown size.¹⁸ One study had 79 participants divided into two intervention groups with an average of two instructors supervising each group of unknown size.⁴¹

Duration

The duration of interventions ranged from 5 weeks to 24 months with the majority ($n = 10$) being conducted between 5 and 16 weeks.^{17–22,40–43}

Judo-specific interventions ranged from 6 weeks to 24 months,^{14,19–21,23–26,40,43} while judo-based programs ranged from 5 to 16 weeks.^{17,18,22,41,42}

Interventions including middle-aged participants ranged from 12 to 24 months,^{23–26} while interventions including older^{17–22,40} and mixed-aged participants^{14,41–43} were shorter in duration (i.e., 5–16 weeks).^{17–22,40–43} Only one study including mixed-aged participants conducted their judo-specific interventions for 9 months and observed participants for up to 3 years and 8 months.¹⁴ The duration of sessions ranged from 45 to 60 min across all 15 studies.

Frequency

The frequency of sessions ranged from one to three times a week. Five studies each performed their intervention once^{17,18,22,41,42} or twice a week,^{19–21,40,43} while four studies had three sessions a week.^{23–26}

Judo-specific interventions were conducted one to three times a week,^{14,19–21,23–26,40,43} while judo-based interventions had one session a week.^{17,18,22,41,42}

Studies including middle-aged participants performed their intervention three times a week,^{23–26} while studies including older^{17–22,40} and mixed-aged participants^{14,41–43} were conducted less often (i.e., one to two times per week).^{14,17–22,40–43} One study that was conducted over 3 years had a supervised session once a month, and participants practiced independently at home at least twice a week.¹⁴

Intensity

Seven studies^{19,21,23–26,42} provided information on intensity ranging from light-to-hard. Six studies performed judo-specific interventions including middle-aged^{23–26} and older participants,^{19,21} while one study conducted a judo-based intervention, including mixed-aged participants.⁴²

The intensity of judo-specific interventions in middle-aged participants ranged from light-to-hard using the Rate of Perceived Exertion (RPE) on the Borg Scale (RPE 11–16),^{23–26} while another study including older participants performed their judo-specific intervention with a lower intensity ranging from light-to-moderate

(no RPE provided).²¹ Another study, including older participants stated that RPE was used; however, no further information was provided.¹⁹

One study conducting a judo-based intervention in mixed-aged participants reported that high-intensity judo-inspired exercises and games were used; however, no information was provided on how intensity was assessed.⁴²

Control

Eight studies (six quasi-experimental, one experimental, one clinical trial) included a control group ranging from seven to 63 participants. Seven studies^{19,20,23–26,40} conducted judo-specific interventions, including middle-aged^{23–26} and older participants,^{19,20,40} while one study conducted a judo-based intervention including mixed-aged participants.⁴²

In six studies^{19,20,23–26} the control group did not receive an intervention and was encouraged not to practice regular PA during the study (i.e., 12–24 months),^{23–26} or maintain their baseline PA.^{19,20} In another study, the control group received a PA intervention over 6 weeks including light-to-moderate aerobic, muscle-strengthening, coordination, balance and flexibility tasks, similar in duration and frequency to the judo intervention,⁴⁰ while another study had a control group consisting of a wait list of participants ($n = 63$) who received the 10-week judo-based intervention after the original study was completed.⁴²

Safety

Eleven studies^{14,17–19,22–26,41,42} reported to use judo mats conducting both, judo-specific^{14,19,23–26} and judo-based^{17,18,22,41,42} interventions in middle-aged,^{23–26} older^{17–19,22} and mixed-aged participants.^{14,41,42} For one study, judo mats were used during the supervised component; however, no information was provided for the unsupervised component.¹⁴

Five of these studies reported on safety and deemed their intervention to be safe as no adverse events were reported.^{14,17,18,41,42} One study was judo-specific, including mixed-aged participants,¹⁴ while four studies were judo-based^{17,18,41,42} and included older^{17,18} and mixed-aged participants.^{41,42} No information was provided on the types of adverse events monitored for.

Feasibility

Two studies reported on feasibility including both, a judo-specific¹⁴ and a judo-based¹⁷ intervention in mixed-aged¹⁴ and older participants,¹⁷ respectively.

One study concluded that their judo-based program was feasible based on recruitment, dropouts, time (i.e., duration of assessments and intervention), study equipment and location (i.e., judo club, healthcare center and workplace).¹⁷ The most time effective setting was the local judo club; having permanent judo mats on the floor and judo instructors available was deemed to be a huge advantage for feasibility.¹⁷ Another study concluded that their judo-specific intervention was feasible as mixed-aged participants could easily learn the exercises.¹⁴

Withdrawals

Seven studies reported on withdrawals. Three studies conducted judo-specific interventions^{19,20,26} including middle-aged²⁶ and older participants,^{19,20} while four studies conducted judo-based interventions, including older^{17,22} and mixed-aged participants.^{41,42}

Withdrawal rates were reported in older participants and ranged from 10% (5 weeks intervention, once/week),²² to 15% (15 weeks, twice a week),²⁰ to 25% (10–16 weeks, one to two times per week),^{17,19} irrespective of the intervention (i.e., judo-specific or judo-based).

Reasons for withdrawals were medical^{17,20,22} or personal²⁰ unrelated to the study, change of workplace,⁴² long vacation⁴¹ or long-term sick leave.⁴¹ Reasons for exclusion from data analysis were absence on assessment day^{17,41,42} or poor attendance (<75%) throughout the intervention.^{19,20,26} One study had 199 participants initially but only reported on 79 participants due to withdrawals caused by COVID-19 disruptions.¹⁸

Outcomes

Balance

Five studies reported on balance using a static balance with visual control test^{23,24} and the Mini-Balance Evaluation Systems Test (Mini-BESTest).^{18,41,42}

Two studies conducted judo-specific interventions in middle-aged participants and reported a significant increase^{23,24} with judo being superior to water aerobics but less effective than resistance training after a 12-month intervention conducted three times a week.²⁴

Three studies conducted judo-based interventions in older¹⁸ and mixed-aged participants^{41,42} and reported a significant increase in balance after weekly sessions over 10–12 weeks.^{18,41,42}

Muscle strength

Two studies reported on muscle strength using 10 maximum repetitions²⁶ 30-s chair stand and an arm dynamometer.¹⁹

Both studies conducted judo-specific interventions with one study including middle-aged participants reported significant improvements and a similar effectiveness to karate after a 12-month intervention conducted three times a week,²⁶ while the other study, including older participants found significant improvements after a 16-week intervention conducted twice a week.¹⁹

Physical performance, functional autonomy and gait performance

Four studies reported on physical performance using the Short Physical Performance Battery (SPPB).^{17,18,41,42} All four studies conducted judo-based interventions, including older^{17,18} and mixed-aged participants,^{41,42} and found significant improvements in physical performance after weekly sessions over 10–16 weeks.

One study assessed functional autonomy using the Group of Development Latin-America for Maturity Autonomy Index (GDLAM Autonomy Index) and showed significant improvements in middle-aged participants after a 12-month judo-specific intervention conducted three times a week.²⁶

Gait performance was assessed using a 10-m Optojump Photocell System²⁰ including older participants showing significant improvements in step length, gait speed, gait cadence and gait cycle time after a 15-week judo-specific intervention conducted twice a week.²⁰

Flexibility

Flexibility was assessed using a back scratch and chair sit-and-reach test.¹⁹ The study included older participants and showed significant improvements in flexibility after 16 weeks of a judo-specific intervention conducted twice a week.¹⁹

Physical activity levels

Three studies reported on PA using the Frändin & Grimby Activity Scale.^{18,41,42} All three studies conducted judo-based interventions.^{18,41,42} Two studies including older¹⁸ and mixed-aged participants⁴¹ found significant improvements in PA after a weekly intervention over 10–12 weeks,^{18,41} while one study including mixed-aged participants reported no change after a weekly intervention over 10 weeks.⁴²

Quality of life and self-rated health

Six studies reported on QoL using the Osteoporosis Assessment Questionnaire (OPAQ),^{23,24,26} SF-12v2,¹⁹ SF-36¹⁴ and the European Quality of Life 5 Dimension 3 Level scale (EuroQoL-5D-3L).¹⁸

Three studies conducting judo-specific interventions in middle-aged participants^{23,24,26} found a significant increase in QoL after 12 months of three sessions a week with judo being superior to resistance training,²⁴ water aerobics²⁴ and karate.²⁶ Another study conducting a judo-specific intervention in mixed-aged participants found that QoL in the high-movement ability group improved in SF-36 mental scores, while the low-movement ability group improved in SF-36 physical scores after 9 months of one session a month.¹⁴ In older participants, no significant changes were found in QoL after conducting a judo-specific intervention over 16 weeks with two sessions per week.¹⁹

One study conducting a judo-based intervention in older participants found no changes in QoL after a 12-week intervention conducted weekly.¹⁸

One study reported on self-rated health using the Euro Quality of Life Visual Analog (EQVAS) scale.¹⁸ Significant improvements were found in older participants after 12 weeks of a judo-based intervention conducted once per week.¹⁸

Fear of falling

Nine studies reported on fear of falling (FOF) using the Fall Efficacy Scale-International/Swedish (FES-I/S)^{17–19,40–43} and the visual analog scale (VAS).^{21,22}

Two studies conducting judo-specific interventions in older participants^{19,21} found no changes in FOF after 16 weeks of intervention conducted twice a week,^{19,21} while two other studies, including older⁴⁰ and mixed-aged participants⁴³ found significant improvements after 6–8 weeks of a twice weekly judo-specific intervention.^{40,43}

Three studies conducting judo-based interventions in older^{18,22} and mixed-aged participants⁴¹ found improvements in FOF after 5–12 weeks of weekly intervention,^{18,22,41} while two other studies including older¹⁷ and mixed-aged participants⁴² found no changes after 10–16 weeks of a weekly judo-based intervention.^{17,42}

Safe falling techniques and hip impact force

Six studies reported on safe falling techniques^{17,18,21,22,41,42} using tests developed by the respective authors^{17,21,22,41,42} and the Strömquist Båathe Falling Technique Test.¹⁸

All six studies showed significant improvements in safe falling techniques.^{17,18,21,22,41,42} One study conducted a judo-specific intervention in older participants over 16 weeks performed twice weekly,²¹ while five studies conducted judo-based interventions including older^{17,18,22} and mixed-aged participants^{41,42} over 5–16 weeks performed once weekly.^{17,18,22,41,42}

One study reported on hip impact force²² using a 1.2 m × 1.2 m force plate covered by judo mats and showed significant improvements in older participants after a weekly judo-based intervention over 5 weeks.²²

Bone mineral density

Four studies reported on BMD^{23–26} using a dual-energy X-ray. All four studies conducted judo-specific interventions including middle-aged participants and reported a significant increase in BMD after 12–24 months of intervention conducted three times per week. One study with a 2-year intervention²⁵ observed that BMD increased significantly after the first year, but had no further increase in the second year. Differences in BMD were also observed between judo and other interventions, with judo being superior to water aerobics in improving lumbar BMD,²⁴ superior to karate in improving total and L2–L4 BMD,²⁶ and superior to resistance training in improving BMD at the trochanter and Ward's triangle.²⁴

Anthropometric assessments

One study reported on body mass index (BMI), waist and hip circumference.¹⁹ The study included older participants and found significant improvements in waist circumference but no changes in hip circumference and BMI after a 16-week judo-specific intervention conducted twice a week.¹⁹

Training enjoyment, motivation and body dissatisfaction

One study reported on training enjoyment using the VAS, and motivation using the Motives for the Physical Activity Measure-Revised (MPAM-R) Questionnaire and the Exercise Self-Regulation Questionnaire (SRQ-E).²¹ The study conducted a judo-specific intervention and found significant improvements in motivation but no changes in training enjoyment in older participants after 16 weeks of intervention conducted twice per week.²¹

One study assessed body dissatisfaction using a body image dimensional assessment (BIDA).¹⁹ The study conducted a judo-specific intervention and showed a significant reduction in body dissatisfaction in older participants after a 16-week intervention conducted twice per week.¹⁹

Discussion

This scoping review suggests that judo interventions have the potential to impact positively on health-related outcomes in middle-aged and older adults. However, only a few studies have been conducted thus far including only small samples sizes, hence more research is needed to confirm these findings.

There was a tendency for interventions including middle-aged adults to be performed over a longer period of time (≥ 12 months), and at a higher frequency (i.e., three times per week) and intensity (RPE light-hard) compared with interventions including older and mixed-aged participants, which were mostly shorter (5–16 weeks) and at a lower frequency (one to two times per week) and intensity (RPE light-moderate).

Outcomes such as QoL and BMD seemed to improve only during longer interventions (i.e., ≥ 9 or ≥ 12 months, respectively), while improvements in balance, physical performance, muscle strength and safe falling techniques were seen across all studies independent of intervention (judo-specific or judo-based), duration or intensity. Improvements were also seen in gait performance, flexibility, functional autonomy, waist circumference, body dissatisfaction and motivation, with no changes observed in BMI, hip circumference and training enjoyment. Results regarding FOF and PA varied with some studies reporting improvements while others showed no change.

BMD is a crucial outcome when it comes to falls as low BMD increases the risk of injury and fractures, thus reducing QoL.⁴⁴ Findings from this scoping review suggest that outcomes such as

BMD and QoL may require long-term judo interventions to show improvements, which is consistent with other studies using martial arts such as Tai Chi, where improvements in BMD were only seen after 8 months with a longer intervention (i.e., 12 months) resulting in greater improvements.⁴⁵ The positive effects of judo on BMD seen in middle-aged women with osteoporosis suggest that martial art interventions such as judo (alone or in combination with Tai Chi) could contribute to the management of osteoporosis. However, to date, neither judo nor Tai Chi are recommended in the osteoporosis guidelines.⁴⁶ and a 2007 systematic review concluded that there is insufficient evidence to support the use of Tai Chi in the management of osteoporosis.⁴⁷ More research is needed, including larger sample sizes and adequate representation of gender with martial art interventions being conducted for longer periods of time (i.e., ≥ 12 months).

Similar to BMD, improvements in QoL were only observed after long-term judo interventions (i.e., 9 months) as opposed to shorter durations (i.e., 4 months), which is consistent with other studies using karate, where improvements in QoL were seen after 6 months with QoL scores being maintained at 12 months.⁴⁸ However, the sample size was small ($n = 15$), which supports the need for more research and longer-term interventions.

Given the longer-term interventions that may be needed to improve crucial health outcomes such as BMD and QoL, the retention of older adults for longer interventions is vital. Gawler *et al.* suggests that older adults (≥ 65 years) may require longer-term interventions to not only improve vital health outcomes, but also to promote reinforcement of skills learnt and develop a routine of maintaining PA for effective falls prevention.⁴⁹ This is supported by Sherrington *et al.* who notes that ongoing participation in exercise is required to retain the benefits of exercise for falls prevention.⁵⁰ Hence, progressive training with increments in intensity based on participants' abilities may be favorable in longer-term interventions. Concerns of poor adherence due to illness and other commitments (i.e., holiday, family, etc.) might be countered by having more flexible study designs, as well as peer support in exercise groups such as in judo where many exercises are practiced in pairs. Peer support proved to be a strong motivational factor to contribute to good compliance.⁵¹

In terms of frequency and the weekly exercise amount required, Sherrington *et al.* reported that to achieve effective falls prevention in older adults (≥ 65 years), challenging balance exercises should be performed for at least ≥ 3 h per week.⁵⁰ However, several studies in this scoping review have shown improvements in balance, physical performance and safe falling techniques by practicing once to twice per week for 45–60 min per session.^{17,18,21,22,41,42} The diversity in the design of exercise interventions for older adults has been shown previously where exercise frequency for frail older adults ranged from one to seven times per week with 10 and 90 min per session.¹¹ Hence, the health status of individuals needs to be considered when planning longer-term interventions, which may be gradually increased not only in intensity, but also in frequency to reach the current exercise guidelines for older adults.⁵²

A limitation of this scoping review is that it only included studies that specifically stated that their intervention was judo-based, which might have not captured other relevant studies with martial arts similar to judo. Furthermore, results for middle-aged participants with osteoporosis may have influenced the effects on BMD, hence more studies are needed, including different gender and health status. Another limitation was that all included articles were required to be in English.

Conclusion

Judo interventions have the potential to impact positively on balance, physical performance, muscle strength and safe falling techniques in middle-aged and older adults with no judo experience. There was a tendency for interventions including middle-aged adults to be performed over a longer period of time, and at a higher frequency and intensity compared with interventions including older adults. Outcomes such as BMD and QoL may require longer interventions to show effects and improvements have only been thus far shown for middle-aged women with osteoporosis. Results regarding FOF and PA levels varied and require further investigation. The current literature is limited to small samples sizes, shorter interventions and only a few studies examining safety and feasibility.

Acknowledgements

UC was supported by the Adelaide Summer Research Scholarship funded by the University of Adelaide. ADJ is salaried through the Hospital Research Foundation and research grants where RV is Chief Investigator. The authors would like to thank Anna Holasek, academic librarian, for her valuable advice in developing the search strategy. Open access publishing facilitated by The University of Adelaide, as part of the Wiley - The University of Adelaide agreement via the Council of Australian University Librarians.

Disclosure statement

The authors declare no conflict of interest.

Author contributions

ADJ and RV conceived the study. UC and LA designed the search strategy and conducted database searches. UC and LA independently screened articles, extracted data, and drafted the manuscript. ADJ supervised the study development and critically revised the manuscript. RV, MH and MV critically revised the manuscript.

Data availability statement

Data sharing is not applicable to this article as no new data were created.

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How to cite this article: Chan U, Ayliffe L, Visvanathan R, Headland M, Verma M, Jadcak AD. Judo-based exercise programs to improve health outcomes in middle-aged and older adults with no judo experience: A scoping review. *Geriatr. Gerontol. Int.* 2023;23:163–178. <https://doi.org/10.1111/ggi.14553>