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REVIEW

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Benefits of aquatic exercise in adults with and without chronic disease—A systematic review with meta-analysis

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Aquatic exercise is being increasingly recommended for healthy individuals as well as people with some special health conditions. A systematic review with meta-analysis was performed to synthesize and analyze data on the effects of water-based training (WT) programs on health status and physical fitness of healthy adults and adults with diseases to develop useful recommendations for health and sports professionals. We searched three databases (PubMed, Web of Science, and Scopus) up to June 2021 for randomized trials that examined WT in adults. A total of 62 studies were included, of which 26 involved only healthy individuals and 36 focused on adults with chronic diseases. In the healthy group, the effects of WT on strength, balance, and cardiorespiratory fitness were beneficial, indicating the usefulness of performing WT for at least 12 weeks (2–3x/week, 46–65 min/session). Among adults with diseases, improvements were observed in patients with fibromyalgia (in balance and cardiorespiratory fitness), bone diseases (pain, balance, flexibility, and strength), coronary artery disease (strength and anthropometry), hypertension (quality of life), stroke (quality of life), diabetes (balance and quality of life), multiple sclerosis (quality of life and balance), and Parkinson's disease (pain, gait, cardiorespiratory fitness, and quality of life). Research is required to determine the effects of WT on patients with heart disease, especially coronary artery disease. In adults with chronic disease, benefits in physical fitness and/or other health-related measures were mainly observed after 8–16 weeks of training. WT is an effective physical activity when the intention is to enhance health and physical fitness in healthy adults and adults with chronic diseases.

KEYWORDS
diseased adults, health-related, healthy adults, physical fitness, water-based exercise

1 | INTRODUCTION

The popularity of aquatic exercise has increased exponentially in the last two decades.[1,2] This increase is likely due to the properties of water, namely buoyancy, drag forces, and the lack of hypo gravity.[3,4] Buoyancy and lack of hypo gravity are responsible for reducing the effect of body weight, compression forces, and joints, while drag forces provide resistance during the movement.[5,6] Thus, aquatic exercise requires much more intense effort but leads to less perceived effort than similar nonwatery activities.[7] Therefore, aquatic exercise may be useful for performing physical exercise and improving health and physical fitness indicators.

In addition to knowledge about the characteristics of the water, it is important to identify and describe the existing knowledge regarding the effects of water-based training (WT) on health and physical fitness indicators. Some studies have found that WT has positive effects on several health and physical fitness parameters,[8,9] while others have shown WT to be less effective,[9–11] indicating that there are divergent results and uncertainty regarding the effects of WT on health and physical fitness indicators. These divergent results were possibly due to the use of different methodologies, specifically regarding the duration of the training program and the intensity used,[12] and the inclusion and comparison of populations with different characteristics, such as people of different ages.

In general, WT has been recommended for people with special health conditions (eg, older adults, obese people, postmenopausal women, subjects with coronary artery disease, and athletes treating injuries)[2] and for healthy individuals. Due to the uncertainty regarding the effects of WT, it is necessary to determine the importance of practicing these activities among people with and without chronic diseases and to identify the main effects of WT based on specific diseases. To the best of our knowledge, no detailed systematic review has exhaustively explored the literature to determine the effects of WT on physical fitness and health-related outcomes in healthy and diseased adult populations. Therefore, the primary purpose of this systematic review was to synthesize and analyze research findings about the effects of WT on health status and physical fitness in this cohort of subjects. We analyzed data from healthy adults and adults with diseases to develop useful recommendations for health and sports professionals.

2 | METHODS

2.1 | Literature search

The current systematic review with meta-analysis was registered in PROSPERO (number: CRD42020147331) and was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[13] and the Cochrane Handbook.[14] Three databases (Web of Science, PubMed, and Scopus) were searched for randomized and nonrandomized controlled trials involving WT in healthy adults and those with some chronic diseases up to June 30, 2021. A comprehensive combination of search terms was used, including [(aquatic exercise OR aquatic activity OR in-water exercise OR water-based exercise OR aquatic training OR water-based training OR in-water training) AND (physical fitness OR health-related) AND (healthy adults OR diseased adults OR healthy elderly or diseased elderly)].

2.2 | Study selection and data extraction

The inclusion criteria for this study were as follows: (1) randomized trials (including nonrandomized trials and randomized controlled trials); (2) adults aged ≥18 years; (3) healthy participants or participants with any chronic disease; (4) comparison group (WT vs. other training programs (eg, WT with different intensity, frequency, or session duration; or land-based training (LT); or water-based combined with land-based training (WLT); or control group (CG)); and (5) without a comparison group. Any article that was not a peer-reviewed manuscript was excluded, as were studies that did not have full methods, results (pre and post and/or mean and SD data), and conclusion sections. Studies were restricted to those written in English. Qualitative reviews, systematic reviews, meta-analysis, theses, dissertations, and conference abstracts were also excluded. The outcomes used in the study had to include at least one physical fitness variable or one health-related variable and/or some specific variables related to disease outcomes. Studies were excluded if (i) participants were pregnant women or adults with any type of cancer or (ii) swimming was considered the training intervention. A minimum of two studies focusing on a specific disease were required to be included in the analysis, thus allowing outcomes, conclusions, and practical recommendations to be summarized. Two researchers independently extracted information from the included full-text publications, and any discrepancies were resolved by discussion until consensus was reached. The following details were extracted: age, sex, intervention period, main primary outcomes assessed, and characteristics of exercise programs (ie, the type of exercise, session duration, frequency, and chronic diseases).

2.3 | Risk of bias

Two reviewers independently assessed the methodological quality of the studies included in the systematic review using the "risk of bias" assessment tool recommended by the Cochrane Collaboration.[15] The authors resolved disagreements by consensus, and a third author was consulted to resolve disagreements if necessary. The risk of bias of each randomized trial was assessed using the following domains: random sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other bias. Each domain was judged as "low risk," "high risk," or "unclear risk." If the judgment was unclear due to lack of information, insufficient detail, or uncertainty concerning the potential for bias, an "unclear risk" was given. Additionally, the risk of bias of each non-randomized trial was evaluated using the ROBINS-I[16] method, scoring each study with the following domains: confounding, selection of participants, classification of interventions, deviation from intended interventions, missing data, measurement of outcomes, and selection of the reported results. These domains were classified as "low," "moderate," "serious," "critical," or "no information." Review Manager Software (version 5.4; The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark) was used to create risk-of-bias graphs in randomized studies, while for non-randomized studies we used the robvis tool.

2.4 | Data analysis

The meta-analysis to determine the effect of the different WT programs in healthy adults and adults with chronic diseases was conducted using Review Manager software (version 5.4; The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). The WT program effects on healthy adults were analyzed regarding anthropometrics, balance, blood pressure, cardiorespiratory fitness, flexibility, quality of life, and strength (subgroups). Depending on the disease (ie, musculoskeletal diseases, heart diseases, diabetes mellitus, multiple sclerosis, and Parkinson's disease), anthropometrics, balance, cardiorespiratory fitness, flexibility, pain, quality of life, strength, lipid profile, and gait variables were analyzed as subgroups. As there was no control group in most of the studies, the means and standard deviation from pre- and post-intervention were used to determine the intervention effect. This intervention effect was calculated using the standardized mean difference (SMD) for each study and 95% confidence intervals (95% CI). In each subgroup, in healthy adults or each chronic disease, the overall WT effects were calculated (Z test) and the weighted mean differences and 95% confidence intervals were computed for continuous variables, using a Mantel-Haenszel fixed-effect method in cases of low statistical inconsistency ($I^2 \leq 50\%$) and using a DerSimonian and Laird random-effect method in cases of moderate or high statistical inconsistency ($I^2 > 50\%$).[17] Statistical heterogeneity was measured by using the Cochrane chi-squared test and the I^2[14] Results were considered statistically significant at $p < 0.05$, and the magnitude of the intervention effect was classified as small (d = 0.20), medium (d = 0.50), and large (d = 0.80).[18,19] The negative values of the SMD favor the benefits of the WT, while the positive values favor the harmful effects of WT. Additionally, in the case of outcomes whose number of articles is insufficient to perform a meta-analysis (eg, diabetes mellitus and multiple sclerosis), the results will be discussed as a systematic review, not using the SMD.

3 | RESULTS

The initial search included 795 articles; after excluding duplicate studies, 713 potentially relevant articles remained. Then, 613 studies were excluded after screening the titles and abstracts, and other 38 studies were excluded for other reasons. Of these, 62 full-text articles were assessed for eligibility, of which 26 articles were included in the analysis of the effects of WT on healthy adults, while 36 studies were included in the analysis of the effects of WT on adults with chronic disease. Among these, 54 studies were included for quantitative analysis (meta-analysis), 26 of which refer to healthy adults and 28 to adults with chronic diseases. A detailed flow chart describing the process of selecting the relevant studies is shown in Figure 1.

The extracted data were synthesized based on the sample of the study, specifically healthy adults (Table 1), and adults with chronic diseases, namely musculoskeletal diseases, heart diseases, diabetes mellitus, multiple sclerosis, and Parkinson's disease (Table 2). The main outcomes were health-related (ie, lipid profile, blood pressure, quality of life, gait, fatigue, and perception of pain) and physical fitness outcomes (ie, strength, balance, cardiorespiratory fitness, anthropometrics, and flexibility).

3.1 | Healthy adults

Of the 26 exercise trials included, 9 studies compared one type of WT with another WT (of which 3 studies also included a CG), 7 studies compared WT with LT (of which 2 studies also included a CG), and 10 other articles compared a WT to a CG. It should also be noted that the minimum duration of the training programs was 4 weeks, and the maximum duration was 28 weeks; approximately 77% of studies lasted between 8 and 12 weeks.

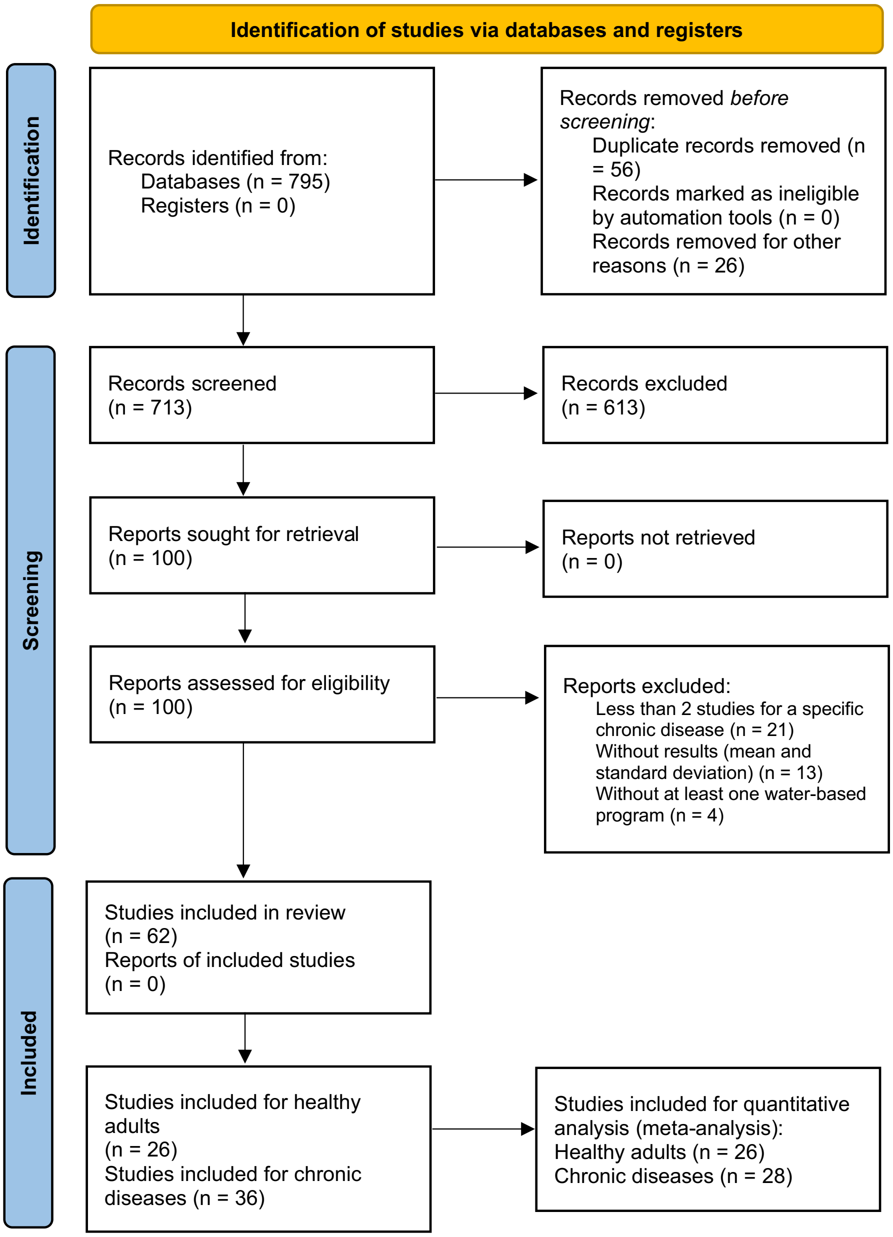

FIGURE 1 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow chart for study identification

Regarding WT, most of the results revealed positive effects (Figure 2), obtaining greater effects especially in strength, cardiorespiratory fitness, and balance. Specifically, in these variables, we found that WT programs had considerable benefits in strength (medium[7] and large[4,5,20–25]), cardiorespiratory fitness (intermediate[20,23] and large[12,21]), and balance (intermediate[20] and large[5,7,20,23–25]). The overall effect showed that WT programs are responsible for positive effects on health status and physical fitness in healthy adults (medium effect).

3.2 | Adults with chronic diseases

Considering the 36 studies focusing on a population with a chronic disease, 6 articles compared different types of WT (of which 2 also included a CG), 11 studies compared WT with LT (where 3 also included a CG), 14 articles compared WT with a CG, 1 study compared WT with LT and WLT, and 4 studies used no comparison (only WT). It was established that the most frequent duration of the programs was 12 weeks (39% of the studies), especially on heart diseases and diabetes mellitus articles. Overall, in adults with chronic diseases, the benefits were significant, mainly for the quality of life and balance, besides in strength, pain, and gait. The studies were grouped according to disease for further analysis, specifically, musculoskeletal diseases (fibromyalgia and bone diseases), heart diseases (coronary artery disease, heart failure, hypertension, and stroke), diabetes mellitus, multiple sclerosis, and Parkinson's disease.

TABLE 1 Effects of water-based activities on healthy population

Author	Subjects	Intervention Period	Design	Intervention	Parameters Assessed
Oliveira et al[58]	74 F (69 y)	12 weeks [2/week]	RCT	WT: 40–45′ MW + 15–20′ Str LT_1: 40–45′ mini-trampoline + 15–20′ Str LT_2: 40–45′ floor gymnastics + 15–20′ Str	Balance
López et al[7]	26 F (67.45 y)	12 weeks [5/week]	RCT	WT: 10′ W + 30′ MW + 10′ Str CG: without intervention	Balance, Cardiorespiratory Fitness, Flexibility, Strength
Martinez et al[1]	26 F (67.45 y)	12 weeks [5/week]	RCT	WT: 10′ W + 30′ MW + 10′ Str CG: without intervention	Quality of Life
Poyhonen et al[4]	24 F (34.2 y)	10 weeks [2-3/week]	RCT	WT: 6–8′ W + 30–45′ RT + 5′ Str CG: without intervention	Strength
Tsourlou et al[5]	22 F (68.85 y)	24 weeks [3/week]	RCT	WT: 10′ W + 25′ AT + 20′ RTRE + 5′ Str CG: without intervention	Anthropometrics, Balance, Flexibility, Strength
Vale et al[25]	52 F (67.3 y)	16 weeks [2/week]	RCT	WT: 60’ intervention GC: without intervention	Balance, Flexibility, Strength
Graef et al[77]	27 F (66.69 y)	12 weeks [2/week]	RCT	WT_1: 50’ [W + ATRE + Str] WT_2: 50’ [W + AT + Str] CG: without intervention	Strength
Moreira et al[50]	90 F (65.3 y)	12 weeks [3/week]	RCT	WT_1: 5′ W + 35′ MW lower limbs + 5′ Str WT_2: 5′ W + 35′ MW + 5′ Str CG: without intervention	Balance, Cardiorespiratory Fitness, Flexibility, Strength
Jurado-Lavanant et al[55]	65 M (21.2 y)	10 weeks [2/week]	RCT	WT: PlyoT LT: PlyoT CG: without intervention	Strength
Miller et al[51]	24 F + 19 M (22.16 y)	8 weeks [2/week]	RCT	WT: PlyoT LT: PlyoT CG: without intervention	Flexibility, Strength
Roth et al[78]	17 F + 7 M (21.81 y)	4 weeks [3/week]	RCT	WT: 30′ intervention LT: 30′ intervention CG: without intervention	Balance
Reichert et al[21]	36 F (67.53 y)	12 weeks [2/week]	RCT	WT_1: 7′ W + 13′ RT + 10′ Str WT_2: 7′ W + 28′ RT + 10′ Str WT_3: 7′ W + 9′ RT + 10′ Str CG: dance and gymnastics classes	Cardiorespiratory Fitness, Strength

(Continues)

TABLE 1 (Continued)

Author	Subjects	Intervention Period	Design	Intervention	Parameters Assessed
Ayán et al[79]	51 F (46.5 y)	24 weeks [2/week]	Non-RCT	WT_1: 12 weeks SCF + 12 weeks FE WT_2: 12 weeks FE + 12 weeks SCF	Quality of Life
Seynnes et al[80]	14 F + 4 M (72.7 y)	11 weeks [2/week]	Non-RCT	WT: 45′ intervention LT: 60′ intervention	Strength
Neiva et al[3]	19 F + 4 M (58.9 y)	12 weeks [2/week]	Non-RCT	WT: 8′ W + 27′ AT + 10′ SE + 5′ Str CG: without intervention	Anthropometrics, Blood Pressure, Cardiorespiratory Fitness, Strength
Sanders et al[23]	66 F (73.2 y)	16 weeks [3/week]	Non-RCT	WT: 10′ W + 35′ SE + 10′ Str CG: without intervention	Balance, Cardiorespiratory Fitness, Flexibility, Strength
Seyedjafari et al[24]	30 M (66 y)	8 weeks [3/week]	Non-RCT	WT: 10′ W + 45′ MW + 5′ Str CG: without intervention	Balance, Strength
Vieira et al[52]	46 F (67.95 y)	12 weeks [2/week]	Non-RCT	WT: 50′ intervention CG: 45′ flexibility intervention	Flexibility
White & Smith[81]	14 F + 4 M (29.15 y)	8 weeks [3/week]	Non-RCT	WT: 5′ W + 40′ MW + 5′ Str CG: without intervention	Strength
Buttelli et al[82]	21 M (21 y)	10 weeks [2/week]	RCLT	WT_1: 5′ W + 25′ RT + 8′ Str WT_2: 5′ W + 50′ RT + 8′ Str	Strength
Carral & Pérez[53]	62 F (68.4 y)	20 weeks [5/week]	RCLT	WT_1: 10–20′ W + 15–30′ ST + 5–10′ Str WT_2: 10–20′ W + 15–30′ CalT + 5–10′ Str	Balance, Cardiorespiratory Fitness, Flexibility, Strength, Quality of Life
Kanitz et al[8]	34 M (65 y)	12 weeks [3/week]	RCLT	WT_1: 30′ ET WT_2: 30′ CT	Cardiorespiratory Fitness, Strength
Reichert et al[20]	18 F + 18 M (67.9 y)	28 weeks [2/week]	RCLT	WT_1: 5′ W + 30–36′ ConT + 4–10′ Str WT_2: 5′ W + 30–36′ IT + 4–10′ Str	Balance, Blood Pressure, Cardiorespiratory Fitness, Flexibility; Strength
Andrade[83]	41 F (64.35 y)	12 weeks [2/weeks]	RCLT	WT_1: 4’ W + 36’ ConT + 4’ Str WT_2: 4’ W + 36’ IT + 4’ Str	Cardiorespiratory Fitness, Strength
Lambert et al[12]	30 F + 30 M (41.5 y)	12 weeks [3/week]	RCLT	WT: ND LT: ND	Anthropometrics, Blood Pressure, Cardiorespiratory Fitness
Robinson et a[22]	32 F (20.2 y)	8 weeks [3/week]	RCLT	WT: 10′ W + 50′ PlyoT + 5′ Str LT: 10′ W + 50′ PlyoT + 5′ Str	Strength

Abbreviations: *AT*, Aerobic Training; *ATRE*, Aerobic Training with Resistive Equipment; *CalT*, Calisthenic Training; *CG*, Control Group; *CT*, Concurrent Training; *ConT*, Continuous Training; *ET*, Endurance Training; *F*, Female; *FE*, Fitness Exercises; *IT*, Interval Training; *LT*, Land-based Training; *M*, Male; *MW*, Main Workout; *ND*, Not Defined; *Non-RCT*, Non-Randomized Controlled Trial; *PlyoT*, Plyometric Training; *RCT*, Randomized Controlled Trial; *RCLT*, Randomized clinical trial; *RT*, Resistance Training; *RTRE*, Resistance Training with Resistive Equipment; *Str*, Stretching; *SE*, Specific Exercitations; *SCF*, Stimulation of Cognitive Function; *W*, Warm-up; *WT*, Water-based Training; *y*, years old.

TABLE 2 Effects of water-based activities on adults with chronic disease

Author	Subjects	Population	Intervention Period	Design	Intervention	Parameters Assessed
Andrade et al[84]	54 F (47.5 y)	Fibromyalgia	16 weeks + 16 weeks Detraining [2/week]	RCT	WT: 45′ intervention CG: without intervention	Pain, Quality of Life
Andrade et al[28]	54 F (47.5 y)	Fibromyalgia	16 weeks [2/week]	RCT	WT: 10′ W + 30′ MW + 5′ Str CG: without intervention	Anthropometrics, Cardiorespiratory Fitness
Tomas-Carus et al[26]	30 F (50.8 y)	Fibromyalgia	32 weeks [3/week]	RCT	WT: 10′ W + 10′ AT + 20′ ET + 10′ AT + 10′ Str CG: without intervention	Balance, Quality of Life, Strength
Munguía-Izquierdo & Legaz-Arrese[85]	60 F (48 y)	Fibromyalgia	16 weeks [3/week]	RCT	WT: 10′ W + 10–20′ ET + 20–30′ AT + 10′ Str CG: without intervention	Pain
Tomas-Carus et al[27]	34 F (51 y)	Fibromyalgia	12 weeks + 12 weeks Detraining [3/week]	RCT	WT: 10′ W + 10′ AT + 20′ ET + 10′ AT + 10′ Str CG: without intervention	Balance, Cardiorespiratory Fitness, Flexibility, Quality of Life, Strength
Cuesta-Vargas et al[30]	58 F/M (38.2 y)	Low Back Pain	15 weeks [3/week]	RCT	WT_1: 30′ intervention + 30′ MW Deep Water Running WT_2: 30′ intervention	Pain
Suomi et al[66]	27 F (57.1 y)	Arthritis	6 weeks [3/week]	RCT	WT: ND CG: without intervention	Flexibility, Strength
Irandoust and Taheri[35]	32 M (68 y)	Low Back Pain	12 weeks [3/week]	RCT	WT: 10′ W + 40′ MW + 10′ Str CG: without intervention	Anthropometrics
Pires et al[31]	55 F/M (50.95 y)	Low Back Pain	6 weeks [2/week]	RCT	WT: 30–50′ intervention + 90′ MW CG: 30–50′ intervention	Pain
Arnold et al[63]	79 F/M (74.46 y)	Osteoarthritis	11 weeks [2-3/week]	RCT	WT_1(3/week): 45′ intervention + 30′ PT WT_2(2/week): 45′ intervention CG: without intervention	Balance, Cardiorespiratory Fitness, Strength
Baena-Beato et al[29]	25 F + 29 M (48.8 y)	Low Back Pain	8 weeks [2-3/week]	Non-RCT	WT_1(2/week): 10′ W + 15–20′ RT + 20–25′ AT + 10′ Str WT_2(3 /week): 10′ W + 15–20′ RT + 20–25′ AT + 10′ Str CG: without exercise	Anthropometrics, Cardiorespiratory Fitness, Flexibility, Pain, Quality of Life, Strength
Bressel et al[32]	16 F + 2 M (64.5 y)	Osteoarthritis	6 weeks [ND]	RCT	WT: 30′ intervention	Balance, Pain, Strength

(Continues)

TABLE 2 (Continued)

Author	Subjects	Population	Intervention Period	Design	Intervention	Parameters Assessed
Yalfani et al[33]	24 F (24.92 y)	Low Back Pain	8 weeks [3/week]	RCT	WT: 15’ W + 50’ MW + 10’ Str LT: 15’ W + 50’ MW + 10’ Str	Balance, Pain
Moreira et al[34]	120 F/M (71.24 y)	Musculoskeletal disorders (osteoarthritis, rheumatic arthritis, fibromyalgia, sciatic back pain, or other chronic low back pain)	16 weeks [2/week]	RCT	WT: 5’W + 40’ MW + Str CG: without intervention	Balance, Flexibility, Pain, Quality of life, Strength
Volaklis et al[36]	34 F/M (54 y)	Coronary Artery Disease	16 weeks [4/week]	RCT	WT: 10′ W + 30–40′ MW + 10′ Str LT: 10′ W + 30–40′ MW + 10′ Str CG: without intervention	Anthropometrics, Cardiorespiratory Fitness, Lipid Profile, Strength
Tokmakidis et al[61]	21 M (51.6 y)	Coronary Artery Disease	16 weeks + 16 weeks Detraining + 16 weeks Retraining [4/week]	RCT	WT: 10′ W + 5′ Str + 50′ MW + 10′ Str CG: without intervention	Anthropometrics, Cardiorespiratory Fitness
Arca et al[38]	52 F (64 y)	Hypertension	12 weeks [3/week]	RCT	WT: 10′ W + 10′ Str + 20′ MW + 10′ Str LT: 10′ W + 10′ Str + 20′ MW + 10′ Str CG: without intervention	Anthropometrics, Lipid Profile
Ruangthai et al[37]	30 F + 11 M (69.2 y)	Hypertension	12 weeks [3/week]	RCT	WT: 10’ W + 40’ MW + 10’ Str LT: 10’ W + 40’ MW + 10’ Str CG: without intervention	Anthropometrics, Lipid Profile, Quality of Life
Silva et al[86]	29 F/M (53 y)	Hypertension	12 weeks [2/week]	RCLT	WT_1Hy: 5′ W + 40′ MW + 5′ Str WT_2NHy: 5′ W + 40′ MW + 5′ Str	Balance
Lee et al[59]	32 F/M (60.62 y)	Stroke	4 weeks [5/week]	RCT	WT: 5′ W + 20′ MW + 5′ Str LT: 5′ W + 20′ MW + 5′ Str	Balance, Cardiorespiratory Fitness, Quality of Life, Strength
Zhang et al[87]	36 F/M (55.5 y)	Stroke	8 weeks [5/week]	RCT	WT: 5′ W + 35′ MW LT: 5′ W + 35′ MW	Strength
Aidar et al[88]	17 F + 19 M (52.25 y)	Stroke	12 weeks [2/week]	RCT	WT: 45–60′ intervention CG: without intervention	Balance

TABLE 2 (Continued)

Author	Subjects	Population	Intervention Period	Design	Intervention	Parameters Assessed
Cruz[89]	9 F + 20 M (47.2 y)	Stroke	4 weeks [3/week]	RCT	WT: 10′ W + 25′ MW + 10′ Str	Balance
Matsumoto et al[39]	32 F + 88 M (62.8 y)	Stroke	12 weeks [2/week]	Non-RCT	WT: 5′ W + 20′ MW + 5′ Str / RT CG: RT	Cardiorespiratory Fitness, Quality of Life
Zhu et al[46]	46 F/M (66 y)	Parkinson	6 weeks [5/week]	RCT	WT_1: 5′ W + 30′ MW + 5′ Str WT_2(obstacles): 5′ W + 30′ MW + 5′ Str	Balance, Gait, Quality of Life
Ayán and Cancela[49]	21 F/M (70.4 y)	Parkinson	12 weeks [2/week]	Non-RCT	WT_1: 60′ intervention WT_2: 60′ RT	Balance, Quality of Life
Cruz[47]	17 F + 13 M (67.17 y)	Parkinson	10 weeks [2/week]	RCLT	WT: 5′ W + 35′ MW + 5′ Str LT: 10′ W + 25′ MW + 10′ Str	Balance, Gait, Pain, Quality of life
Ayán and Cancela[48]	16 F/M (65.30 y)	Parkinson	12 weeks [2/week]	RCT	WT: 10′ W + 35′ MW + 10′ Str	Balance, Cardiorespiratory Fitness, Flexibility, Strength, Quality of Life

Abbreviations: *AT*, Aerobic Training; *CG*, Control Group; *ET*, Endurance Training; *F*, Female; *HY*, Hypertensive; *LT*, Land-based Training; *M*, Male; *MW*, Main Workout; *ND*, Not Defined; *NHY*, Non-Hypertensive; *Non-RCT*, Non-Randomized Controlled Trial; *PT*, Physical Therapy; *RCT*, Randomized Controlled Trial; *RCLT*, Randomized clinical trial; *RT*, Rehabilitation Therapy; *Str*, Stretching; *W*, Warm-up; *WT*, Water-based Training; *y*, years old.

Concerning musculoskeletal diseases (Figure 3), we observed that WT was beneficial in fibromyalgia, improving balance and cardiorespiratory fitness, especially in the studies of Tomas-Carus[26,27] (large effect). Additionally, we observed that aquatic exercise was ineffective at improving anthropometry in individuals with fibromyalgia.[28] Regarding adults with bone diseases (Figure 3) (ie, osteoarthritis and low back pain), several articles reported substantial progress mainly in the relief of pain (large effect[29–34]), balance (large effect[32,34]), flexibility (medium[34] and large effect[29]), and strength (medium[34] and large effect[29]), but also in the quality of life (large effect[29]), anthropometry (large effect[35]), and cardiorespiratory fitness (large effect[29]). Furthermore, large intervention effects were found in pain, cardiorespiratory fitness, flexibility, quality of life, and strength in the overall analysis of musculoskeletal diseases.

Among heart diseases (Figure 4), using aquatic exercise among adults with coronary artery disease led to large increases in strength (large effect[36]) and anthropometrics (large effect[36]). Regarding hypertension, we found that aquatic programs were slightly effective for improving quality of life (medium effect[37]), but not for anthropometrics[37,38] and lipid profile.[37,38] In people with stroke, a significantly improved quality of life (large effect[39]) was reported. The overall results suggested large improvements in quality of life in heart diseases. Nevertheless, despite the significant results in these two variables, this group of diseases only induced small effects on health status and physical fitness.

In individuals with diabetes mellitus, we can infer that WT caused improvements in several physical fitness and health-related outcomes, specifically balance,[40] and quality of life.[41] In addition, there were also positive effects on the lipid profile, especially on glucose,[42] and in blood pressure.[40] In multiple sclerosis, the quality of life[43,44] and balance[45] proved to be the parameters that were most positively affected after these programs, although gait[45] and fatigue[44] also showed slight increases.

Among Parkinson's disease (Figure 5), it was mostly their levels of pain, gait, cardiorespiratory fitness, and quality of life (large effects[46–49]) that were enhanced after WT. Additionally, large improvements were found in cardiorespiratory fitness[48] and balance.[49] In general, WT was responsible for producing medium effects in individuals with Parkinson's disease.

3.3 | Risk of bias

Overall, in randomized studies, there was a dominance of the low risk in the different key criteria, both in studies applied to healthy adults (58%) and adults with chronic

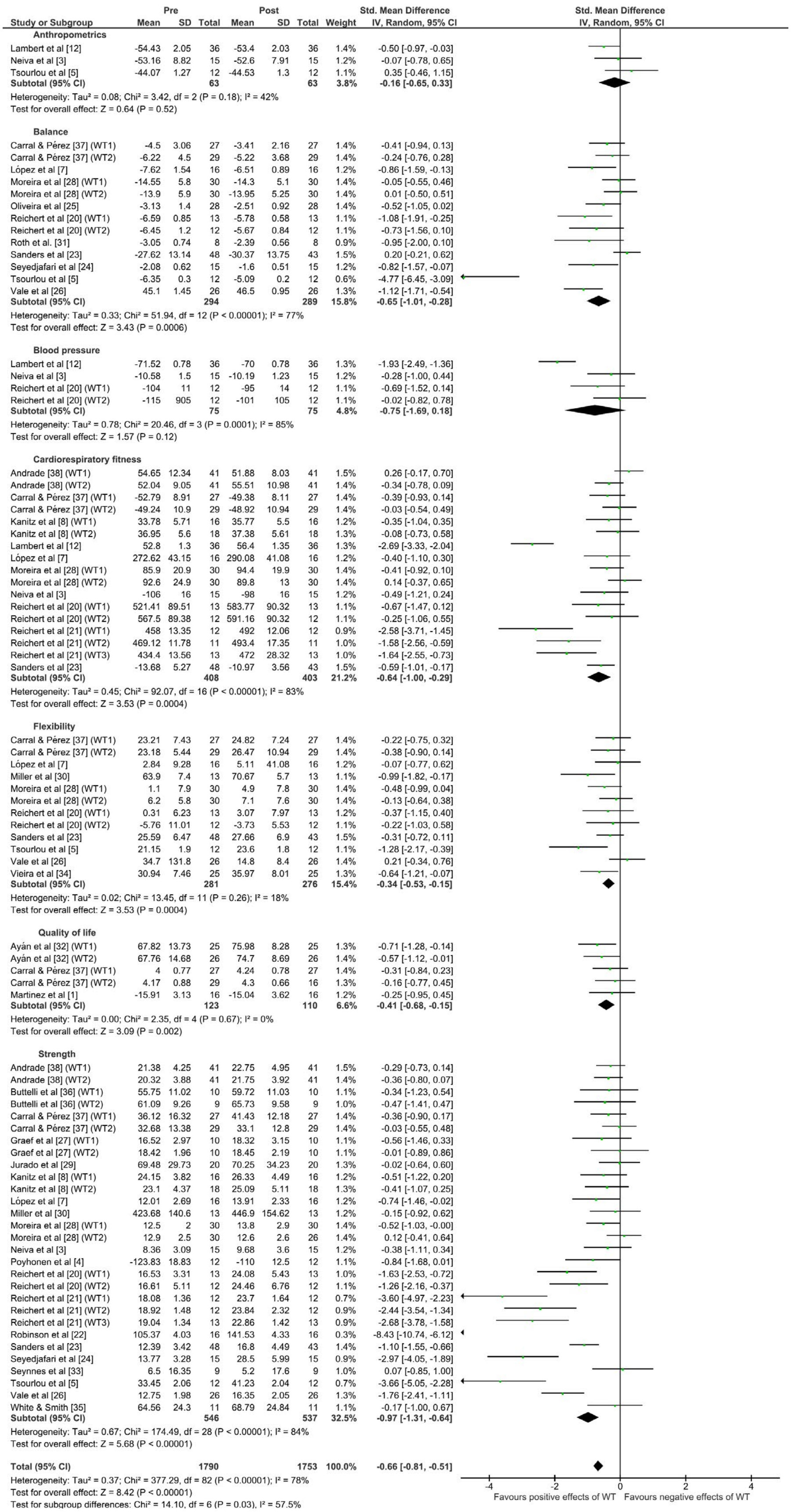

FIGURE 2 Forest plot of comparison for healthy population. The center of each square represents the standard mean difference for individual trials, and the corresponding horizontal line stands for 95% confidence interval (CI). The diamonds represent pooled results

Study or Subgroup	Pre Mean	Pre SD	Pre Total	Post Mean	Post SD	Post Total	Weight	Std. Mean Difference IV, Random, 95% CI
Anthropometrics								
Andrade et al [41]	-229.63	13.03	27	-230.43	25.56	27	2.2%	0.04 [-0.49, 0.57]
Baena et al [42] (WT1)	-40.67	1.83	18	-40.13	1.9	18	2.2%	-0.28 [-0.94, 0.37]
Baena et al [42] (WT2)	-43.47	1.73	21	-42.97	1.8	21	2.2%	-0.28 [-0.89, 0.33]
Irandoust & Taheri [48]	-20.69	0.33	16	-19.92	0.3	16	1.9%	-2.38 [-3.31, -1.45]
Subtotal (95% CI)			**82**			**82**	**8.5%**	**-0.66 [-1.52, 0.20]**
Heterogeneity: Tau² = 0.64; Chi² = 20.22, df = 3 (P = 0.0002); I² = 85%								
Test for overall effect: Z = 1.50 (P = 0.13)								
Balance								
Arnold et al [52] (WT1)	38.17	9.77	28	39.67	7.43	28	2.3%	-0.17 [-0.70, 0.35]
Arnold et al [52] (WT2)	38.5	12.07	26	38.4	13	26	2.2%	0.01 [-0.54, 0.55]
Bressel et al [45]	70.53	9.46	18	79.39	7.09	18	2.1%	-1.04 [-1.74, -0.34]
Moreira et al [47]	40.9	2.4	60	52.1	3.3	60	2.2%	-3.86 [-4.47, -3.25]
Tomas-Carus et al [39]	-23.1	7.2	15	-15	10	15	2.1%	-0.90 [-1.66, -0.15]
Tomas-Carus et al [40]	38	14.5	17	37.5	12	17	2.2%	0.04 [-0.64, 0.71]
Yalfani et al [46]	-2.3	0.57	12	-2	0.66	12	2.0%	-0.47 [-1.28, 0.34]
Subtotal (95% CI)			**176**			**176**	**15.1%**	**-0.91 [-1.99, 0.16]**
Heterogeneity: Tau² = 1.98; Chi² = 116.55, df = 6 (P < 0.00001); I² = 95%								
Test for overall effect: Z = 1.67 (P = 0.10)								
Cardiorespiratory fitness								
Andrade et al [41]	63.08	11.35	27	63.61	9.64	27	2.2%	-0.05 [-0.58, 0.48]
Arnold et al [52] (WT1)	355.2	93.9	28	398.5	89.3	28	2.2%	-0.47 [-1.00, 0.07]
Arnold et al [52] (WT2)	357.4	118.1	26	371.9	136.9	26	2.2%	-0.11 [-0.66, 0.43]
Baena et al [42] (WT1)	23.95	1.3	18	25.35	1.35	18	2.1%	-1.03 [-1.73, -0.33]
Baena et al [42] (WT2)	24.2	1.25	21	26.8	1.25	21	2.1%	-2.04 [-2.80, -1.28]
Tomas-Carus et al [40]	6.28	1.79	17	9.01	1.85	17	2.1%	-1.46 [-2.23, -0.70]
Subtotal (95% CI)			**137**			**137**	**13.0%**	**-0.82 [-1.42, -0.22]**
Heterogeneity: Tau² = 0.45; Chi² = 27.46, df = 5 (P < 0.0001); I² = 82%								
Test for overall effect: Z = 2.69 (P = 0.007)								
Flexibility								
Baena et al [42] (WT1)	9.4	2	18	13	1.9	18	2.1%	-1.80 [-2.59, -1.02]
Baena et al [42] (WT2)	8.4	1.9	21	13.2	1.8	21	2.0%	-2.54 [-3.38, -1.71]
Moreira et al [47]	-9.85	10.95	60	-4.3	8.2	60	2.3%	-0.57 [-0.94, -0.20]
Suomi et al [51]	44.58	13.88	17	51.15	13.18	17	2.1%	-0.47 [-1.16, 0.21]
Tomas-Carus et al [40]	17	7.5	17	18	8	17	2.1%	-0.13 [-0.80, 0.55]
Subtotal (95% CI)			**133**			**133**	**10.7%**	**-1.06 [-1.83, -0.29]**
Heterogeneity: Tau² = 0.65; Chi² = 29.35, df = 4 (P < 0.00001); I² = 86%								
Test for overall effect: Z = 2.71 (P = 0.007)								
Pain								
Andrade et al [49]	4.46	1.96	27	4.68	1.9	27	2.2%	-0.11 [-0.65, 0.42]
Baena et al [42] (WT1)	-10.9	1.23	18	-7.43	1.03	18	1.9%	-2.99 [-3.97, -2.01]
Baena et al [42] (WT2)	-12	1.13	21	-4.8	0.98	21	1.4%	-6.68 [-8.30, -5.06]
Bressel et al [45]	-57.1	26.9	18	-15.8	10.6	18	2.0%	-1.98 [-2.79, -1.16]
Cuesta et al [43] (WT1)	-37.5	9.65	29	-10.35	6.05	29	2.0%	-3.33 [-4.14, -2.51]
Cuesta et al [43] (WT2)	-35.45	9.65	29	-19	11.4	29	2.2%	-1.54 [-2.13, -0.95]
Moreira et al [47]	-8.4	1.5	60	-5.2	1.8	60	2.3%	-1.92 [-2.35, -1.48]
Munguía & Legaz [50]	16.78	4.45	29	17.92	3.53	29	2.3%	-0.28 [-0.80, 0.24]
Pires et al [44]	-34.77	14.33	30	-20.13	13.37	30	2.2%	-1.04 [-1.58, -0.50]
Yalfani et al [46]	-59.83	9.8	12	-29	12.8	12	1.8%	-2.61 [-3.75, -1.47]
Subtotal (95% CI)			**273**			**273**	**20.4%**	**-2.09 [-2.89, -1.30]**
Heterogeneity: Tau² = 1.47; Chi² = 126.22, df = 9 (P < 0.00001); I² = 93%								
Test for overall effect: Z = 5.15 (P < 0.00001)								
Quality of life								
Andrade et al [49]	31.4	16.39	27	33.48	19.28	27	2.2%	-0.11 [-0.65, 0.42]
Baena et al [42] (WT1)	56.23	5.14	18	66.83	4.45	18	2.0%	-2.16 [-3.00, -1.32]
Baena et al [42] (WT2)	57.27	4.8	21	66.24	4.18	21	2.1%	-1.96 [-2.70, -1.21]
Moreira et al [47]	63.78	13.33	60	64.05	14.6	60	2.3%	-0.02 [-0.38, 0.34]
Tomas-Carus et al [39]	40.68	21.31	15	56.6	23.31	15	2.1%	-0.69 [-1.43, 0.05]
Tomas-Carus et al [40]	37.83	24.22	17	45.67	24.28	17	2.1%	-0.32 [-0.99, 0.36]
Subtotal (95% CI)			**158**			**158**	**12.9%**	**-0.83 [-1.52, -0.13]**
Heterogeneity: Tau² = 0.64; Chi² = 38.97, df = 5 (P < 0.00001); I² = 87%								
Test for overall effect: Z = 2.34 (P = 0.02)								
Strength								
Arnold et al [52] (WT1)	7.6	3	28	9.1	2.8	28	2.2%	-0.51 [-1.04, 0.02]
Arnold et al [52] (WT2)	6.9	4.3	26	7.5	3.9	26	2.2%	-0.14 [-0.69, 0.40]
Baena et al [42] (WT1)	38.05	1.95	18	42.55	2.05	18	2.0%	-2.20 [-3.05, -1.35]
Baena et al [42] (WT2)	40.85	1.85	21	47.75	1.9	21	1.9%	-3.61 [-4.62, -2.60]
Bressel et al [45]	12.88	4.19	18	13.12	3.21	18	2.2%	-0.06 [-0.72, 0.59]
Moreira et al [47]	11.8	4	60	14.9	3.95	60	2.3%	-0.77 [-1.15, -0.40]
Suomi et al [51]	44.58	13.88	17	51.15	13.18	17	2.1%	-0.47 [-1.16, 0.21]
Tomas-Carus et al [39]	0.78	0.23	15	0.95	0.25	15	2.1%	-0.69 [-1.43, 0.05]
Tomas-Carus et al [40]	38	14.5	17	37.5	12	17	2.2%	0.04 [-0.64, 0.71]
Subtotal (95% CI)			**220**			**220**	**19.3%**	**-0.86 [-1.42, -0.31]**
Heterogeneity: Tau² = 0.60; Chi² = 57.10, df = 8 (P < 0.00001); I² = 86%								
Test for overall effect: Z = 3.04 (P = 0.002)								
Total (95% CI)			**1179**			**1179**	**100.0%**	**-1.11 [-1.41, -0.82]**
Heterogeneity: Tau² = 0.91; Chi² = 472.67, df = 46 (P < 0.00001); I² = 90%								
Test for overall effect: Z = 7.48 (P < 0.00001)								
Test for subgroup differences: Chi² = 8.73, df = 6 (P = 0.19), I² = 31.3%								

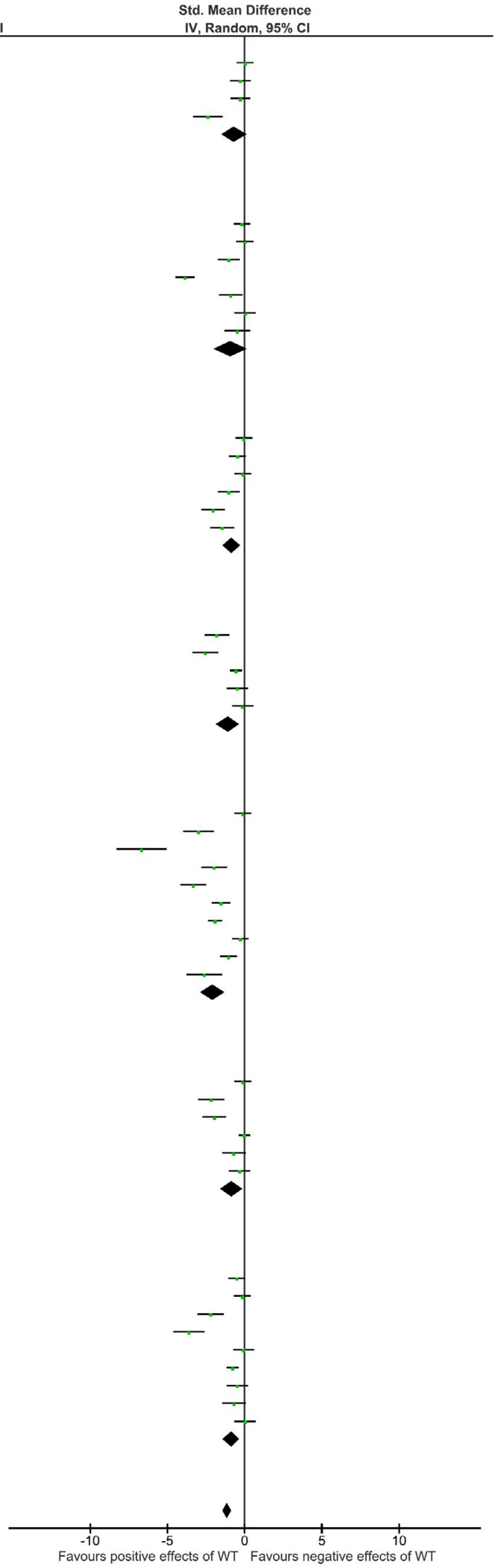

FIGURE 3 Forest plot of comparison for Musculoskeletal diseases—Fibromyalgia and Bone diseases. The center of each square represents the standard mean difference for individual trials, and the corresponding horizontal line stands for 95% confidence interval (CI). The diamonds represent pooled results

Study or Subgroup	Pre Mean	Pre SD	Pre Total	Post Mean	Post SD	Post Total	Weight	Std. Mean Difference IV, Random, 95% CI
Anthropometrics								
Arca et al [55]	-58.3	7.76	19	-58.8	7.28	19	4.9%	0.07 [-0.57, 0.70]
Ruangthai et al [54]	-30.86	4.54	13	-30.48	4.68	13	4.2%	-0.08 [-0.85, 0.69]
Tokmakidis et al [58]	-67.72	7.99	11	-66.87	7.41	11	3.9%	-0.11 [-0.94, 0.73]
Volaklis et al [52]	-80.2	3	12	-76.65	2.6	12	3.7%	-1.22 [-2.11, -0.34]
Subtotal (95% CI)			**55**			**55**	**16.7%**	**-0.29 [-0.83, 0.25]**
Heterogeneity: Tau² = 0.15; Chi² = 5.87, df = 3 (P = 0.12); I² = 49%								
Test for overall effect: Z = 1.05 (P = 0.29)								
Balance								
Aidar et al [61]	-19.18	3.68	19	-19.03	3.93	19	4.9%	-0.04 [-0.67, 0.60]
Cruz et al [62]	22.54	10.45	29	25.45	10.65	29	5.6%	-0.27 [-0.79, 0.25]
Lee et al [57]	41	14.41	18	50.11	13.81	18	4.7%	-0.63 [-1.30, 0.04]
Silva et al [59] (WT1)	30.5	2.05	16	31	1.85	16	4.6%	-0.25 [-0.95, 0.45]
Silva et al [59] (WT2)	31.75	0.7	13	31.7	0.3	13	4.2%	0.09 [-0.68, 0.86]
Subtotal (95% CI)			**95**			**95**	**24.0%**	**-0.24 [-0.52, 0.05]**
Heterogeneity: Tau² = 0.00; Chi² = 2.41, df = 4 (P = 0.66); I² = 0%								
Test for overall effect: Z = 1.61 (P = 0.11)								
Cardiorespiratory fitness								
Lee et al [57]	74.88	15.3	18	76.21	16.98	18	4.8%	-0.08 [-0.73, 0.57]
Matsumoto et al [56]	58.85	14.3	60	62.4	14.15	60	6.5%	-0.25 [-0.61, 0.11]
Tokmakidis et al [58]	48.53	6.7	11	49.04	6.81	11	3.9%	-0.07 [-0.91, 0.76]
Volaklis et al [52]	11	1.9	12	12.3	1.8	12	3.9%	-0.68 [-1.51, 0.15]
Subtotal (95% CI)			**101**			**101**	**19.1%**	**-0.25 [-0.52, 0.03]**
Heterogeneity: Tau² = 0.00; Chi² = 1.46, df = 3 (P = 0.69); I² = 0%								
Test for overall effect: Z = 1.74 (P = 0.08)								
Lipid profile								
Arca et al [55]	-105.6	30.9	19	-113.6	35.8	19	4.9%	0.23 [-0.40, 0.87]
Ruangthai et al [54]	-137.54	52.44	13	-121.08	28.4	13	4.2%	-0.38 [-1.15, 0.40]
Volaklis et al [52]	-137.2	60.48	12	-129.5	10.73	12	4.1%	-0.17 [-0.97, 0.63]
Subtotal (95% CI)			**44**			**44**	**13.1%**	**-0.06 [-0.48, 0.36]**
Heterogeneity: Tau² = 0.00; Chi² = 1.53, df = 2 (P = 0.46); I² = 0%								
Test for overall effect: Z = 0.26 (P = 0.79)								
Quality of life								
Lee et al [57]	0.72	0.18	18	0.79	0.15	18	4.8%	-0.41 [-1.07, 0.25]
Matsumoto et al [56]	29.78	12.9	60	44.28	11.54	60	6.3%	-1.18 [-1.57, -0.79]
Ruangthai et al [54]	39.64	3.46	13	42.02	3.98	13	4.1%	-0.62 [-1.41, 0.17]
Subtotal (95% CI)			**91**			**91**	**15.2%**	**-0.81 [-1.32, -0.29]**
Heterogeneity: Tau² = 0.12; Chi² = 4.50, df = 2 (P = 0.11); I² = 56%								
Test for overall effect: Z = 3.06 (P = 0.002)								
Strength								
Lee et al [57]	51.81	16.81	18	65.13	54.61	18	4.8%	-0.32 [-0.98, 0.34]
Volaklis et al [52]	285.5	8.9	12	320.2	10.8	12	2.2%	-3.39 [-4.70, -2.07]
Zhang et al [60]	19.43	6.45	18	17.41	5.13	18	4.8%	0.34 [-0.32, 1.00]
Subtotal (95% CI)			**48**			**48**	**11.8%**	**-1.01 [-2.66, 0.64]**
Heterogeneity: Tau² = 1.91; Chi² = 24.57, df = 2 (P < 0.00001); I² = 92%								
Test for overall effect: Z = 1.20 (P = 0.23)								
Total (95% CI)			**434**			**434**	**100.0%**	**-0.36 [-0.59, -0.12]**
Heterogeneity: Tau² = 0.19; Chi² = 56.97, df = 21 (P < 0.0001); I² = 63%								
Test for overall effect: Z = 3.00 (P = 0.003)								
Test for subgroup differences: Chi² = 5.97, df = 5 (P = 0.31), I² = 16.2%								

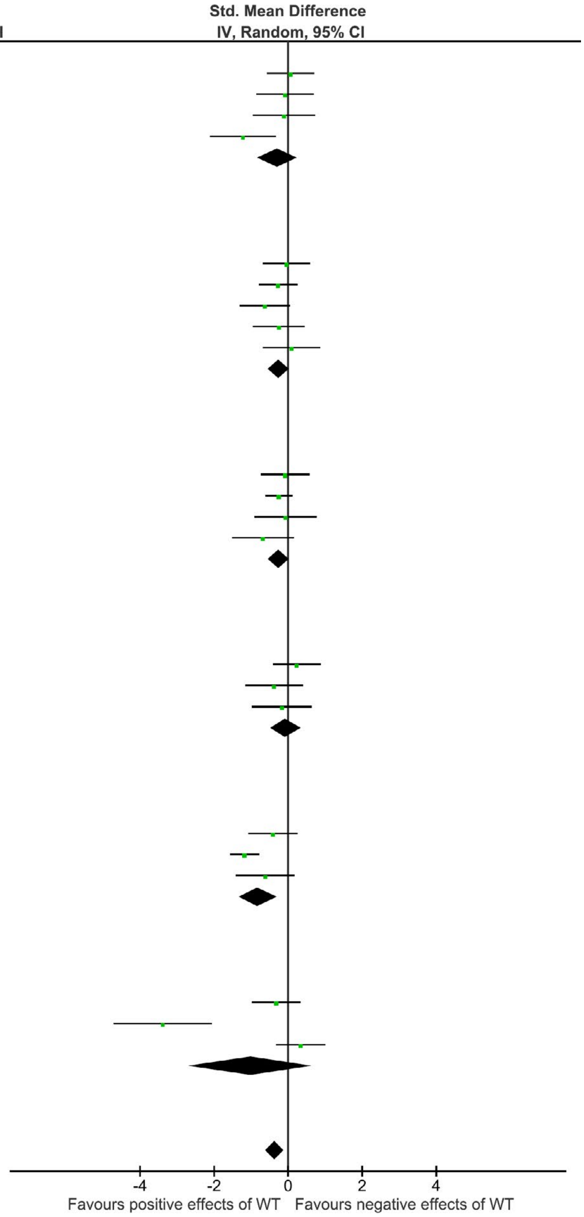

FIGURE 4 Forest plot of comparison for heart diseases—coronary artery disease, hypertension, and stroke. The center of each square represents the standard mean difference for individual trials, and the corresponding horizontal line stands for 95% confidence interval (CI). The diamonds represent pooled results

diseases (65%). However, there is a lack of information regarding the risk of bias in many articles, with 34% of the key criteria for healthy adults and 30% of the key criteria for adults with diseases having an unclear risk of bias. In studies of healthy adults, a high risk of bias was found in the incomplete outcome data (16%). Additionally, unclear risk of bias was shown to be common, especially concerning the blinding of participants and personnel (95%), allocation concealment (85%), and the blinding of outcome (68%). Regarding adults with chronic diseases, a high risk of bias was mainly observed for allocation concealment (19%) and random sequence generation (12.5%). Additionally, there was an unclear risk, particularly in the blinding of participants and personnel (78%), the blinding of outcome assessment (62.5%), and allocation concealment (53%) (Figures 6–9). In nonrandomized studies, in healthy adults the overall risk bias was mostly: moderate (43%), in bias due to selection of participants; low (28.5%) in bias due to confounding, due to deviations from intended interventions, due to missing data and in the selection of the reported result; and serious (28.5%), in classifications of interventions. There was also a lack of information about the risk of bias in the domain of the bias in the measurement of outcome. In adults with low (50%), with a preponderance in bias due to confounding, in the classification of interventions, due to deviations

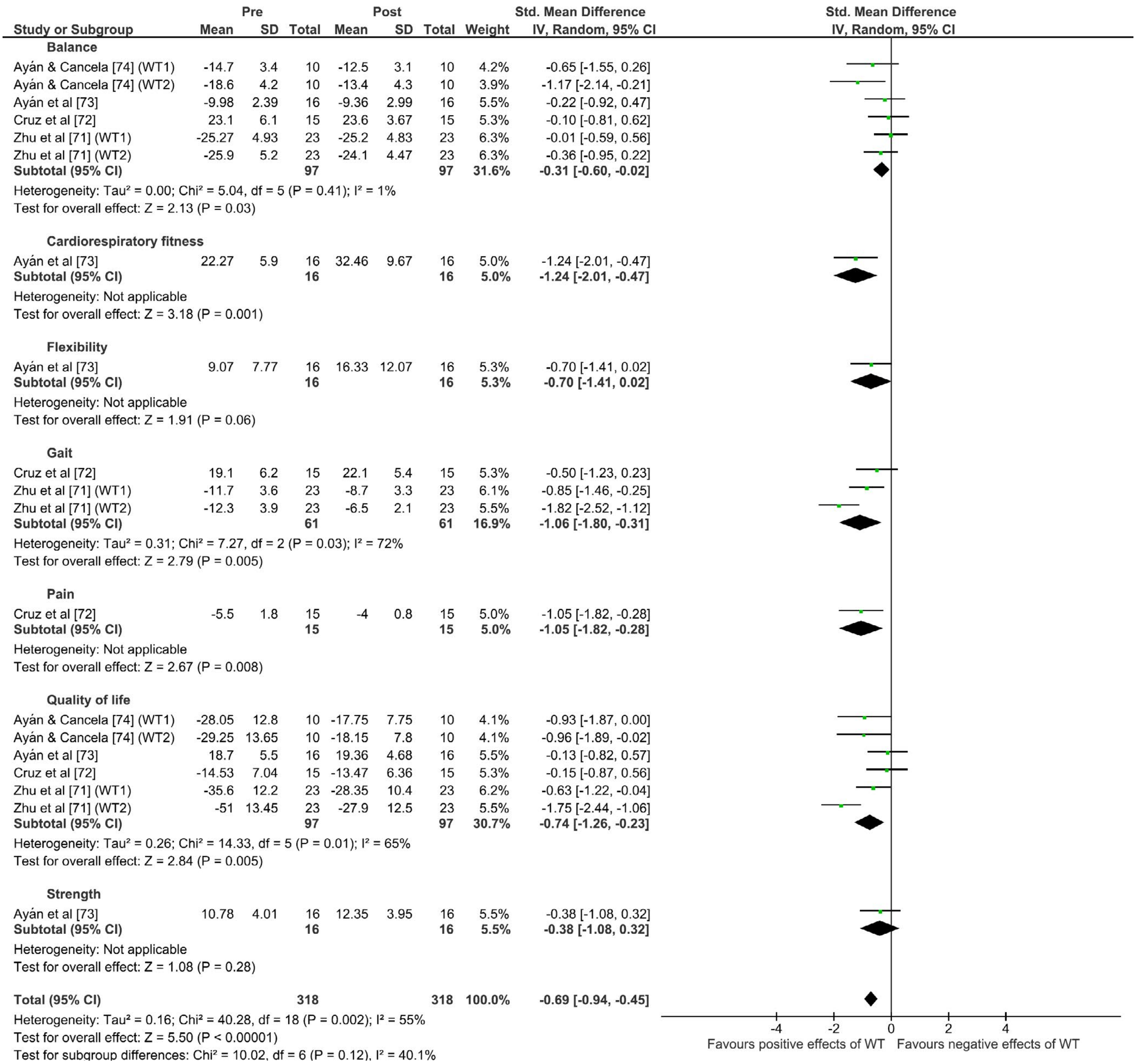

FIGURE 5 Forest plot of comparison for Parkinson. The center of each square represents the standard mean difference for individual trials, and the corresponding horizontal line stands for 95% confidence interval (CI). The diamonds represent pooled results

intended interventions, due to missing data, in measurements of outcome and selection of the reported result; and moderate (50%), in bias due to selections of participants (Figures 10–13).

4 | DISCUSSION

This review aimed to verify the changes in health and physical fitness parameters produced by WT in both healthy adults and adults with chronic diseases. In different populations, WT was shown to be significantly effective, improving several parameters related to physical fitness and health-related outcomes. Regarding healthy adults, there were significant enhancements in strength, balance, and cardiorespiratory fitness. When analyzing adults with chronic disease, WT was demonstrated to be beneficial for health and physical fitness, mainly in the quality of life and balance, but also in strength, pain, and gait.

4.1 | Healthy adults

Regarding healthy adults, the positive effects were mostly related to strength,[4,5,7,20–25] cardiorespiratory

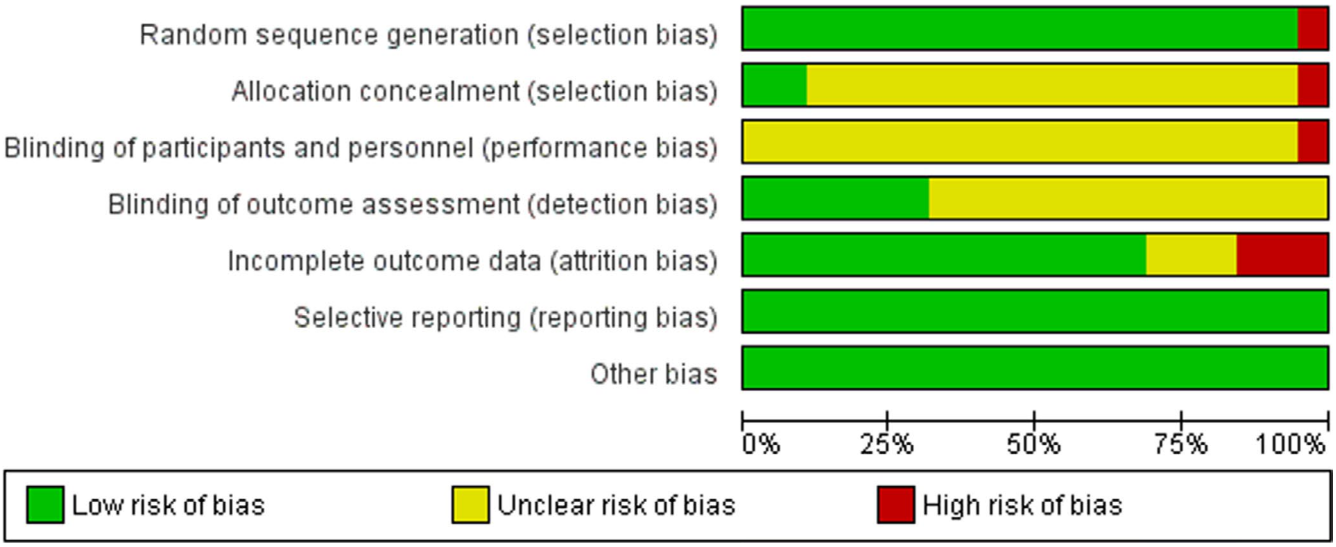

FIGURE 6 Risk-of-bias item presented as percentages across randomized studies for healthy population

fitness,[12,20,21,23] and balance,[5,7,20,24,25] being these variables the main responsible for the medium overall effect (SMD = −0.66). Nevertheless, contradictory results were found concerning flexibility[5,7,20,25,50–53] and blood pressure,[3,12,20] and no significant changes were observed in anthropometrics.[3,5] Most of the outcomes analyzed were shown to require at least 12 weeks of WT with 2–3 weekly sessions lasting between 46 and 65 min each.

Improvements in cardiorespiratory fitness were mainly promoted in studies with a duration of at least 12 weeks.[12,21] Moreover, better results seem to exist after an aquatic program compared to LT.[12] This can be explained by the difference in fluid densities, for which air is nearly 800 times lower than water.[6,23] Consequently, water offers more resistance to movement than air, thus requiring greater energy expenditure and putting a higher load on cardiac function, allowing cardiorespiratory levels to increase.[6] We should be aware that the intensity used in these programs was not fully reported/monitored, which could produce different results. For instance, in WT, interval training has been shown to be more effective in improving heart rate and oxygen consumption than continuous training.[52] These results seem to be enhanced when interval training is combined with the aid of additional loads, specifically floating vests, preventing contact of the feet with the bottom of the pool, removing the impact, and allowing higher physical demand and a reduced risk of injuries.[8,20]

There is a belief that WT is not the most reliable way to improve strength.[54] However, some recent studies found that WT focused on resistance training increased maximal dynamic strength.[21] These unclear results could be explained by the low intensity (undefined in most of the studies) or different water depths used. According to Kanitz et al.,[8] the improvement in strength depends on the water depth, with shallow water being more propitious to produce better results than deep water. In deep water, the feet do not touch the bottom of the pool, which could reduce muscle stimulation, the maximum speed of movement, and the production of force. This type of resistance exercise can also influence strength. For example, plyometric training is commonly used in programs outside of the water and is associated with improvements in muscular strength and explosiveness.[51,55,56] This training method was also effective at improving strength when performed in water for 8 weeks.[22] These results are interesting since they contradict the suggestions that the aquatic environment provides little strain on muscles and bones.[55,57] The velocity of the movement that is required by this training method could allow an increase in intensity, thus improving force production.[21] However, it is necessary to be careful about the excessive and inappropriate use of these exercises, as they can cause muscle injuries.[54] The main results suggested that plyometrics might be used to improve strength after 8 weeks of training, as long as used with caution.

The meaningful increases in balance could be due to the hydrostatic pressure and viscous force produced by the water during the exercises, allowing a different proprioceptive and sensory response in water compared to the land. This positively affects neuromuscular coordination, balance ability, and postural control.[24,58] Moreover, the improvement in balance could be due to continuous muscle activation that is required to stabilize body position.[58] By adding resistance equipment, it is possible to further potentiate the static and dynamic balance as a result of the simultaneous stimulation of the leg muscles and the muscles of support involved in spinal and pelvic

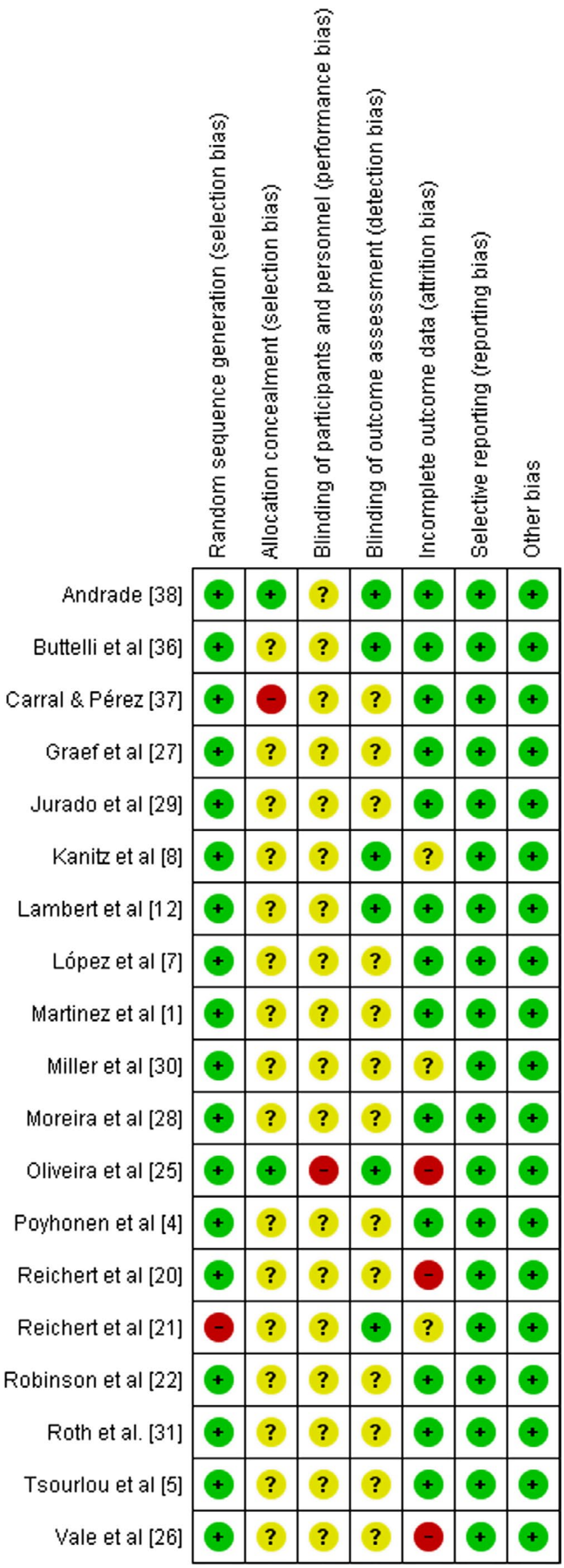

FIGURE 7 Judgments about each risk-of-bias item for each randomized study for healthy population. + indicates low risk,? indicates unclear risk, − indicates high risk

movements.[24,50] Nevertheless, the depth at which the activity is performed influences balance acquisition. Bento et al.[57] reported that it is possible to increase the levels of static and dynamic balance to a depth greater than 2 meters, but they were unable to develop static balance (only dynamic) with water at the level of the xiphoid process.

4.2 | Adults with chronic disease

The literature regarding the effect of WT in participants with chronic diseases is mainly focused on musculoskeletal diseases, heart diseases, diabetes mellitus, multiple sclerosis, and Parkinson's disease. Of these, the best results after performing aquatic programs were found in those who suffered from musculoskeletal diseases, diabetes, and multiple sclerosis. Nevertheless, the individuals with Parkinson's disease moderately improved the generality of health and physical fitness parameters. Regarding the outcomes with the greatest improvement in several studies were balance[26,32,34,40,45,49,59] and quality of life,[26,29,37,39,41,43,45,46,49] but also in strength[26,29,34,36] and pain,[29–34,47] and although little studied, gait also improved significantly.[45–47] Some parameters were not affected by WT: anthropometry in individuals with fibromyalgia,[28] diabetes,[60] and hypertension[37,38]; the lipid profile in subjects with coronary artery disease[35] and hypertension[38]; cardiorespiratory fitness in people who suffered from a stroke[39,59] and coronary artery disease[36,61]; and flexibility in individuals with fibromyalgia.[27] Furthermore, in most of the chronic diseases analyzed, it was observed that the most suitable duration of WT to produce significant effects on the different outcomes was 8–16 weeks of training, 3 times per week for 45–65 min. The exceptions are in individuals with Parkinson's disease (2/5 sessions per week) and heart diseases (2–4 times per week).

4.2.1 | Musculoskeletal diseases

In musculoskeletal diseases, we analyzed studies that investigated the effects of WT on fibromyalgia and bone diseases. In general, major improvements were found in pain, cardiorespiratory fitness, flexibility, quality of life, and strength, with these variables providing a substantial contribution to the large overall effect (SMD = −1.11). Concerning individuals with fibromyalgia, we recognize the advantages of WT, essentially in balance[26] and

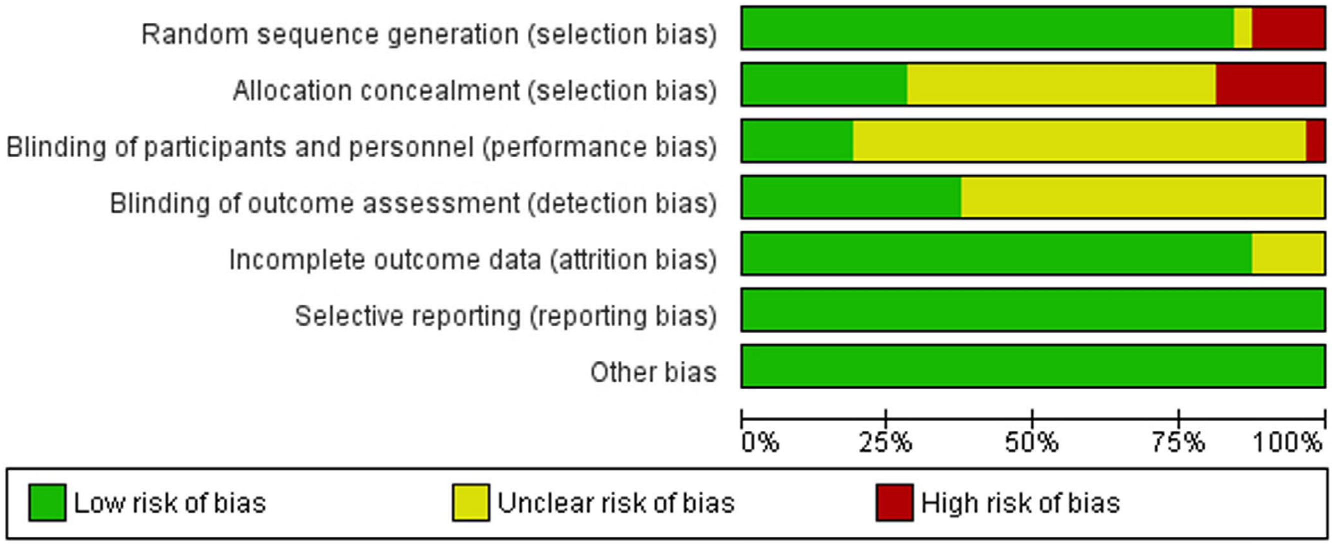

FIGURE 8 Risk-of-bias item presented as percentages across randomized studies for population with diseases

cardiorespiratory fitness.[27] These outcomes are relevant, considering that this disease is strongly associated with problems of balance and frequent falls[62] due to sensory disorders and muscle weakness.[26] In line with these improvements, we also verified a slight improvement in strength, especially among individuals using WT with an emphasis on aerobic and resistance training.[26] Although there are potential improvements in quality of life,[26] only a few studies analyzed this variable, and more water training (≥12 weeks, three weeks, ≈ 60 min duration each session) was required to manifest strong effects. When the purpose of the training is to relieve successive pain, such as the typical symptoms of fibromyalgia, exercise/therapy should occur in water at temperatures between 30°C and 34°C.[35]

Regarding bone diseases, the studies investigated arthritis/osteoarthritis and low back pain. In these studies, the perception of pain,[29–34] balance,[32,34] flexibility,[29,34] and strength[29,34] showed better results, with some also significant effects in quality of life,[29] in anthropometry,[35] and in cardiorespiratory fitness.[29] To observe these greater effects, 6–16 weeks of training, 2–3 times per week, are needed. In diseases such as low bone mineral density, osteoporosis, joint pain, and muscle weakness,[63–65] the literature recognizes the need to generate an impact to increase the osteogenic effect through the tension and compression that the bone is subjected to when exposed to different loads.[64] As previously noted, the properties of the aquatic environment, namely fluctuation, reduced impact and led to the WT being classified as exercises with low osteogenic effects.[64,66,67] Despite this, one of the main purposes of research in most bone diseases is to attempt to lighten the pain caused by the respective diseases, as successfully attained in some investigations.[29–34] Thus, WT seems to be a safe method when the intention is to reduce the pain of these patients. It should be noted that although water exercise could be unfavorable in the direct increase in bone mineral density, some increases in muscle strength can help to strengthen the bone.[64] However, for this to occur, it is necessary to perform exercises at high intensities, recruit type II muscle fibers, and stimulate the strengthening of bone tissue.[68] Moreover, WT also has positive effects on low back pain, probably because the exercise performed in water is propitious to aerobic training at higher intensities than would be possible on land.[29]

4.2.2 | Heart diseases

The heart diseases assessed were coronary artery disease, hypertension, and stroke. In people with coronary artery disease, there were significant changes, essentially in strength[36] and anthropometry,[36] after performing a WT. In the case of hypertension, there were no great changes; however, the positive effects were mainly on quality of life,[37] despite them being ineffective in anthropometry[37,38] and lipid profile.[37,38] There was a lack of studies on blood pressure, and this is considered the most accurate predictor of future coronary artery disease in individuals over 50 years of age.[69–72] Concerning individuals with stroke, these developments in the quality of life[39] with water and exercise are essentially due to the viscosity and drag forces that reduce the spastic response of the muscle and pain.[39] Ultimately, despite the large effects on some indicators (quality of life) and the small overall effect (SMD = −0.36) obtained by patients with heart diseases, the studies examined herein did not fully elucidate the impact of WT on heart diseases.

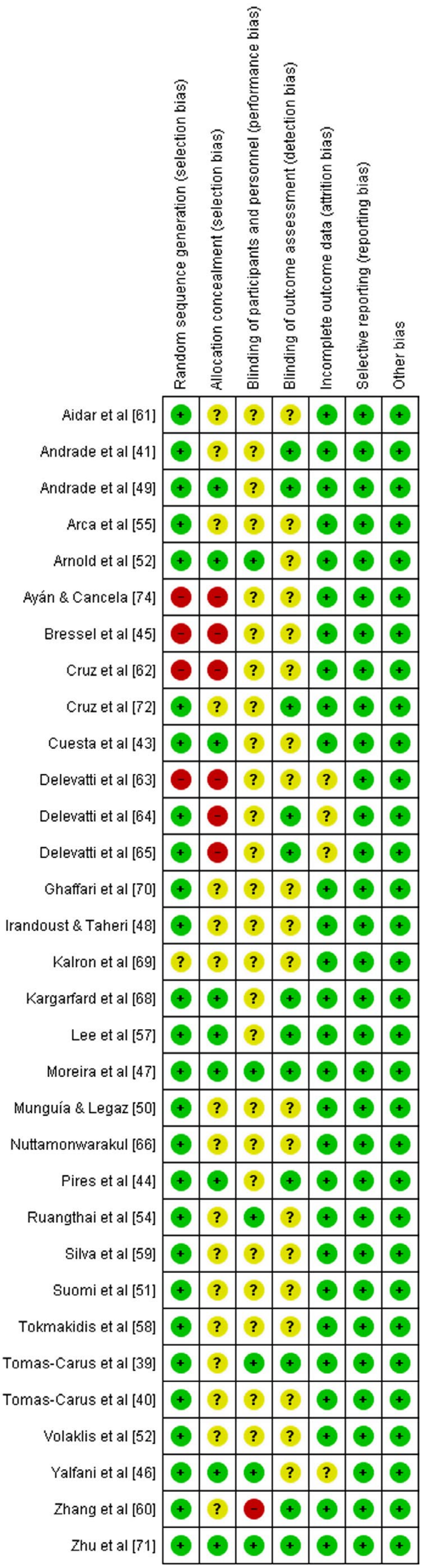

FIGURE 9 Judgments about each risk-of-bias item for each randomized study for population with diseases. + indicates low risk,? indicates unclear risk, – indicates high risk

4.2.3 | Diabetes mellitus

The programs performed in an aquatic context proved to be indicated for diabetes, particularly when the aim was to improve balance[40] and quality of life.[41] Furthermore, blood pressure[40] and lipid profile[42] also revealed favorable results after the practice of these activities, highlighting the improvement in glucose levels.[42] In all of these outcomes, 12 weeks of WT, with 3 lessons weekly, for 45–50 min each lesson, were required to produce significant effects in people with diabetes. Nevertheless, there is a lack of studies with a program duration beyond 12 weeks. Additionally, further studies are needed in these individuals to analyze body composition, cholesterol, and triglyceride responses. A possible improvement in these parameters, together with the results obtained in glucose (with nutritional control), can decrease the risk of developing heart problems.[60,73]

4.2.4 | Multiple sclerosis

Individuals with multiple sclerosis participating in WT had considerable improvements in their quality of life[43,44] and balance,[45] and slight increases in gait[45] and fatigue.[44] The improvement in gait after a short WT of 3 weeks should be highlighted[45]; this is perhaps due to the fact that water enables weight to be reduced and resistance to be increased during exercise due to buoyancy.[43] These results are even more important considering that patients with multiple sclerosis lose the capacity to walk over the years.[74] Moreover, WT performed systematically was shown to improve the quality of life of individuals with multiple sclerosis[43,44] maybe due to gains in walking ability and decreased fatigue.[43,44,75] Training in water 3 times/week for 8 weeks seems to be sufficient for substantial improvements in these outcomes, regardless of session duration. Therefore, it is necessary to consider the training method to be applied, as aerobic training seems to be more effective than resistance training, presumably due to the improvement of cardiovascular capacity resulting from the superior capacity to produce work in the aquatic environment.[43]

4.2.5 | Parkinson's disease

Interestingly, Parkinson's disease has been recently studied regarding the effects of WT. In these subjects, pain,[47]

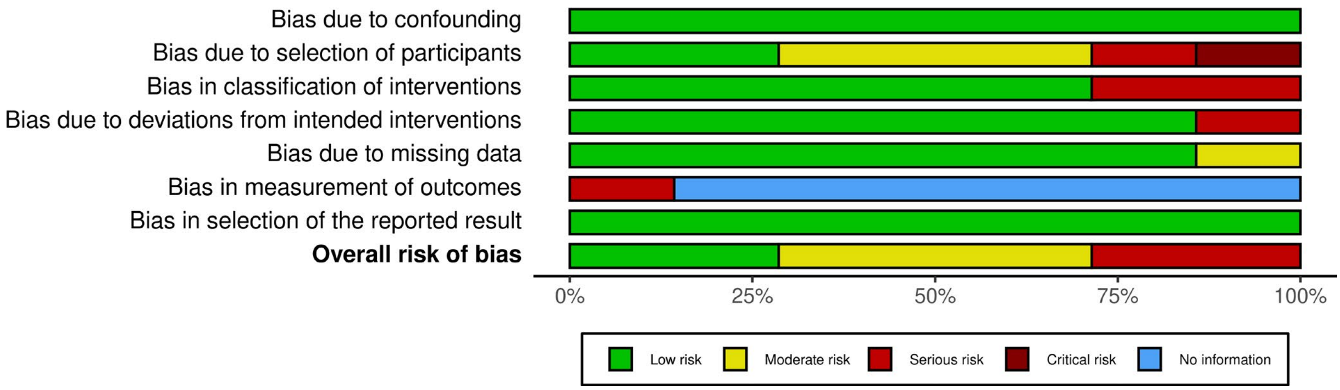

FIGURE 10 Risk-of-bias item presented as percentages across nonrandomized studies for healthy population

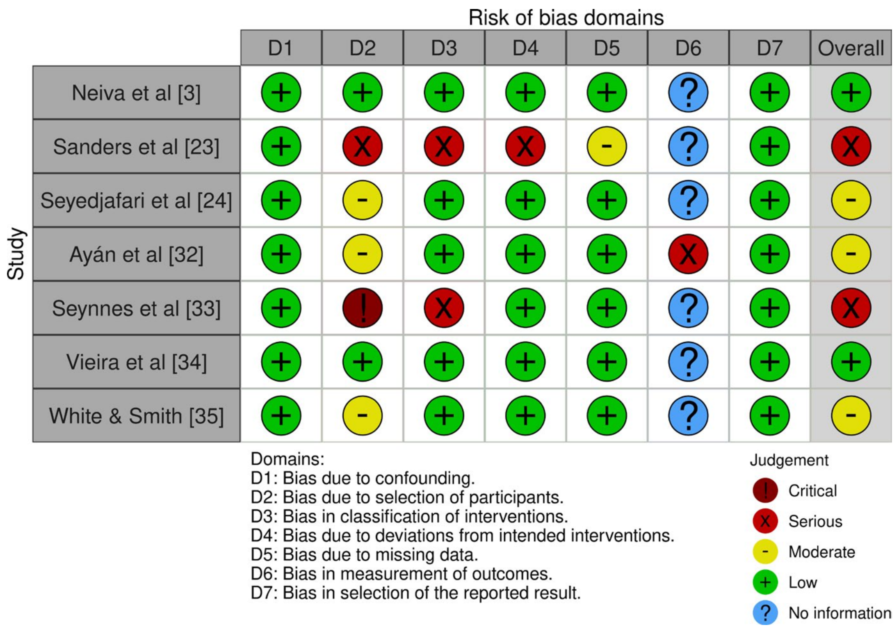

FIGURE 11 Judgments about each risk-of-bias item for each nonrandomized study for healthy population.! indicates critical risk, X indicates serious risk, - indicates moderate risk, + indicates low risk,? indicates no information

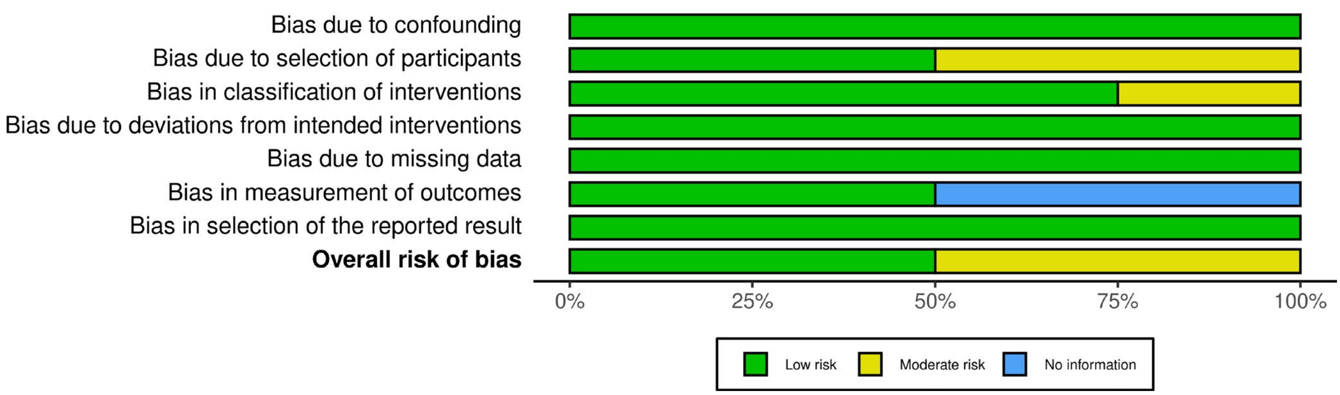

FIGURE 12 Risk-of-bias item presented as percentages across nonrandomized studies for population with diseases

quality of life,[46,49] cardiorespiratory fitness,[48] and gait[46] levels were mainly improved, and in the background, there were also moderate changes in balance,[49] with a medium overall effect obtained essentially by these indicators. The hydrostatic pressure, turbulence, and buoyancy allow more demanding work in postural control, mobility, and stimulation at a higher level in Parkinson's disease patients.[46] Moreover, water temperature also plays a key role

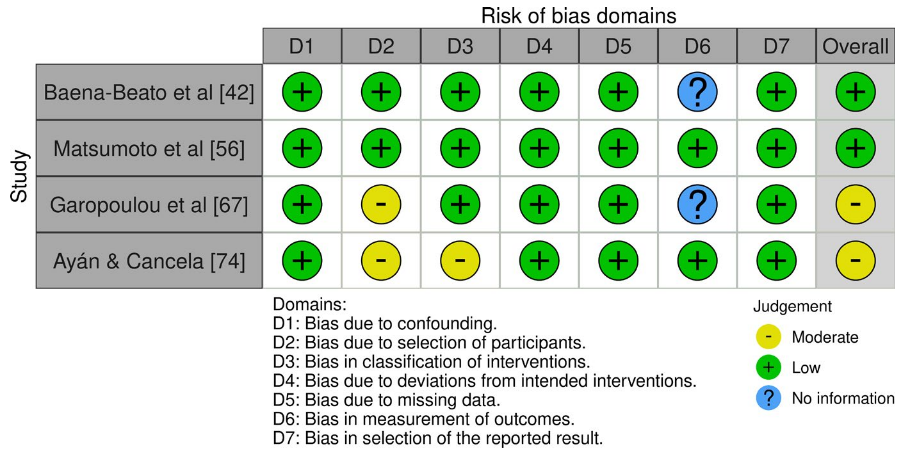

FIGURE 13 Judgments about each risk-of-bias item for each nonrandomized study for population with diseases.! indicates critical risk, X indicates serious risk, - indicates moderate risk, + indicates low risk,? indicates no information

because warm water increases body temperature, dilates blood vessels, relaxes muscles, reduces muscle stiffness, and optimizes balance.[46] This is important because the quality of life among these patients increases mainly due to the development of balance and the consequent decrease in the number of falls,[49] improvements in the mental and emotional state through social interaction in group exercise[48,49] and pain reduction.[47] Only 6 weeks (2/5 lessons per week) of WT was sufficient to significantly improve most outcomes among people with Parkinson's disease.

In conclusion, the current review suggested that WT is reliable for obtaining improvements in the health and physical fitness of adults with and without chronic diseases. In healthy individuals, WT mainly improves strength, cardiorespiratory fitness, and balance. Although specific adaptations exist according to each disease, it can be reported that water-based programs mainly improve the balance, quality of life, strength, pain, and gait in adults with chronic diseases.

4.3 | Perspective

Worldwide, the participation in physical activity training programs performed in-water has increased, mainly because of the specific properties of the water. Research suggests that exercise, and specifically WT, could be used as a complement to medical treatment for health-related issues or to maintain/improve physical fitness and quality of life.[76] The WT is mainly recommended for people with specific diseases, but little was known about the ideal practices to be performed. We highlighted the effects on balance, cardiorespiratory fitness, and strength in healthy adults, whereas balance, quality of life, strength, pain, and gait were improved in individuals with chronic diseases. Beneficial effects in healthy adults seem to be consistent after 12 weeks of training, with 2–3 sessions per week of 46–65 min. Although further research is needed to define the optimal dose of exercise in some diseases, in general, benefits in physical fitness and/or other health-related measures were observed after 8–16 weeks of WT. Future studies should better understand the effect of WT intensity, one of the main factors of exercise load. Additionally, more studies are needed on the effect of WT in individuals with specific diseases, for instance, those with heart disease.

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CONFLICT OF INTEREST

The authors declare no conflict of interests.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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