EFFECTS OF RECREATIONAL SOCCER ON FAT MASS IN UNTRAINED SEDENTARY ADULTS: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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ABSTRACT

Purpose. The aim of this systematic review with meta-analysis was to assess the effects of recreational soccer on fat mass in untrained sedentary adults.

Methods. The following databases were searched: Web of Science, Scopus, SPORTDiscus, and PubMed. The inclusion criteria were: (i) sedentary adult population not restricted to sex, clinical condition; (ii) exposure to intervention programs based on soccer; (iii) intervention groups compared with passive or active (not related with soccer) control groups; (iv) fat mass (indirectly or directly measured); (v) randomized controlled trials. The database search initially yielded 4565 titles. From those, 22 articles were eligible for the systematic review and meta-analysis. The age of the included population varied from 20 to 68 years.

Results. No significant differences in fat mass changes were found between recreational soccer groups and active controls (*ES* = –0.070, trivial; 95% *CI*: –0.28 to 0.14; $p = 0.505$; $I^2 = 0.0\%$; Egger's test $p = 0.986$). However, significant changes in fat mass were observed between recreational soccer groups and passive controls (*ES* = –0.43, small; 95% *CI*: –0.59 to –0.27; $p < 0.001$; $I^2 = 35.0\%$; Egger's test $p = 0.652$).

Conclusions. Regular participation in recreational soccer is as effective as participation in analytical exercise approaches such as continuous running to produce significant fat mass reductions in untrained sedentary populations, independently of sex and clinical condition. However, recreational soccer arouses a greater interest as it has the advantage of increasing the motivation to maintain participation in an active lifestyle.

Key words: football, body fat, body composition, health promotion

Introduction

The deleterious effects of a sedentary lifestyle are well known, and there is extensive literature regarding the different implications that sedentary lifestyle has on different structures of the human body (e.g., skeletal muscle, bone, organs, and adipose tissues) [1, 2]. To prevent these effects, there are non-pharmacological strategies that can produce positive adaptations in the general health, body composition, and physical performance among untrained individuals [3].

One of the main consequences of sedentary lifestyle is the excessive accumulation of subcutaneous and internal fat mass in the whole human body, which, in turn, leads to associated type 2 diabetes, hypertension, and cardiovascular and respiratory diseases [4]. In fact, a higher fat mass to fat-free mass ratio (more fat mass than fat-free mass) has been related

to sarcopenic obesity (e.g., muscle degeneration concurrent with fat accumulation) [5]. Furthermore, maintaining this type of lifestyle in long-term can cause chronic diseases that limit life quality and body functionality, which is related to higher levels of depression and a higher risk of mortality [6].

To overcome the above-mentioned negative consequences of a sedentary lifestyle, participating in physical exercise activities has proven to be an effective non-pharmacological strategy for reducing fat mass accumulation and the associated diseases [7–9]. There are general guidelines that promote the prescription of 30–60-min moderate-intensity exercise 3 times per week [10]. However, these types of recommendations usually fail to produce clear insights regarding the effects that different modes of exercise have on fat mass loss. There is extensive literature recommending aerobic continuous training interventions conducted on treadmills, stationary bikes, and/or rowing ergometers [10]. Although continuous aerobic training presents its potential benefits regarding fat mass loss, it is excessively repetitive and psychologically exhausting when compared with other intermittent training interventions [11, 12]. Also, both continuous and intermittent aerobic exercise modes produce positive effects on human health, with intermittent exercise being the most promising method [13, 14].

Given the highly monotonous aspect of continuous aerobic training, the practice of more enjoyable intermittent aerobic exercise, such as recreational soccer, has been extensively studied regarding its effects on the general health, cardiorespiratory fitness, and motivation of sedentary adults [11, 15–17]. Indeed, a systematic review aiming to analyse the effects of recreational soccer on aerobic fitness and general health in sedentary healthy and unhealthy individuals revealed that this type of physical activity produced significant positive effects on the cardiovascular system and skeletal muscles in both groups [18]. Interestingly, Aslan et al. [19] recently found that young adult sedentary subjects participating in only 1 session per week of recreational soccer exhibited significant decreases in body fat, as well as significant increases in aerobic, power, and strength performance after 8 weeks of the intervention. However, the same study did not determine any adaptation in fat-free mass, heart rate measures, or anaerobic performance, suggesting the need of higher frequency (e.g., 2–3 sessions per week) [19].

Furthermore, as mentioned earlier, recreational soccer has an exponential potential to promote regular exercise in sedentary populations owing to the inherent motivational, social, and competitive aspects of

this kind of training intervention [11, 16]. To date, the overall systematic reviews and meta-analyses have investigated the effects that recreational soccer has on physical fitness and general health parameters [3, 15, 17, 20]. However, to the best of the authors' knowledge, there is no systematic review with meta-analysis with a focus on the effects of recreational soccer on fat mass changes. For those reasons, the aim of this systematic review with meta-analysis was to assess the impact of recreational soccer on fat mass in untrained sedentary adults.

Material and methods

The current systematic review and meta-analysis is in line with the recommendations of the Cochrane Collaboration guidelines [21]. The structure of the article follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines [22].

Eligibility criteria

The eligibility criteria of the systematic review with meta-analysis were based on the PICOS model (Population, Intervention, Comparator, Outcomes, Study design). Table 1 presents the inclusion and exclusion criteria.

Information sources

Four electronic databases (PubMed, Scopus, SPORT-Discus, and Web of Science) were searched for relevant publications prior to 30 July 2021. After the selection of the articles, a manual search was performed in the reference list of the included articles aiming to retrieve additional studies that might fit the eligibility criteria. The final list of included articles and the eligibility criteria were sent to 2 independent experts in recreational soccer to help identify eventual relevant articles not included in the search. The experts were selected from the list of experts in soccer in the Expertscape website. The search strategy was not provided to the experts in order not to bias them in their searches.

Search strategy

Keywords and synonyms were entered in various combinations in all fields of the 4 databases: (("untrained" OR "sedentary") "adult*") AND (("recreational" OR "walk*" OR "medic*") AND ("soccer" OR "football")) AND ("fat*" OR "body fat" OR "body com-

Table 1. Inclusion and exclusion criteria for the systematic review

Item	Inclusion criteria	Exclusion criteria
Population	Untrained adults (> 18 years old), no restrictions for sex or clinical condition. Adults were not exposed to specific pharmacological or diet-oriented plan	Adults exposure to regular exercise. Youth participants (< 18 years old). Participants exposed to specific pharmacological or diet-oriented plan
Intervention	Recreational soccer training lasting for a minimum of 4 weeks, without restrictions for weekly frequency	Other team sports (e.g., Australian football, American football, basketball, volleyball, handball). Programs with less than 4 weeks of training. Combined training (recreational soccer and other training methods)
Comparator	Passive or active control groups	Passive control with evidence of participation in structured exercise
Outcomes	Pre- and post-intervention values (mean and standard deviation) of fat mass (direct, indirect, and criterion methods)	Other outcomes not including fat mass (e.g., skinfold thickness, lean mass, body mass index); no information on pre- or post-intervention values (e.g., follow-up excluded)
Study design	Randomized controlled trials	Non-randomized controlled trials
Additional criteria	Only original and full-text studies written in English	Written in other language than English. Article types other than original (e.g., reviews, letters to editors, trial registrations, proposals for protocols, editorials, book chapters, conference abstracts)

position" OR "health indices") AND ("intervention" OR "RCT" OR "control*" OR "experimental"). The search results were exported to the EndNote software. No filters or limits were used.

Selection process

FMC and FTGF performed the searches, the removal of duplicates, screening of titles and abstracts, and analysis of the full texts in an independent way. Any disagreements were discussed with a third author (RS).

Data collection process

The data items were defined before the data extraction, with the aim to avoid bias in the analysis. FMC and FTGF performed the data extraction independently; in cases of discrepancy, a third author (RS) entered the discussion until a consensus was achieved. An Excel datasheet was designed on the basis of the Cochrane Consumers and Communication Review Group's template [23] in order to assess inclusion requirements, and subsequently tested on 10 randomly selected studies (i.e., pilot testing).

Data items

Only repeated measures (at least pre-post) were considered for data analysing and reporting. Fat mass (%) was selected as the main outcome. Only fat mass of the total body was considered and extracted. No partial regions were considered. Fat mass was extracted for indirect methods (e.g., anthropometry, bioelectric impedance analysis), direct methods (e.g., total body water, total body counting, neutron activation), and criterion methods (e.g., body density, dual-energy X-ray absorptiometry, computed tomography, magnetic resonance imaging). Additional information about the study was also extracted: (i) participants (e.g., number, age, sex, clinical condition); and (ii) training intervention (duration, weekly frequency, training regimen, intensity).

Assessment of methodological quality

The Physiotherapy Evidence Database (PEDro) scale was used to assess the methodological quality of the included studies. There are 11 items on the PEDro checklist, but item 1 is not included in the total score. Therefore, the methodological quality of the included

studies was rated from 0 (lowest quality) to 10 (highest quality). This scale evaluates different aspects of the study design, such as participant eligibility criteria, randomization, blinding, attrition, and reporting of data. The validity and reliability of the PEDro scale has been established previously [24–26]. Additionally, its agreement with other scales (e.g., Cochrane risk of bias tool) has been reported [27]. Moreover, the PEDro scale is probably one of the scales most frequently used in the literature, helping to make comparisons between meta-analyses. In accordance with cut-off scores, the methodological quality was rated as 'poor' (< 4), 'fair' (4–5), 'good' (6–8), or 'excellent' (9–10) in some sub-fields; however, it is not possible to satisfy all scale items in some areas of physiotherapy practice. More-over, in the context of this study, it is not possible to blind the participants regarding whether they are trained or not, which makes item 5 of the PEDro scale an unfair criterion to assess the methodological quality of studies in our systematic review. Therefore, as outlined in previous systematic reviews in some sub-fields of physiotherapy [28, 29], the methodological quality of studies was interpreted by using the following convention, based on the summary score: studies that scored ≤ 3 points were considered as being of 'poor quality,' studies scoring 4 or 5 points were considered as being of 'moderate quality,' and studies that scored 6–10 points were considered as being of 'high quality'. Two authors performed the methodological quality assessment independently. Disagreements in the evaluations between the reviewers were resolved through discussion and consensus.

Summary measures, synthesis of results, and publication bias

A meta-analysis was carried out only in the case of having 3 or more studies providing baseline and follow-up data for the same measure. Pre-training and post-training mean and standard deviation (*SD*) for dependent variables were used to calculate effect sizes (*ES*; Hedges' *g*) for each outcome measure in the recreation soccer training and control groups. Data were standardized with post-intervention *SD* values. The random-effects model was used to account for differences between studies that might impact on the small-sided game (SSG)-based effect [36, 37]. The *ES* values are presented with 95% confidence intervals (CI). The calculated *ES* values were interpreted by using the following scale: < 0.2, trivial; 0.2–0.6, small; > 0.6–1.2, moderate; > 1.2–2.0, large; > 2.0–4.0, very large; > 4.0, extremely large [38]. Heterogeneity

was assessed with the I^2 statistics, with values of < 25%, 25–75%, and > 75% considered to represent low, moderate, and high levels of heterogeneity, respectively [39]. The risk of bias was explored by using the extended Egger's test [40]. When bias was present, the trim and fill method was applied [41], with L0 assumed as the default estimator for missing studies [42]. All analyses were carried out with the Comprehensive Meta-Analysis software (version 2; Biostat, Englewood, NJ, USA). Statistical significance was set at $p \leq 0.05$.

Ethical approval

The conducted research is not related to either human or animal use.

Results

Study selection

The initial search made in the databases retrieved 4565 titles (SportDISCUS: 411; PubMed: 21; Web of Science: 11; Scopus: 4122). Those titles were exported to the EndNote™ reference manager (X9; Clarivate Analytics, Philadelphia, PA, USA). The duplicates (*n* = 2362) were removed automatically and manually. In addition, there were records marked as ineligible by automation tools (*n* = 7). The remaining 2196 articles were screened for their relevance on the basis of the abstract and title, which led to the removal of another 2158 studies. The full texts of the remaining 38 articles were examined diligently; after reading them, further 16 studies were excluded for the following reasons (R): R1, no fat mass: 5; R2, youth participants: 4; R3, no recreational soccer: 2; R4, footballers: 1; R5, acute responses: 1; R6, cross-sectional study: 1; R7, cohort study: 1; R8, calorie restricted diet: 1 (more information: Figure 1). The remaining 22 articles were included in the systematic review, providing mean and *SD* post-training data for the main outcome.

Study characteristics

The characteristics of the 22 included studies can be found in Table 2. The included randomized controlled studies involve 22 experimental (soccer) groups with 777 participants, 9 active control groups with 158 participants, and 21 passive control groups with a total of 728 participants.

The characteristics of the recreational soccer interventions and control groups are presented in Tables 3 and 4, respectively.
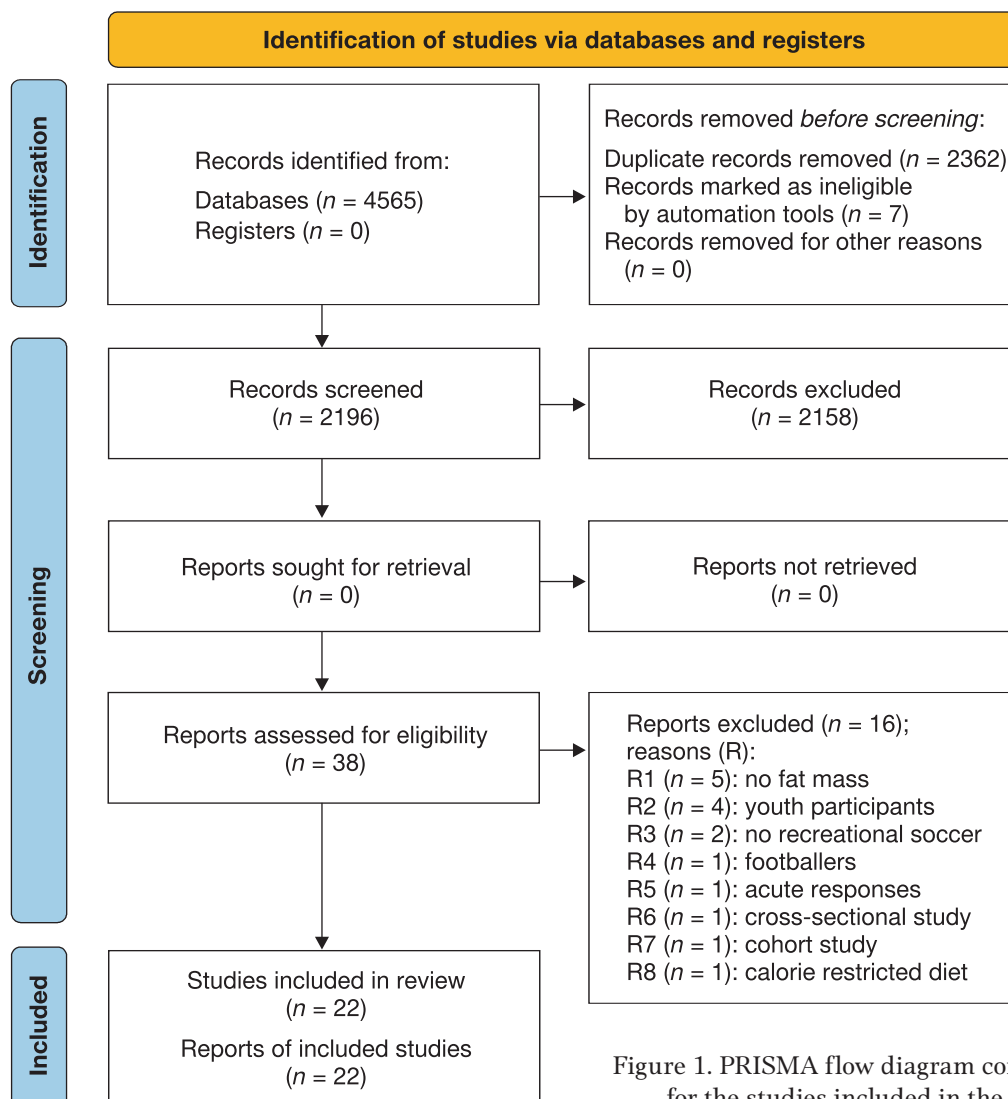
Figure 1. PRISMA flow diagram considering the selection process for the studies included in the present systematic review

Methodological quality of the studies

The included studies were scored on the basis of the PEDro checklist (Table 5). The mean score for the 22 included studies was 6.81 ± 0.58 (minimum: 6; maximum: 8). It was observed that the studies had 'good' methodological quality.

Results of syntheses

Table 6 presents the summary of results of total fat mass (kg) or relative fat mass (%) reported before and after the recreational soccer intervention, as well as in the active control and passive control groups in the included articles.

Overall, 9 studies provided fat mass data involving 9 soccer training groups and 9 active control groups compared (pooled n = 350). The results (Fig-ure 2) showed similar changes in fat mass after soccer training and among active controls (ES = –0.070, trivial; 95% CI: –0.28 to 0.14; p = 0.505; I^2 = 0.0%; Egger's test p = 0.986).

Regarding interventions with males (3 study groups; ES = –0.24; 95% CI: –0.68 to 0.21; p = 0.301; within-group I^2 = 0.0%) and those with females (6 study groups; ES = –0.03; 95% CI: –0.26 to 0.21; p = 0.834; within-group I^2 = 0.0%), both sex groups achieved a non-significant (and similar, i.e., p = 0.412 between sexes) reduction of fat mass after soccer training compared with active controls.

A total of 21 studies provided fat mass data involving 21 soccer training groups and 21 passive control groups compared (pooled n = 1000). The results (Figure 3) showed a greater change in fat mass after soccer training than among passive controls (ES = –0.43, small; 95% CI: –0.59 to –0.27; p < 0.001; I^2 = 35.0%; Egger's test p = 0.652).

Table 2. Characteristics of the included studies

Study	n	Mean age (years)	Sex	Population	Type of control group	Instrument used for measuring fat mass	Outcome extracted
Krustrup et al. [30]	Soccer group: 13 Running group: 12 Passive control: 11	Soccer group: 30 ± 2 Running group: 31 ± 2 Passive control: 30 ± 2	Men	Healthy	1 active (running) 1 passive	DXA	Fat mass – total (kg)
Knoepfli-Lenzin et al. [31]	Football group: 15 Running group: 15 Passive control: 17	Football group: 37 ± 4 Running group: 36 ± 5 Passive control: 38 ± 5	Men	Mild hypertension	1 active (running) 1 passive	DXA	Relative fat mass (%)
Krustrup et al. [32]	Football group: 25 Running group: 25 Passive control: 15	Football group: 37 ± 2 Running group: 37 ± 1 Passive control: 33 ± 2	Women	Healthy	1 active (running) 1 passive	DXA	Relative fat mass (%)
Krustrup et al. [33]	Football group: 9 Running group: 10 Passive control: 9	Football group: 40 ± 3 Running group: 40 ± 2 Passive control: 38 ± 4	Women	Healthy	1 active (running) 1 passive	DXA	Relative fat mass (%)
Randers et al. [45]	Football group: 10 Passive control: 7	All: 20–43	Men	Healthy	1 passive	DXA	Relative fat mass (%)
Randers et al. [46]	Soccer group: 22 Passive control: 10	Soccer group: 37 ± 10 Passive control: 43 ± 9	Men	Homeless	1 passive	DXA	Fat mass – total (kg)
Gray et al. [47]	Intervention group: 51 Comparison group: 52	Intervention group: 48.2 ± 8.4 Comparison group: 45.9 ± 8.4	Men	Overweight and obese	1 passive	Electronic bioimpedance	Relative fat mass (%)
Krustrup et al. [48]	Soccer group: 22 Doctor's advice group: 11	All: 31–54	Men	Mild-to-moderate hypertension	1 passive	DXA	Relative fat mass (%)
Andersen et al. [49]	Football group: 12 Passive control: 9	Football group: 50.6 ± 7.1 Passive control: 48.7 ± 9.2	Men	Type 2 diabetes mellitus	1 passive	DXA	Fat mass – total (kg)
Barene et al. [34]	Soccer group: 37 Zumba group: 35 Passive control: 35	Soccer group: 44.1 ± 8.7 Zumba group: 45.9 ± 9.6 Passive control: 47.4 ± 9.5	Women	ND	1 active (Zumba) 1 passive	DXA	Relative fat mass (%)
Barene et al. [35]	Soccer group: 24 Zumba group: 25 Passive control: 25	Soccer group: 44.1 ± 8.7 Zumba group: 45.9 ± 9.6 Passive control: 47.4 ± 9.5	Women	ND	1 active (Zumba) 1 passive	DXA	Relative fat mass (%)

Connolly et al. [36]	Soccer group: 13 Vibration group: 17 Passive control: 14	Soccer group: 39 ± 6 Vibration group: 40 ± 4 Passive control: 40 ± 5	Women	Healthy	1 active (vibration) 1 passive	DXA	Relative fat mass (%)
De Sousa et al. [50]	Football + diet: 19 Diet: 15	All: 48–68	Men and women	Type 2 diabetes mellitus	1 passive	DXA	Relative fat mass (%)
Mohr et al. [51]	Football group: 21 Control group: 20	Football group: 45 ± 3 Control group: 43 ± 3	Women	Mild hypertension	1 passive	DXA	Fat mass – total (kg)
Uth et al. [52]	Football group: 23 Control group: 26	Football group: 67.1 ± 7.1 Control group: 66.5 ± 4.9	Men	Prostate cancer	1 passive	DXA	Relative fat mass (%)
Andersen et al. [38]	Football group: 9 Resistance group: 9 Control group: 8	Football group: 68.0 ± 4.0 Resistance group: 69.1 ± 3.1 Control group: 67.4 ± 2.7	Men	Healthy	1 active (resistance) 1 passive	DXA	Relative fat mass (%)
Krustrup et al. [53]	Soccer group: 19 Control group: 12	Soccer group: 45 ± 6 Control group: 45 ± 4	Women	Mild hypertension	1 passive	DXA	Relative fat mass (%)
Uth et al. [54]	Football group: 21 Control group: 20	Football group: 67.1 ± 7.1 Control group: 66.5 ± 4.9	Men	Prostate cancer	1 passive	DXA	Fat mass – total (kg)
Reddy et al. [43]	Football group: 11 Control group: 9	All: 50–65	Men and women	ND	1 passive	Electronic bioimpedance	Relative fat mass (%)
Hunt et al. [55]	Football Fans in Training: 374 Comparison group: 373	Football Fans in Training: 47.0 ± 8.07 Comparison group: 47.2 ± 7.89	Men	Overweight and obese	1 passive	Electronic bioimpedance	Relative fat mass (%)
Aslan et al. [19]	Soccer group: 10 Control group: 10	Soccer group: 22.1 ± 1.8 Control group: 23.4 ± 1.6	Men	Healthy	1 passive	Skinfold thickness	Relative fat mass (%)
Ortiz et al. [37]	Soccer group: 17 Running group: 10	Soccer group: 28.8 ± 3.6 Running group: 27.1 ± 4.7	Women	Healthy	1 active (running)	Skinfold thickness	Relative fat mass (%)

ND – not described, DXA – dual-energy X-ray absorptiometry

Table 3. Characteristics of recreational soccer interventions

Study	Duration (weeks)	Days per week	Sessions per person per week (n)	Total sessions	Training formats	Training pitch dimensions	Sets	Recovery between sets (min)	Recovery between sets (intensity)	Total work duration (min)	Work duration per set (min)	Work intensity (HRmax)
Krustrup et al. [30]	12	2–3	2.3	27.6	5 vs. 5 to 6 vs. 6 to 7 vs. 7	40 ′ 60 m	3–4	ND	ND	60	ND	82 ± 2%
Knoepfli-Lenzin et al. [31]	12	3	2.4 ± 0.2	ND	3 vs. 3 to 4 vs. 4 and 5 vs. 5	ND	1	ND	ND	60	50	79.9 ± 4.5%
Krustrup et al. [32]	16	2	1.80	28.8	5 vs. 5 to 7 vs. 7 to 9 vs. 9	30–40 ′ 45–60 m	First 6 weeks: 4 After 6 weeks: 2	First 6 weeks: 2 After 6 weeks: 3	ND	60	First 6 weeks: 12 After 6 weeks: 25	83 ± 0%
Krustrup et al. [33]	16	2	1.78	121 ± 9	4 vs. 4 to 5 vs. 5	20–30 ′ 30–40 m	ND	ND	ND	60	ND	First 4 months: 82 ± 2% Next 12 months: 81 ± 1%
Randers et al. [45]	64	2	First 12 weeks: 2.4 Next 52 weeks: 1.3	First 12 weeks: 28.5 Next 52 weeks: 66.7	4 vs. 4 to 5 vs. 5	25–40 ′ 30–50 m	ND	ND	ND	60	ND	First 12 weeks: 81 ± 3% Next 52 weeks: 82 ± 2%
Randers et al. [46]	12	3	2.8 ± 0.8	32 ± 9	4 vs. 4	22-m asphalt pitch	ND	ND	ND	60	ND	82 ± 4%
Gray et al. [47]	52	2	12	ND	ND	ND	ND	ND	ND	90	ND	ND
Krustrup et al. [48]	24	2	1.7 + 0.5	43 + 13	5 vs. 5 to 6 vs. 6 to 7 vs. 7	30–45 ′ 45–60 m	4	2	ND	60	12	85 ± 7%
Andersen et al. [49]	24	2	1.5	37.6	4 vs. 4 to 5 vs. 5 to 6 vs. 6	20 ′ 40 m	5	2	ND	60	10	83 ± 2%

Study												
Barene et al. [34]	12	2–3	2.4 ± 0.5	28.6 ± 6.3	3 vs. 3 to 4 vs. 4 and 5 vs. 5 to 6 vs. 6 to 7 vs. 7	10 × 20 m and 20 × 40 m	ND	ND	ND	60	ND	78.3 ± 4.4%
Barene et al. [35]	40	2–3	55.4 ± 8.8	–	3 vs. 3 to 4 vs. 4	10 × 20 m	2	5	–	50	25	78.6 ± 3.2%
Connolly et al. [36]	16	2	ND	ND	2 vs. 2, 3 vs. 3, or 4 vs. 4	15 ´ 25 m and 20 ´ 40 m	1	ND	ND	15	15	85 ± 5%
De Sousa et al. [50]	12	3	ND	36	3 vs. 3 to 7 vs. 7	ND	2	3	ND	40	12	Above 70%
Mohr et al. [51]	15	3	3.0 ± 0.1	ND	4 vs. 4 to 10 vs. 10	ND	ND	ND	ND	60	ND	80.5 ± 1.1% and 98.9 ± 1.4%
Uth et al. [52]	12	2–3	ND	28	5 vs. 5 to 7 vs. 7	ND	2–3	ND	ND	60	15	84.6%
Andersen et al. [38]	52	2–3	1.7 ± 0.3	ND	3 vs. 3 to 4 vs. 4 to 5 vs. 5	30–45 ´ 45–60 m	3–4	2	ND	60	15	ND
Krustrup et al. [53]	52	4	2.5 ± 0.4	128 ± 29	4 vs. 4 to 8 vs. 8	ND	4	ND	ND	60	12	86.1 ± 5.9%
Uth et al. [54]	32	2–3	0.9–1.6	ND	ND	ND	2–3	ND	ND	45–60	15	ND
Reddy et al. [43]	12	1	ND	ND	5 vs. 5	ND	1	ND	ND	60	45–50	76%
Hunt et al. [55]	52	2	12	ND	ND	ND	ND	ND	ND	90	ND	ND
Aslan et al. [19]	8	1	ND	ND	ND	30 ´ 50 m	ND	ND	ND	60	ND	80.6 ± 4.3%
Ortiz et al. [37]	8	3	3	ND	7 vs. 7 or 8 vs. 8	55 ´ 40 m	ND	ND	ND	50	ND	86.9%

ND – not described, HRmax – maximal heart rate

Table 4. Characteristics of control groups

Study	Active control	Passive control
Krustrup et al. [30]	Participants completed 3–4 sets within 1 hour of running, 2 or 3 times per week for 12 weeks, with an average intensity of 82% HRmax	Continued daily life activities
Knoepfli-Lenzin et al. [31]	Running group completed a 1-hour training session 2.5 times per week for 12 weeks. The mean training intensity was 79.4 ± 1.3%	Maintained their sedentary lifestyle
Krustrup et al. [32]	Running group performed 5 min of low-intensity warm-up (walking and jogging), followed by four 12-min sessions consisting of moderate-intensity continuous running (80–84% of their HRmax), twice a week for 16 weeks. After the 6 weeks, all runners were able to run for 55 min continuously	Performed no physical training, only measurements were made (before and after 16 weeks)
Krustrup et al. [33]	One hour of running 2 times a week for 16 months. The running speed was individually adjusted to elicit 81% HRmax during the first 4 weeks, and 82% in the last 12 months	Performed no physical training, continued their usual daily life activities
Randers et al. [45]	–	Instructed to remain physically inactive over the first 12 weeks. No restrictions were applied during the last 52-week period
Randers et al. [46]	–	Continued their normal routines
Gray et al. [47]	–	No details were given. Only, the comparison group received the Football Fans in Training program 4 months after the intervention group
Krustrup et al. [48]	–	Doctor's advice group received traditional physician-guided recommendations (favourable effects of healthy lifestyle, recommended physical activity, nutrition) on cardiovascular risk factor modification
Andersen et al. [49]	–	Inactive; no details
Barene et al. [34]	Zumba group: continuous dance movements to Latin music with varying intensity, 2–3 sessions (1 hour) per week for 12 weeks. Average heart rate during training was 136 ± 17 bpm or 75.3 ± 7.1% HRmax	No details; only measurements were made
Barene et al. [35]	Zumba group: continuous dance movement (1 hour) using Latin music with varying intensity, twice a week throughout the 40 weeks. The average heart rate during the 1-hour training sessions was 136 ± 17, which corresponds to 74.9 ± 7.2% HRmax	Only measurements were made; no intervention was applied

Connolly et al. [36]	Vibration group performed 15-min training sessions (7 exercises) with average heart rates of 90 bpm, twice per a week for 16 weeks. The protocol consisted of a 3-min warm-up at a frequency of 6 Hz with an amplitude of 2 mm. Each 1-min bout was followed by 1 min of recovery. The frequency and amplitude were increased in certain weeks	Continued their normal daily lives
De Sousa et al. [50]	–	Diet group: received dietary counselling for weight reduction, 500–1000 kcal of energy intake per day. The prescribed diet was balanced and rich in fibre (minimum of 20 g/day). The diet consisted of 45–60% carbohydrate, 15–20% protein, and 20–30% fat
Mohr et al. [51]	–	Inactive: had no training or lifestyle changes during the 15-week period
Uth et al. [52]	–	Encouraged to maintain their baseline physical activity level
Andersen et al. [38]	Resistance training: 5-min low-intensity warm-up, followed by leg press, seated leg extension, hamstring curl, pull-down, and lateral dumbbell raises. Sets were interspaced by 1.5-min rest, and at the end of the session, 5-min core training was made. Exercise progressed: 3 × 16–20RM (weeks 0–4), 3 × 12RM (weeks 5–8), 3 × 10RM (weeks 9–12), and 4 × 8RM (weeks 13–52)	Inactive; no details
Krustrup et al. [53]	–	Inactive: did not take part in physical training and were encouraged not to implement lifestyle changes during the 1-year period
Uth et al. [54]	–	Encouraged to maintain their habitual level of physical activity
Reddy et al. [43]	–	No details
Hunt et al. [55]	–	No details were given. Only, comparison group put on a 12-month waiting list, the Football Fans in Training program applied after the 12 months
Aslan et al. [19]	–	Continued their routine daily lives
Ortiz et al. [37]	Running group: 50 min 3 times a week for 8 weeks (5 ´ 5 min at an intensity corresponding to onset of blood lactate accumulation) (85.7%), with passive recovery periods of 1 min for 2 days. For one day, they practised continuously for 50 min at the intensity corresponding to lactate threshold (67.3–70.5%). The average heart rate during the training period: 82.2% HRmax	–

HRmax – maximal heart rate, RM – repetition maximum

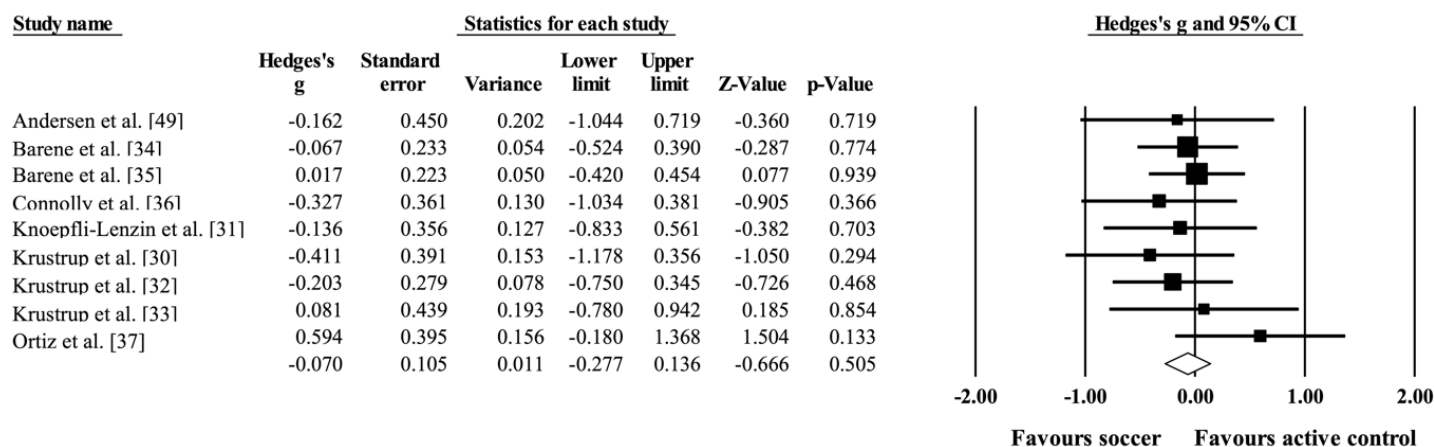| Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Andersen et al. [49]	-0.162	0.450	0.202	-1.044	0.719	-0.360	0.719
Barene et al. [34]	-0.067	0.233	0.054	-0.524	0.390	-0.287	0.774
Barene et al. [35]	0.017	0.223	0.050	-0.420	0.454	0.077	0.939
Connolly et al. [36]	-0.327	0.361	0.130	-1.034	0.381	-0.905	0.366
Knoepfli-Lenzin et al. [31]	-0.136	0.356	0.127	-0.833	0.561	-0.382	0.703
Krustrup et al. [30]	-0.411	0.391	0.153	-1.178	0.356	-1.050	0.294
Krustrup et al. [32]	-0.203	0.279	0.078	-0.750	0.345	-0.726	0.468
Krustrup et al. [33]	0.081	0.439	0.193	-0.780	0.942	0.185	0.854
Ortiz et al. [37]	0.594	0.395	0.156	-0.180	1.368	1.504	0.133
	-0.070	0.105	0.011	-0.277	0.136	-0.666	0.505

Figure 2. Changes (reduction) in fat mass after soccer training compared with active controls.
Values shown are effect sizes (Hedges' *g*) with 95% confidence intervals (CI). The size of the plotted squares reflects the statistical relative weight of the study. The white diamond reflects the overall result
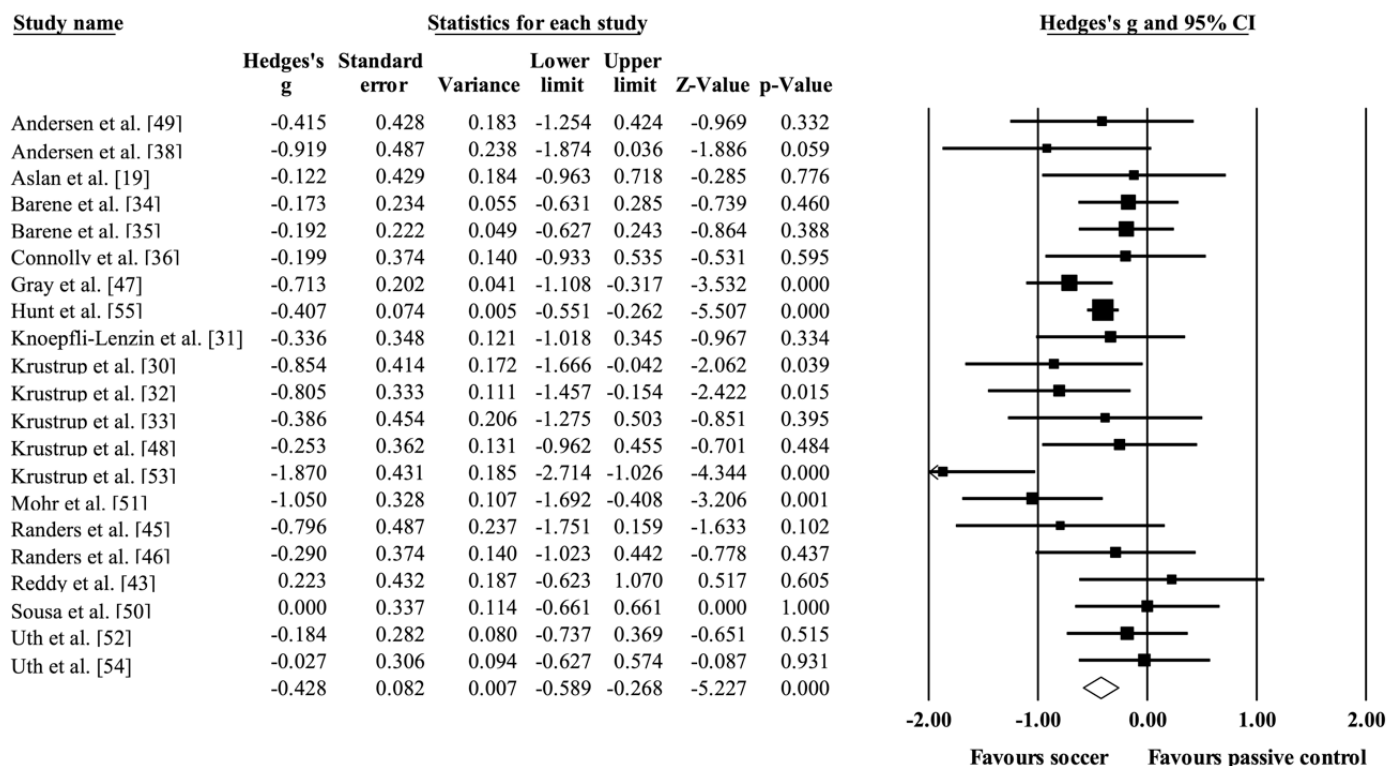
Study name	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Andersen et al. [49]	-0.415	0.428	0.183	-1.254	0.424	-0.969	0.332
Andersen et al. [38]	-0.919	0.487	0.238	-1.874	0.036	-1.886	0.059
Aslan et al. [19]	-0.122	0.429	0.184	-0.963	0.718	-0.285	0.776
Barene et al. [34]	-0.173	0.234	0.055	-0.631	0.285	-0.739	0.460
Barene et al. [35]	-0.192	0.222	0.049	-0.627	0.243	-0.864	0.388
Connolly et al. [36]	-0.199	0.374	0.140	-0.933	0.535	-0.531	0.595
Gray et al. [47]	-0.713	0.202	0.041	-1.108	-0.317	-3.532	0.000
Hunt et al. [55]	-0.407	0.074	0.005	-0.551	-0.262	-5.507	0.000
Knoepfli-Lenzin et al. [31]	-0.336	0.348	0.121	-1.018	0.345	-0.967	0.334
Krustrup et al. [30]	-0.854	0.414	0.172	-1.666	-0.042	-2.062	0.039
Krustrup et al. [32]	-0.805	0.333	0.111	-1.457	-0.154	-2.422	0.015
Krustrup et al. [33]	-0.386	0.454	0.206	-1.275	0.503	-0.851	0.395
Krustrup et al. [48]	-0.253	0.362	0.131	-0.962	0.455	-0.701	0.484
Krustrup et al. [53]	-1.870	0.431	0.185	-2.714	-1.026	-4.344	0.000
Mohr et al. [51]	-1.050	0.328	0.107	-1.692	-0.408	-3.206	0.001
Randers et al. [45]	-0.796	0.487	0.237	-1.751	0.159	-1.633	0.102
Randers et al. [46]	-0.290	0.374	0.140	-1.023	0.442	-0.778	0.437
Reddy et al. [43]	0.223	0.432	0.187	-0.623	1.070	0.517	0.605
Sousa et al. [50]	0.000	0.337	0.114	-0.661	0.661	0.000	1.000
Uth et al. [52]	-0.184	0.282	0.080	-0.737	0.369	-0.651	0.515
Uth et al. [54]	-0.027	0.306	0.094	-0.627	0.574	-0.087	0.931
	-0.428	0.082	0.007	-0.589	-0.268	-5.227	0.000

Figure 3. Changes (reduction) in fat mass after soccer training compared with passive controls.
Values shown are effect sizes (Hedges' *g*) with 95% confidence intervals (CI). The size of the plotted squares reflects the statistical relative weight of the study. The white diamond reflects the overall result

Table 6. Summary of the included studies and results of fat mass before and after intervention

Study	Group	Population	Sex	n	Before (mean ± SD)	After (mean ± SD)	After – before (Δ%)
Krustrup et al. [30]	SG	H	M	13	19.9 ± 2.4	17.2 ± 2.1	–13.5
Knoepfli-Lenzin et al. [31]	SG	C	M	15	29.2 ± 4.3	27.2 ± 4.3	–6.8
Krustrup et al. [32]	SG	H	W	25	35.8 ± 1.2	33.8 ± 1.3	–5.5
Krustrup et al. [33]	SG	H	W	9	34.4 ± 1.8	32.7 ± 1.9	–4.9
Randers et al. [45]	SG	H	M	10	23.6 ± 2.6	19.8 ± 2.5	–16.1
Randers et al. [46]	SG	Homeless	M	22	14.1 ± 7.1	12.4 ± 6.5	–12.0
Gray et al. [47]	SG	C	M	51	30.8 ± 3.8	29.4 ± 4.0	–4.5
Krustrup et al. [48]	SG	C	M	22	30.7 ± 4.9	28.5 ± 4.2	–7.1
Andersen et al. [49]	SG	C	M	12	29.5 ± 2.0	27.8 ± 2.0	–5.7
Barene et al. [34]	SG	ND	W	37	34.7 ± 6.1	33.6 ± 6.2	–3.1
Barene et al. [35]	SG	ND	W	41	34.7 ± 6.1	33.5 ± 6.0	–3.4
Connolly et al. [36]	SG	H	W	13	37.4 ± 6.9	35.7 ± 6.2	–4.5
De Sousa et al. [50]	SG	C	M/W	19	34.6 ± 1.6	32.2 ± 1.5	–6.9
Mohr et al. [51]	SG	C	W	21	36.6 ± 2.0	34.3 ± 2.0	–6.2
Uth et al. [52]	SG	C	M	23	32.6 ± 5.8	31.7 ± 5.6	–2.7
Andersen et al. [38]	SG	H	M	9	27.2 ± 2.3	25.6 ± 2.4	–5.8
Krustrup et al. [53]	SG	C	W	19	35.8 ± 2.2	32.2 ± 2.0	–10.5
Uth et al. [54]	SG	C	M	21	26.8 ± 7.8	26.5 ± 8.4	–1.1
Reddy et al. [43]	SG	ND	M/W	11	27.1 ± 7.3	30.9 ± 19.6	14.0
Hunt et al. [55]	SG	C	M	374	31.8 ± 5.7	29.6 ± 5.6	–6.9
Aslan et al. [19]	SG	H	M	10	13.2 ± 2.1	12.7 ± 2.3	–3.7
Ortiz et al. [37]	SG	H	W	17	27.2 ± 4.4	27.4 ± 4.5	0.7
Krustrup et al. [30]	AC	H	M	12	20.7 ± 2.7	19.0 ± 2.6	–8.2
Knoepfli-Lenzin et al. [31]	AC	C	M	15	29.7 ± 4.1	28.3 ± 4.3	–4.7
Krustrup et al. [32]	AC	H	W	25	32.6 ± 1.7	30.9 ± 1.6	–5.2
Krustrup et al. [33]	AC	H	W	10	34.9 ± 2.4	33.0 ± 2.7	–5.4
Barene et al. [34]	AC	ND	W	35	36.0 ± 5.8	35.3 ± 5.6	–1.9
Barene et al. [35]	AC	ND	W	38	36.0 ± 5.8	34.7 ± 5.5	–3.6
Connolly et al. [36]	AC	H	W	17	38.9 ± 6.9	39.3 ± 6.3	1.0
Ortiz et al. [37]	AC	H	W	10	27.1 ± 4.3	24.5 ± 4.7	–9.5
Andersen et al. [38]	AC	H	M	9	29.4 ± 2.3	28.2 ± 2.3	–4.0
Krustrup et al. [30]	PC	H	M	11	19.6 ± 3.3	19.3 ± 3.3	–1.5
Knoepfli-Lenzin et al. [31]	PC	C	M	17	29.7 ± 7.1	29.8 ± 7.3	0.3
Krustrup et al. [32]	PC	H	W	15	28.8 ± 1.6	28.0 ± 1.7	–2.7
Krustrup et al. [33]	PC	H	W	9	29.4 ± 2.7	28.6 ± 2.5	–2.7
Randers et al. [45]	PC	H	M	7	24.4 ± 4.3	23.8 ± 5.2	–2.4
Randers et al. [46]	PC	Homeless	M	10	17.4 ± 8.8	18.0 ± 10.0	3.4
Gray et al. [47]	PC	C	M	52	30.7 ± 5.4	32.8 ± 5.6	6.8
Krustrup et al. [48]	PC	C	M	11	30.9 ± 7.0	29.9 ± 5.4	–3.2
Andersen et al. [49]	PC	C	M	9	31.0 ± 5.3	30.9 ± 5.2	–0.3
Barene et al. [34]	PC	ND	W	35	36.3 ± 6.4	36.3 ± 6.4	0.0
Barene et al. [35]	PC	ND	W	39	36.3 ± 6.4	36.3 ± 6.4	0.0
Connolly et al. [36]	PC	H	W	14	35.4 ± 8.2	35.2 ± 8.2	–0.5
De Sousa et al. [50]	PC	C	M/W	15	37.5 ± 1.8	35.1 ± 1.8	–6.4
Mohr et al. [51]	PC	C	W	20	33.0 ± 1.6	32.6 ± 1.5	–1.2
Uth et al. [52]	PC	C	M	26	32.9 ± 5.2	32.9 ± 4.0	0.0
Andersen et al. [38]	PC	H	M	8	29.4 ± 1.8	29.8 ± 1.6	1.3
Krustrup et al. [53]	PC	C	W	12	30.4 ± 2.0	30.5 ± 1.8	0.1
Uth et al. [54]	PC	C	M	20	30.2 ± 6.0	30.1 ± 6.1	–0.3
Reddy et al. [43]	PC	ND	M/W	9	31.1 ± 5.7	31.3 ± 7.5	0.6
Hunt et al. [55]	PC	C	M	373	31.5 ± 5.2	31.5 ± 5.2	0.0
Aslan et al. [19]	PC	H	M	10	12.7 ± 2.3	12.5 ± 2.4	–1.57

Δ% – percentage changes representing the mean differences (after – before), SG – soccer group, AC – active control,
PC – passive control, H – healthy, C – clinical, ND – not described, W – women, M – men

Regarding interventions with males (12 study groups; $ES = -0.42$; 95% CI: -0.54 to -0.30; $p < 0.001$; within-group $I^2 = 0.0\%$) and those with females (7 study groups; $ES = -0.62$; 95% CI: -1.04 to -0.20; $p = 0.004$; within-group $I^2 = 67.4\%$), both sex groups achieved a significant (and similar, i.e., $p = 0.362$ between sexes) reduction of fat mass after soccer training compared with passive controls.

Regarding interventions with healthy participants (7 study groups; $ES = -0.58$; 95% CI: -0.88 to -0.27; $p < 0.001$; within-group $I^2 = 0.0\%$) and those with a clinical condition (10 study groups; $ES = -0.49$; 95% CI: -0.74 to -0.22; $p < 0.001$; within-group $I^2 = 57.6\%$), both groups achieved a significant (and similar, i.e., $p = 0.662$ between groups) reduction of fat mass after soccer training compared with passive controls.

Discussion

This systematic review with meta-analysis aimed to analyse the effects of recreational soccer on fat mass in untrained sedentary adults. A meta-analysis for control groups was conducted. The results showed that fat mass was significantly reduced after recreational soccer interventions compared with passive control groups. However, there were no significant differences in fat mass reduction between recreational soccer and active control groups.

Recreational soccer vs. active control groups

Regarding the included recreational soccer and other exercise activities (active controls) interventions, both groups demonstrated similar effects in fat mass reduction, without significant differences between them. The lack of differences between both groups in fat mass changes suggests that participation in different physical exercise interventions produces similar body fat mass changes. From the 9 included studies that used active control groups, 8 [30–37] involved continuous aerobic activities, such as continuous running or Zumba. Only 1 study [38] implemented resistance training, which has a more intermittent nature. Given that, these findings corroborate the potential of continuous and intermittent exercise interventions to induce significant improvements in general health [8, 13]. Although the overall result, shown in Figure 2, reveals a lack of differences between the groups, the studies together tend to favour the recreational soccer interventions. Indeed, this tendency was previously reported for intermittent and continuous physical activities [13].

Furthermore, both males and females exhibited similar, not significantly different reductions in fat mass after recreational soccer interventions compared with the active groups. The lack of significant differences between recreational soccer and active groups in fat mass changes after the training interventions may be due to the more controlled exercise intensity in the active groups, as the studies involved continuous running and individualized the running intensity. In fact, Krustrup et al. [33] adjusted all training sessions intensity to 81% and 82% of maximal heart rate measure to maintain a consistent intensity during 16 months. Also, given the high intensity of soccer displacements, it may be possible that participating in only 2–3 sessions per week produces physiological adaptations similar to those with aerobic continuous stimulus in just 8 weeks of practice [37].

However, the recreational soccer groups are expected to present more intra- and inter-subject variations in exercise intensity during the interventions [39]. Given that, it seems that a more longitudinal recreational soccer approach (i.e., more than 12 weeks of practice) is required to produce greater changes (reduction) in fat mass [32]. Despite the similarities of fat mass changes between the groups, recreational soccer interventions have the advantage of being more enjoyable and less monotonous [17, 40]. Indeed, untrained populations would benefit from the regular practice of a recreational team sport as their maintenance in such interventions is more effective than in endurance interventions. This maintenance is usually related to the psychosocial development and community integration [41].

Recreational soccer vs. passive control groups

There were significant differences in fat mass changes between recreational soccer and passive control groups, independently of sex and population (healthy or with clinical conditions). Indeed, extensive literature exists regarding positive effects that participation in regular physical exercise has on sedentary population's general health [42]. However, to the best of our knowledge, there is no systematic review with meta-analysis focused on the influence of recreational soccer on fat mass changes over time. The findings of the present study suggest the effectiveness of regular participation in recreational soccer to significantly reduce the fat mass of untrained sedentary populations.

In fact, the included studies generally showed significant reductions in fat mass after a period of the recreational soccer intervention. In contrast, one study

reported increases in fat mass after 12 weeks of recreational soccer intervention [43]. However, in that study, the authors used a 'walking football' 5 vs. 5 SSG only once a week, and they affirmed that their study revealed a lack of positive impact on fitness and body composition. This corroborates the need to implement more regular sessions per week, with activities of a higher intensity than walking [20]. Interestingly, a relatively recent systematic review of systematic reviews that analysed the relationships between physical activity and health status demonstrated that it was not 'evidence-based' to recommend a given threshold of weekly physical activity volume [42]. The authors of the above-mentioned systematic review of systematic reviews based that statement on the fact that minimal physical activity (very low weekly volume) produced relative risk reductions and, consequently, positive health adaptations in untrained sedentary individuals [42].

Despite that, sedentary populations seem to benefit from more regular participation in weekly physical activities, aiming to produce more than minimal positive general health and fitness adaptations over time [15]. In fact, a study conducted among 114 healthy individuals revealed that although weekly volumes of physical exercise below the international recommendations produced minimal health benefits, larger volumes presented greater improvements in body composition, aerobic capacity, and musculoskeletal system [44].

Limitations, future research, and practical implications

The studies included in the present systematic review with meta-analysis involved some limitations. Primarily, the limitations were as follows: (i) limited sample sizes of the overall studies; (ii) lower number of studies with active control groups; (iii) the use of different SSG protocols (different pitch dimensions and numbers of players), with no distinction between them regarding the effects of fat mass changes; (iv) not focusing on fat mass changes; and (v) the use of different activities in active control groups. Future studies should focus on the effects of longitudinal and more consistent recreational soccer interventions on body composition parameters. Also, analysing the differences between SSG protocols (e.g., 3v3, 5v5, or 7v7) in terms of fat mass changes would be interesting.

Despite the limitations of the included studies, the present systematic review with meta-analysis revealed some practical implications. A main one refers to the implementation of recreational soccer as an effective way to reduce fat mass in untrained sedentary individuals. The lack of differences between recreational soccer and other traditional/analytical aerobic continuous interventions is of great importance in clinical practice as individuals who have a preference for practising team sports can expect similar effective reductions of fat mass. Also, these reductions occur independently of sex and clinical condition, which reinforces the benefits of regular participation in recreational soccer in cases of individuals with mild-to-moderate hypertension, type 2 diabetes mellitus, prostate cancer, and overweight or obesity. Furthermore, the practice of recreational soccer presents the advantage of being a more enjoyable, fun, and motivational intervention than traditional aerobic continuous training.

Conclusions

This systematic review and meta-analysis investigated the effects of recreational soccer on fat mass changes in untrained sedentary adults compared with active and passive controls. There were no significant differences between recreational soccer and active control groups in fat mass changes after the training interventions. However, fat mass was significantly reduced after recreational soccer interventions compared with passive control groups. This systematic review with meta-analysis highlights the benefits and greater pertinence of regular participation in recreational soccer to reduce fat mass and increase the motivation to be active when compared with other traditional training interventions, such as continuous running.

Disclosure statement
No author has any financial interest or received any financial benefit from this research.

Conflict of interest
The authors state no conflict of interest.

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