Recreational football is medicine against non-communicable diseases: A systematic review

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The purpose of this research was to conduct a systematic review of published articles related to the effect of recreational football on non-communicable diseases.

A systematic review of Web of Science, SPORTDiscus, MEDLINE, and PubMed databases was performed according to PRISMA guidelines. Only empirical studies were included. There were no restrictions on the types of study design eligible for inclusion. The primary outcome measures result from the potential effects of recreational football on non-communicable diseases (e.g., blood pressure, bone density, LDL cholesterol, and fat mass).

A total of 44 articles met the inclusion criteria and were included. Recreational football is shown to: (a) decrease blood pressure and resting heart rate, improve cardiac structure and function, as well as increase maximal oxygen uptake in both sexes; (b) reduce cholesterol and triglycerides levels, increase insulin sensitivity, and have a positive impact on glycemic control; (c) improve bone mineralization, increase both bone mineral density and content, as well as acting as a stimulus for osteogenesis; and (d) be clearly beneficial for bone health, while slightly beneficial for body composition, muscle strength, and maximal oxygen uptake in adults with prostate cancer.

The present systematic review demonstrated the benefits of recreational football practice on non-communicable diseases related to cardiovascular and bone health, body composition, type 2 diabetes, and prostate cancer. The effectiveness of recreational football on the aforementioned diseases may be related to age and gender; however, further research is required.

KEYWORDS
blood pressure, body composition, bone, cancer, health promotion, Recreational soccer, T2DM, training
1 | INTRODUCTION

Non-communicable diseases (NCDs), also known as chronic diseases, tend to be of long duration and are the result of a combination of diverse factors (eg, genetic, physiological, environmental, and behavioral). NCDs kill 41 million people each year (71% of all deaths globally). Of these people, 15 million are between the ages of 30 and 70 years old.1 Cardiovascular diseases account for most NCD deaths (17.9 million people per year), followed by cancers (9.0 million), respiratory diseases (3.9 million), and diabetes (1.6 million).2

Physical inactivity has been identified as the fourth leading risk factor for global mortality, contributing to 6% of deaths worldwide.3 In turn, overweight and obesity are responsible for 5% of global mortality, followed by high blood glucose (6%), tobacco use (9%), and high blood pressure (13%).3 Elimination of physical inactivity could reduce 6% and 10% of the major NCDs, that is, coronary heart disease, type 2 diabetes mellitus (T2DM), and breast and colon cancers, subsequently increasing life expectancy.4 In this context, the urgent need to create and develop intervention programs that are effective in promoting active lifestyles has been emphasized by different entities (eg, WHO and UNESCO). As one of the most popular and most widely played sports in the world, football can have an important role in promoting active lifestyles.

The use of randomized controlled trials (RCTs) to investigate recreational football (RF) as a strategy to improve health and well-being has increased exponentially in the last decade. Moreover, several special issues, systematic reviews, and meta-analyses have confirmed that RF is an adequate exercise intervention for health promotion5,6 including women's fitness and health adaptations and mechanisms.7,8 as well as for disease prevention and treatment in untrained men.9 Additionally, RF effectively improves cardiorespiratory fitness10,11 and produces broad-spectrum physical fitness benefits which are all related to NCDs. Based on the aforementioned comprehensive research, FIFA (the Fédération Internationale de Football Association) introduced the slogan “Playing football for 45 minutes twice a week - best prevention of NCDs.” However, conclusions are based on RCTs which have separately investigated the effects of RF on the most common NCDs such as cardiovascular disease, type 2 diabetes, obesity, osteoporosis, and cancer. Therefore, an overall conclusion based on the use of RF in the prevention and treatment of NCDs, based on a systematic literature review, remains elusive.

It is important that the currently available evidence be identified and appraised, so that interventions on RF that are effective in managing NCDs may be identified and put into practice. The purpose of this systematic review was to systematically review the results of the published scientific papers concerning the effects of RF on NCDs.

2 | METHODS

2.1 | Protocol and registration

This systematic review protocol was registered at the International Prospective Register of Systematic Reviews (PROSPERO) under number CRD42018107448.

2.2 | Search strategy: databases and inclusion criteria

A systematic review of the available literature was conducted according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines.12

The electronic databases Web of Science, SPORTDiscus, MEDLINE, and PubMed were searched for relevant publications prior to 31 August 2018 by using the keywords “football” OR “soccer” each one associated with the terms: “disease*” OR “cancer” OR “cardiovascular” OR “blood pressure” OR “hypertension” OR “overweight” OR “obesity” OR “tobacco” OR “smoking” OR “diabetes” OR “insulin” OR “cholesterol” OR “hyperglycemia” OR “hyperlipidemia” OR “dyslipidemia” OR “triglycerides” OR “osteoporosis” OR “bone health” OR “bone density” OR “chronic respiratory” OR “pulmonary disease” OR “asthma” OR “kidney disease” OR “prostatic hyperplasia” OR “renal failure” OR “kidney failure”. The publications included in the first search round met the following criteria: (a) contained relevant data concerning NCDs; (b) were performed on RF male/female participants (all ages); and (c) were written in the English Language. Studies were excluded if they: (a) were performed in the context of competitive football and (b) did not contain any relevant data about RF and NCDs.

Two reviewers (HS and FC) independently screened citations and abstracts to identify articles potentially meeting the inclusion criteria. For those articles, full-text versions were retrieved and independently screened by those reviewers, to determine whether they met inclusion criteria. Any disagreement regarding study eligibility was resolved by consensus including a third reviewer (ZM).

2.3 | Quality of the studies and extraction of data

The overall methodological quality of the studies was assessed by two independent reviewers using the Physiotherapy Evidence Database (PEDro) scale. Agreement between reviewers was assessed using k statistics (k = 0.96) for full-text screening and rating of relevance and risk of bias. In the event of disagreement about the risk of bias, the third reviewer checked the data and took the final decision on it.
A data extraction sheet (from Cochrane Consumers and Communication Review Group’s data extraction template) was adapted to this review’s study inclusion requirements and then tested on ten randomly selected studies (pilot test). One author extracted the data, and another verified it.

3 | RESULTS
3.1 | Search, selection, and inclusion of publications

The initial search identified 1537 titles in the aforementioned databases, and an additional 17 papers were selected on the basis of their references. These data were then exported to reference manager software (EndNote™ X8, Clarivate Analytics). Any duplicates (1147 references) were eliminated either automatically or manually. The remaining 407 articles were then screened for relevance based on their title and abstract, resulting in 317 studies being eliminated from the database. The full text of the remaining 90 articles was examined in more detail; 46 were rejected because they did not meet the inclusion criteria. At the end of the screening procedure, 44 articles were selected for in-depth reading and analysis (Figure 1). The main factor for study exclusion (n = 18) was their lack of relevance to the research topic of this review. Other studies were excluded because they contained data from other sports (n = 13) or were developed in the context of competitive football.

3.2 | General description of the studies

In this review, we grouped the studies according to the most common NCDs, namely: (a) cardiovascular health; (b) type 2 diabetes; (c) overweight/obesity; (d) cancer; and (e) osteoporosis (Figure 2). Nevertheless, some papers included topics that studied multiple NCDs and other health-related measures. Thus, an article included in a specific “disease” could also be classified in another “disease” whenever its content justified it.14-16

3.2.1 | Cardiovascular health

Recreational football interventions have been conducted to analyze the effects of regular exercise in the management of some markers associated with cardiovascular diseases or cardiovascular risk (Table 1). RF was commonly based on small-sided games played for 1 hour twice or three times a week, depending on the studies’ design.

The unique pathology used as inclusion criterion during RCT was mild-to-moderate hypertension (n = 4).17-20 The majority of the studies were conducted in adult untrained participants (n = 14); however, there were studies conducted on youth (<18 years old) (n = 3) and elderly (>65 years old) (n = 3) populations. Men (n = 12), women (n = 6), and both studied at the same time (n = 2) were analyzed across the studies.

The majority of the studies were conducted as RCT (n = 16); however, some of them were cross-sectional (n = 4) and one of the studies was a controlled training study without randomization.21 The period of RCT was between 12 weeks and 1217,24 and 16 months.25 Usually, the RCT compared a football intervention against a passive control group (n = 8). However, some studies also compared football against running-based intervention (n = 6) or strength training (n = 2).

The variables more commonly studied during the articles related to cardiovascular health were as follows: (a) arterial blood pressure; (b) systolic and diastolic function (measured by echocardiography); (c) resting heart rate; (d) maximal oxygen uptake; and (e) cholesterol and triglyceride concentrations. However, the reviewed studies tested other variables such as fitness status, body composition, bone health, or blood metabolites such as glucose.

3.2.2 | Type 2 diabetes

In all reviewed studies (Table 2), it was verified that RF has a positive effect against type 2 diabetes.26-29 All studies screened were with adults, and it was clear that football practice lowered cholesterol and triglycerides levels,27,29 increased insulin sensitivity,27,28 and positive impacted on glycemic control.26 Altogether, it seems that RF practice of at least 1-hour duration, twice a week, has the potential to prevent type 2 diabetes and long-term morbidity, and may be used in the treatment of T2DM.

3.2.3 | Overweight/Obesity

Five of the seven articles (all intervention studies), performed in several different countries with sample sizes range from 12 to 742, reported positive associations between football practice and reductions in body mass (Table 3). The two studies that reported no changes in body mass index and percentage of body fat among participants, after 5- and 6-month intervention, were performed with children and adolescents.34,35 A third study with children and adolescents showed that lean body mass (4.3%, ES = 0.40; 95% CI: −0.48, 1.29; P = .382) and muscle mass (4.4%, ES = 0.40; 95% CI: −0.48, 1.29; P = .378) very likely increased in the RF group.33 All the studies with adults and older adults were consistent in showing that at least a 40-week RF intervention significantly reduced body mass index and total body fat mass, and made positive changes to other biomarkers of health risk, lifestyle behaviors, and psychological outcomes.15,30-32
The reviewed studies on RF as part of the treatment on cancer or post-cancer patients (Table 4) only analyzed the effects of football on men with prostate cancer. All of the studies were RCTs comparing RF intervention to the control groups, during periods that ranged from 12 to 32 weeks. The main aim of these studies was to analyze the effects of RF intervention on the androgen deprivation that usually leads to decreases in bone mass. Based on that, bone mineral density was one of the common variables measured across the cancer studies. Other variables such as maximal oxygen uptake, muscle strength, body composition, or postural balance were also analyzed.

### 3.2.4 Cancer

The impact of RF interventions on blood pressure is one of the most researched topics in the literature. Results of short periods of RF intervention (12 to 16 weeks) revealed that, generally, blood pressure decreases more in healthy or mild-to-moderate arterial hypertensive men and women when compared to a control group. Similar evidence can be found in parasympathetic activity as verified by heart rate variability.

### 3.2.5 Osteoporosis

The results from the reviewed studies showed that there is a beneficial relationship between football practice and bone health (Table 5) in children, adolescents, adults, and older adults. Among children and adolescents, a 10-month to 1-year intervention significantly improves bone mineralization, bone mineral content, and bone stiffness. The effect of football on bone health was more pronounced than in other activities such as swimming and cycling. Among adults and older adults, regular football practice twice or three times per week is related to an increase in bone mineral density and bone mineral content. These studies presented consistent results. However, most were performed in Scandinavian countries with a sample size across studies ranged from 22 to 295 participants.

### 4 DISCUSSION

The aim of this paper was to systematically review the results of the published scientific evidence concerning the effects of RF on NCDs. After in-depth analysis, it was decided that the most appropriate way to discuss the results would be to categorize research topics according to the most common NCDs.

#### 4.1 Cardiovascular health

The impact of RF interventions on blood pressure is one of the most researched topics in the literature. Results of short periods of RF intervention (12 to 16 weeks) revealed that, generally, blood pressure decreases more in healthy or mild-to-moderate arterial hypertensive men and women when compared to a control group. Similar evidence can be found in parasympathetic activity as verified by heart rate variability.
<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age—y (mean ± SD)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Observation</th>
<th>Main outcomes measured</th>
<th>Main results</th>
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<tbody>
<tr>
<td>Skoradal, Weihe, Patursson, Mortensen, Connolly, Krustup, Mohr</td>
<td>Male and female</td>
<td>61 ± 6</td>
<td>50</td>
<td>Faroe Island</td>
<td>Randomized controlled trial; 16-wk intervention; football + dietary vs dietary</td>
<td>Participants diagnosed with prediabetes. Participants that took part in regular physical activity were excluded</td>
<td>Blood pressure; maximal oxygen uptake; oral glucose tolerance test; plasma parameters</td>
<td>16 wk of football training combined with dietary advice promoted improvements in metabolic and cardiovascular health compared to dietary advice alone</td>
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<tr>
<td>Krstrup, Skoradal, Randers, Weihe, Uth, Mortensen, Mohr</td>
<td>Female</td>
<td>E. G.—45 ± 6; C. G.—45 ± 4</td>
<td>41</td>
<td>Faroe Island</td>
<td>Randomized controlled trial; 1-y intervention; soccer training group vs inactive control group</td>
<td>Sedentary lifestyle for the last 2 y; mild hypertension; body mass index &gt;25 kg/m²</td>
<td>Blood pressure; body fat; bone mineral content; physical performance; plasma profile</td>
<td>1 y of recreational football training improved the cardiovascular, metabolic, and muscle-skeletal health profile</td>
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<tr>
<td>Hammami, Kasmi, Farinatti, Fgiri, Chamari, Bouhlel</td>
<td>Male</td>
<td>15.8 ± 0.6</td>
<td>12</td>
<td></td>
<td>Randomized counterbalanced design; 2 experiments with 48-72 h of interval; small-sided games group vs repeated-sprint running session</td>
<td>Untrained healthy adolescents were included</td>
<td>Heart rate; blood pressure</td>
<td>Both training interventions resulted in similar exercise intensity without any changes in post-exercise blood pressure. Heart rate value declined after 20-minute interventions was similar between interventions. However, heart rate was lower after small-sided games than repeated sprints at 30 minutes after intervention</td>
</tr>
<tr>
<td>Reddy, Dias, Holland, Campbell, Nagar, Connolly, Krustrup, Hubball</td>
<td>Male and female</td>
<td>E. G.—61.1 ± NS; C. G.—58.3 ± NS</td>
<td>20</td>
<td>England</td>
<td>24-wk intervention; walking football vs control group</td>
<td>Warm-up + 45-50 min/wk for 12 wk; small-sided games</td>
<td>Body composition; blood pressure</td>
<td>Only the measures for blood pressure improved more for players than for controls. This was significant for mean arterial blood pressure</td>
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<tr>
<td>Wegmann, Steffen, Putz, Wurtz, Such, Faude, Bohm, Meyer</td>
<td>Male</td>
<td>47.1 ± 5.1</td>
<td>100</td>
<td>Germany</td>
<td>Cross-sectional study describing the prevalence of cardiovascular risk factors, fitness, and real-life physiological load characteristics of training and competition in veteran football players</td>
<td>&gt; 40 y old; veteran football players</td>
<td>Body composition; electrocardiography; heart rate; blood pressure; cholesterol and blood lipids</td>
<td>Results obtained regarding cardiovascular risk were similar with previous data found in general population. Circulatory strain during veterans’ training and competition was considered high</td>
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<tr>
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<tbody>
<tr>
<td>Schmidt, Andersen, Andersen, Randers, Hornstrup, Hansen, Bangsbo, Krusen</td>
<td>Male</td>
<td>68.1 ± 2.1</td>
<td>54</td>
<td>Denmark</td>
<td>Randomized controlled trial; veteran football players vs untrained elderly health control subjects</td>
<td>-</td>
<td>Body composition; heart rate; blood pressure; maximal oxygen uptake; cholesterol; triglyceride; fasting glucose</td>
<td>Lifelong football training was associated with larger left ventricular end-diastolic volume and better left ventricular systolic function compared with untrained elderly health control subjects. Endothelial function and cardiovascular fitness were better in veteran football players. Body composition was also better (less fat mass) in veteran players</td>
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<tr>
<td>Schmidt, Hansen, Andersen, Andersen, Hornstrup, Krustrup, Bangsbo</td>
<td>Male</td>
<td>Football training group—68.0 ± 4.0</td>
<td>32</td>
<td>Denmark</td>
<td>Randomized controlled trial; 1-y intervention with three groups: football training vs strength training vs control group</td>
<td>Healthy men aged 65-75 y without history of regular exercise</td>
<td>Body composition; heart rate; blood pressure; maximal oxygen uptake; cholesterol; triglyceride</td>
<td>Football training group had significant improvements in cardiac structure, left and right ventricular systolic function, and left ventricular diastolic function, whereas the strength group only improved systolic function. More time also increased the differences between groups. Football training group also reduced resting heart rate and meaningfully improved maximal oxygen uptake. Finally, body composition was also improved in the football group</td>
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<tr>
<td>Randers, Andersen, Petersen, Sundstrup, Jakobsen, Bangsbo, Saltin, Krustrup</td>
<td>Male</td>
<td>Soccer players—69.5 ± 3.7</td>
<td>33</td>
<td>Denmark</td>
<td>Cross-sectional study. Comparison between four groups: soccer players; endurance-trained; strength-trained; and untrained</td>
<td>Incremental cycle test (minutes); maximal oxygen uptake; resting heart rate; blood pressure; body composition; muscle capillaries and muscle fiber type; muscle glycogen; fasting blood glucose</td>
<td>Football players had more muscle capillaries per fiber than strength-trained and untrained participants. Moreover, football players also had meaningful lower values of resting heart rate than untrained. Football players had also a great exercise capacity, heart rate reserve, and percentage of type IIx fibers than untrained players</td>
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<td>Mohr, Lindenskov, Holm, Nielsen, Mortensen, Weihe, Krustrup⁴⁷</td>
<td>Female</td>
<td>EG—45 ± 3 CG—43 ± 3</td>
<td>41</td>
<td>Faroe Islands</td>
<td>Randomized controlled trial. 15-wk intervention group (football) and inactive control group</td>
<td>Sedentary and premenopausal women</td>
<td>Body composition; incremental endurance test; heart rate; blood pressure; cholesterol; triglyceride concentration</td>
<td>After 15 wk, recreational football led to decreases in fat mass, blood pressure, total cholesterol, and triglyceride and increased more endurance capacity compared to the inactive control group</td>
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<td>Andersen, Randers, Hansen, Hornstrup, Schmidt, Dvorak, Sogaard, Krustrup, Bangsbo⁴⁸</td>
<td>Male</td>
<td>EG—45.8 ± 7.2 CG—46.9 ± 7.6</td>
<td>31</td>
<td>Denmark</td>
<td>Randomized controlled trial. 6-mo football training intervention vs control group</td>
<td>Untrained males diagnosed with mild-to-moderate arterial hypertension</td>
<td>Blood pressure; submaximal exercise test; echocardiography; tissue Doppler imaging</td>
<td>6 mo of football training elicited improvements in cardiac structure and function. Moreover, decreases in blood pressure were found</td>
</tr>
<tr>
<td>Randers, Andersen, Omtoft, Bendiksen, Johansen, Horton, Hansen, Krustrup⁴⁶</td>
<td>Female</td>
<td>EG—24.4 ± 4.0 CG—27.0 ± 6.5</td>
<td>57</td>
<td>Denmark</td>
<td>Cross-sectional study. Comparison between elite football players and untrained women</td>
<td>16-wk intervention with untrained women</td>
<td>Body composition; heart rate; blood pressure; lipid levels; cardiorespiratory, sprint and intermittent running performance; echocardiography</td>
<td>Cardiac ventricular dimensions and systolic and diastolic functional parameters were better in elite players. It improved maximal oxygen uptake, intermittent running, fat and lean mass, HDL cholesterol, and resting heart rate was also observed in elite players. However, the 16-wk intervention with untrained participants contributed to decrease the differences in cardiac function, systolic and diastolic blood pressures, and fitness performance</td>
</tr>
<tr>
<td>Krustup, Randers, Andersen, Jackman, Bangsbo, Hansen¹⁹</td>
<td>Male</td>
<td>46 ± NS</td>
<td>33</td>
<td>Denmark</td>
<td>Randomized controlled trial. 6-mo football training intervention. Comparison between training intervention and group receiving doctor’s advice on a healthy lifestyle.</td>
<td>Diagnosed with mild-to-moderate hypertension.</td>
<td>Maximal oxygen uptake; blood pressure; incremental test; heart rate; peak lactate; blood glucose; plasma insulin; cholesterol; C-reactive protein.</td>
<td>Football training group improved physical fitness and had better results in the treatment of mild-to-moderate hypertension than traditional physician-guided advice group. Blood pressure decreased after 6 mo of training, while maximal oxygen uptake increased. Resting heart rate also decreased in the football group.</td>
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TABLE 1 (Continued)

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<thead>
<tr>
<th>Study</th>
<th>Gender</th>
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<tbody>
<tr>
<td>Hansen, Andersen, Rebelo, Brito, Hornstrup, Schmidt, Jackman, Mota, Rego, Oliveira, Seabra, Krustup⁵⁰</td>
<td>Male and female</td>
<td>8-12</td>
<td>31</td>
<td>Portuguese</td>
<td>Randomized controlled trial. Two groups (3-mo football group vs control) were compared</td>
<td>Overweight or obese participants</td>
<td>Systolic and diastolic function; peripheral artery function; body composition; blood pressure; heart rate</td>
<td>Football training intervention was associated with changes in left ventricular posterior wall diameter, tricuspid annular plane systolic excursion and global isovolumetric relaxation time, and absence of the increase in systolic blood pressure that was observed in the control group</td>
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</tbody>
</table>
| Randers, Petersen, Andersen, Krustrup, Hornstrup, Nielsen, Nordentoft, Krustrup⁵¹ | Male        | EG—37 ± 10  
CG—43 ± 9 | 55 | Denmark       | Controlled training study. Two groups were compared: 12-wk intervention street-festival football training group, and control group | Not randomized. Homeless men                                                              | Heart rate; activity profile in training and during daily life; maximal oxygen uptake and ventilation; body composition; blood lipoproteins and glucose; incremental cycle ergometer and Yo-Yo intermittent endurance test | Marked effects after 12-wk football intervention were found on the cardiovascular risk profile, increased maximal oxygen uptake, and decreased the fat percentage and LDL cholesterol. Meaningful improvements were also found in endurance and intermittent exercise capacity in the 12-wk football training intervention |
<p>| Randers, Nielsen, Krustrup, Sundstrup, Jakobsen, Nybo, Dvorak, Bangsbo, Krustrup⁵² | Male        | 20-43             | 22 | Denmark       | Randomized controlled trial. Two groups: 64-wk football intervention and control group | Healthy untrained male with no physical training in the last 2 y                       | Body composition; maximal oxygen uptake; heart rate; blood pressure; cholesterol; blood glucose; glyco- gen content; muscle oxidative level; fiber size; lower-limb power; balance; incremental test; sprint | Elevated lean body mass, maximal oxygen uptake, exercise performance, and muscle oxidative level were found in 64 wk of football intervention. Moreover, reduced blood pressure and fat mass were obtained immediately after 12 wk of intervention and maintained during the intervention year. One-year intervention was more beneficial than the first 12 wk in the 30-meter sprint and reduction in blood lactate during submaximal exercise |</p>
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<tr>
<td>Krustrup, Hansen, Randers, Nybo, Martone,</td>
<td>Female</td>
<td>36 ± 2</td>
<td>56</td>
<td>Denmark</td>
<td>Randomized controlled trial. Three groups:</td>
<td>Healthy untrained pre-menopausal women without prior experience of football</td>
<td>Cholesterol; triglycerides; resting blood glucose; fasting plasma insulin; systolic</td>
<td>16 wk of recreational football resulted in reductions in blood pressure, resting heart rate, and fat mass. Moreover, benefits for muscle capillarization and pulse pressure wave and increases in maximal oxygen uptake were found</td>
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<tr>
<td>Andersen, Junge, Bune, Junge, Bangsbo</td>
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<td>16-wk football group, 16-wk running group, and control group</td>
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<td>systolic and diastolic blood pressure; body composition; heart rate</td>
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<td>systolic and diastolic function; heart rate; blood pressure; fasting blood glucose; maximal oxygen uptake; 30-meter sprint; balance; isokinetic strength</td>
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<td>Bone mineral density, left and right ventricular end-diastolic diameter, and right ventricular systolic function were markedly improved after 4 mo of recreational football. Improvements were better than in the running group. Quadriceps peak force in slow and fast concentric and eccentric movements was higher after 16 than 4 mo of recreational football intervention</td>
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<tr>
<td>Knoepfli-Lenzin, Sennhauser, Toigo,</td>
<td>Male</td>
<td>20-45</td>
<td>57</td>
<td>Switzerland</td>
<td>Randomized controlled trial. Three groups:</td>
<td>-</td>
<td>Blood pressure; blood lipids and glucose; maximal oxygen uptake; resting heart rate and variability; body composition</td>
<td>Recreational football decreased diastolic blood pressure, total cholesterol, and fat mass. Improvements in cardiovascular fitness and maximal oxygen consumption were also found after football intervention</td>
</tr>
<tr>
<td>Boutellier, Bangsbo, Krustrup, Junge,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12-wk football group, 12-wk running group, and control group</td>
<td></td>
<td>Blood pressure; blood lipids and glucose; maximal oxygen uptake; resting heart rate and variability; body composition</td>
<td></td>
</tr>
<tr>
<td>Dvorak</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blood pressure; fasting blood samples; DXA scanning; maximal oxygen uptake and peak ventilation; cholesterol; heart rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Blood pressure was reduced after 3 mo of football intervention. Body fat, body mass, and resting heart rate also decreased, while cardiopulmonary capacity increased</td>
<td></td>
</tr>
<tr>
<td>Andersen, Randers, Westh, Martone,</td>
<td>Male</td>
<td>47 ± NS</td>
<td>25</td>
<td>Denmark</td>
<td>Randomized controlled trial. Two groups:</td>
<td>Mild-to-moderate arterial hypertension</td>
<td>Blood pressure; fasting blood samples; DXA scanning; maximal oxygen uptake and peak ventilation; cholesterol; heart rate</td>
<td></td>
</tr>
<tr>
<td>Hansen, Junge, Dvorak, Bangsbo, Krustrup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3-mo football intervention and control group</td>
<td></td>
<td>Blood pressure; fasting blood samples; DXA scanning; maximal oxygen uptake and peak ventilation; cholesterol; heart rate</td>
<td></td>
</tr>
</tbody>
</table>

(Continues)
<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age—y (mean ± SD)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Observation</th>
<th>Main outcomes measured</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andersen, Hansen, Sogaard, Madsen, Bech, Krustrup&lt;sup&gt;51&lt;/sup&gt;</td>
<td>Female</td>
<td>36.5 ± 8.2</td>
<td>47</td>
<td>Denmark</td>
<td>Randomized controlled trial. Three groups: 16-wk football intervention; 16-wk running intervention; and control group</td>
<td>Healthy sedentary women</td>
<td>Maximal oxygen uptake; systolic and diastolic function; cardiac dimensions</td>
<td>Cardiac dimensions and systolic and diastolic left ventricular function increased after the 16-wk intervention. Maximal oxygen uptake also increased 16% after football training intervention</td>
</tr>
<tr>
<td>Krstrup, Nielsen, Krustrup, Christensen, Pedersen, Randers, Aagaard, Petersen, Nybo, Bangsbo&lt;sup&gt;73&lt;/sup&gt;</td>
<td>Male</td>
<td>20-43</td>
<td>36</td>
<td>Denmark</td>
<td>Randomized controlled trial. Three groups: 12-wk football intervention; 12-wk running intervention and control group</td>
<td>Healthy untrained men</td>
<td>Maximal oxygen uptake; heart rate; cholesterol; blood pressure; body composition; muscle capillaries</td>
<td>Blood pressure decreased after 12 wk of the recreational football intervention. Lean body and leg bone mass were greater in recreational football than in the running group. Fat oxidation and reductions in LDL cholesterol were also higher in recreational football than in running</td>
</tr>
<tr>
<td>Castagna, Belardinelli, Impellizzeri, Abt, Coutts, D'Ottavio&lt;sup&gt;73&lt;/sup&gt;</td>
<td>NS</td>
<td>E.G—16.7 ± 1.2, CG—16.9 ± 1.8</td>
<td>31</td>
<td>Italy</td>
<td>Cross-sectional study</td>
<td>High school students</td>
<td>Maximal aerobic power; heart rate; perceived exertion</td>
<td>The 5 vs 5 format of play may be appropriate to enhance cardiovascular fitness in high school students. HRpeak was higher than recommended by ACSM to develop cardiovascular fitness. It was also found that heart rate during intermittent physical activities may have a lower predictive ability of the actual aerobic involvement if compared to continuous exercise</td>
</tr>
</tbody>
</table>

Abbreviations: CG, control group; EG, experimental group; NS, not specified.
and heart rate measurements.\textsuperscript{20,22,23} It is also possible that improvements in the flexibility of the heart and vascular system and a reduced resistance due to higher muscular vascularization may explain the benefits seen by participating in RF.\textsuperscript{23,47}

In the case of short period interventions, results seem to suggest that a short period of RF intervention can lead to meaningful decreases in blood pressure (5-12 mm Hg) in healthy and mild-to-moderate hypertensive men and women.\textsuperscript{20,23,47,49} Longer interventions (one year or more) of RF training were associated with decreases of 5 mm Hg in mean arterial pressure of mild hypertensive women, while no changes were found in a control group.\textsuperscript{17} Furthermore, despite a decrease in the volume of training completed by healthy male participants after an initial 12-week period, decreases in systolic and diastolic blood pressure of 8 and 3 mm Hg, respectively, were still observed.\textsuperscript{48} Resting heart rate seems to be sensitive to RF intervention in short-\textsuperscript{47} and long-term\textsuperscript{19,24} interventions. Similar to blood pressure, resting heart rate seems to be more sensitive to the initial intervention turning stable after a short period (12 to 16 weeks) even in cases of longer interventions.

The effects of RF interventions on cardiac structure and function have been reported.\textsuperscript{18,24,50} Generally, results suggest an increase in the left ventricular posterior wall thickness and diameter.\textsuperscript{50,51} These results are in line with previous studies that combined dynamic and static workloads.\textsuperscript{51} Interestingly, such changes are not as apparent in sedentary participants that participated in regular physical training programs in similar time periods, suggesting that RF is more efficacious based on its specific demands and intermittent movement patterns.\textsuperscript{51}

Increases in left ventricular systolic and diastolic performances were found in RF and running-based interventions with improvements in the peak systolic velocity, respectively.\textsuperscript{51} Differences were found between RF and running-based groups on isovolumetric relaxation with a decrease of 26% in the football group compared to only 14% in the running group.\textsuperscript{51} It was also found that left ventricular diastolic mitral flow ratio and peak early diastolic velocity improved by 25% and 12%, respectively, during a RF intervention, while no meaningful changes were found in the strength or control groups.\textsuperscript{24} Therefore, RF interventions seem to elicit changes in both cardiac structure and function with meaningful improvements in comparison with strength interventions or control groups or with similar effects in comparison with running-based groups. However, none of the studies revealed the intra- or interobserver reliability of the technicians that executed the echocardiography.

Fitness was also an important parameter measured in the reviewed studies, and maximal oxygen uptake (VO\textsubscript{2max}) was the most studied fitness variable. Improvements between 8% and 15% of VO\textsubscript{2max} have been observed following short-term RF programs.\textsuperscript{23,51} The changes promoted by short-term programs remain almost unchanged until the 15th month.\textsuperscript{48} In a longer period of intervention, it was also found that RF also improved VO\textsubscript{2max}, with changes of 7% and 8% in the 3rd and 6th months, which was more than in the control group.\textsuperscript{18} Considering the evidence, it is possible to suggest that RF interventions elicit improvements on maximal oxygen uptake in short- and long-term periods, thus being beneficial for the participants. However, one of the limitations of all the studies is that no dose-response was studied regarding the quantification of load occurred, and for that reason, monitoring instruments should be used to better characterize the relationships between training stimulus and the variations in cardiovascular parameters.

### 4.2 Overweight/Obesity

Although football practice is an intensive physical activity, in two studies with children football participation did not significantly change body mass index.\textsuperscript{34,35} On the other hand, in one study with children it was observed that football training reduces body mass index.\textsuperscript{33} These contradictory results are in line with the general physical activity literature that suggests that moderate-to-vigorous physical activity is not necessarily associated with lower body mass index or fat mass and is part of a multifaceted relationship.\textsuperscript{52-54} Nevertheless, we should be aware that the use of body mass index for establishing weight status in relation to health risk in children is problematic, particularly during the period of peak growth velocity.\textsuperscript{55} Results from previous studies\textsuperscript{56} that evaluated effects of the school-based intervention “FIFA 11 for Health” warn for the necessary caution in the interpretation of these type of results.

Previously, it was observed that although organized sports, such as football, contribute to children achieve their physical activity recommendations, participation in organized sports does reduce the likelihood of being classified as overweight or obese.\textsuperscript{57} However, there is also evidence that moderate-to-vigorous physical activity is related to lower adiposity.\textsuperscript{58} Nevertheless, prospective association between moderate-to-vigorous physical activity and adiposity does not equate to causality. There is evidence that physical activity is not strongly prospectively related to adiposity and may not be a determinant of adiposity.\textsuperscript{59}

In adults, results were different than for children. The four reviewed studies showed that football intervention significantly reduced total body fat mass and fat percentage.\textsuperscript{15,30-32} RF appears to be an effective activity to promote positive body composition changes, mainly due to the high energy expenditure leading to greater energy consumption and consequently promoting body fat reduction.\textsuperscript{33} Additionally, the multiple strength training elements and frequent performance
<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age—y (mean ± SD)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Observation</th>
<th>Main outcome measured</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul, Bangsbo, Nassis</td>
<td>Male</td>
<td>32.3 ± 6.0</td>
<td>15</td>
<td>-</td>
<td>Cross-over design</td>
<td>Participants played a 60-min 9-a-side football match or rested (control group)</td>
<td>Body fat, heart rate, blood sample</td>
<td>A single 60-min football match can attenuate the triglyceride response to a high-fat meal in normal and overweight individuals.</td>
</tr>
<tr>
<td>Vieira de Sousa, Fukui, Krstrup, Dagogo-Jack, Rossi da Silva</td>
<td>Male and female</td>
<td>61.1 ± 6.4</td>
<td>51</td>
<td>Brazil</td>
<td>RCT; 12-wk intervention; football + diet vs diet group</td>
<td>40-min sessions 3 times/wk</td>
<td>VO_{2max}, heart rate, blood sample, fat mass, lean mass</td>
<td>Football was effective at lowering insulin-like growth factor binding protein-3 and glucose levels, which contribute to decreased insulin resistance and cardiovascular risks.</td>
</tr>
<tr>
<td>Reddy, Dias, Holland, Campbell, Nagar, Connolly, Krstrup, Hubball</td>
<td>Male and female</td>
<td>EG—61.1 ± NS</td>
<td>20</td>
<td>England</td>
<td>24-wk intervention; walking football vs control group</td>
<td>Warm-up + 45-50 min/wk for 12 wk; small-sided games</td>
<td>BMI, cholesterol, glucose</td>
<td>There were overall positive effects (eg, for cholesterol) for both groups.</td>
</tr>
<tr>
<td>Andersen, Schmidt, Thomassen, Hornstrup, Frandsen, Randers, Hansen, Krstrup, Bangsbo</td>
<td>Male</td>
<td>49.8 ± 1.7</td>
<td>21</td>
<td>Denmark</td>
<td>24-wk intervention; football vs control group</td>
<td>1 h twice a week. Small-sided (4-a-side, 5-a-side, 6-a-side) games</td>
<td>BMI, blood lactate, plasma free fatty acids, heart rate</td>
<td>Recreational football improved VO_{2peak} and lowered total body and android fat mass in men with type 2 diabetes. Positive impact of football training on glycemic control was observed. Changes may be associated with reduced long-term morbidity, and football may be used to the treatment of type 2 diabetes.</td>
</tr>
<tr>
<td>Vieira de Sousa, Fukui, Krstrup, Pereira, Silva, Rodrigues, de Andrade, Hernandez, da Silva</td>
<td>Male and female</td>
<td>48-68</td>
<td>44</td>
<td>Brazil</td>
<td>RCT; 12-wk intervention</td>
<td>3 × 40 min/wk for 12 wk; small-sided games</td>
<td>BMI, VO_{2max}, heart rate, blood sample</td>
<td>Football practice 2 h/wk and a calorie-restricted diet promoted much greater health benefits for T2D patients than a calorie-restricted diet alone. Football training lowered cholesterol and triglycerides levels and increased insulin sensitivity. It suggests that football is an effective way to reduce insulin resistance, beta cell dysfunction, and risk factors for cardiovascular disease in T2D patients.</td>
</tr>
</tbody>
</table>

Abbreviations: CG, control group; EG, experimental group; NS, not specified.
### TABLE 3 Characteristics of included studies on overweight/obesity

<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age range (mean)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Observation</th>
<th>Main outcome measured</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cvetkovic, Stojanovic, Stojiljkovic, Nikolic, Scanlan, Milanovic⁵³</td>
<td>Male</td>
<td>11-13</td>
<td>35</td>
<td></td>
<td>12-wk intervention; football, high-intensity interval training group vs control group</td>
<td>Recreational football and HIIT groups performed regular PE classes (2 times/wk) plus the associated training intervention. Control group participated only in PE classes</td>
<td>Total body fat, fat mass, muscle mass, lean mass, BMI</td>
<td>Significant differences were found between football and control groups in body mass and BMI. The magnitude of changes was higher with the football intervention compared to high-intensity interval training group and control group for body composition</td>
</tr>
<tr>
<td>Andersen, Schmidt, Pedersen, Krustrup, Bangsbo⁵²</td>
<td>Male</td>
<td>68.1 ± 2.1</td>
<td>27</td>
<td>Denmark</td>
<td>RCT; 52-wk intervention; football, resistance groups vs control group</td>
<td>1-h session 2 times/wk for 16 wk, and 3 times/wk for the following 36 wk</td>
<td>Dietary intake, physical activity, fat mass, lean mass, blood sample</td>
<td>Long-term football training reduces BMI and improves antioxidative capacity. Long-term resistance training impacts muscle protein enzyme expression and increases lean body mass</td>
</tr>
<tr>
<td>Seabra, Seabra, Brito, Krustrup, Hansen, Mota, Rebelo, Rego, Malina⁵⁵</td>
<td>Male</td>
<td>10.3 ± 1.8</td>
<td>12</td>
<td>Portugal</td>
<td>5-mo intervention; football vs control group</td>
<td>After school program, 4 days/wk, 60-90 min/session</td>
<td>BMI, body fat and lean mass</td>
<td>Participants in the football group had significantly greater improvements in body image, self-esteem, and perceived physical competence compared with the control group. Changes in % body fat and lean body mass did not differ groups</td>
</tr>
<tr>
<td>Hunt, Wyke, Gray, Anderson, Brady, Bunn, Donnan, Fenwick, Grieve, Leishman, Miller, Mutrie, Rauchhaus, White, Treweek⁵¹</td>
<td>Male</td>
<td>47.1 ± 8.0</td>
<td>747</td>
<td>United Kingdom (Scotland)</td>
<td>RCT; 12-mo intervention; football vs control group</td>
<td>Participants were football fans</td>
<td>BMI, body fat, waist circumference</td>
<td>Intervention helped men to achieve significant changes in weight, waist circumference, body fat, and BMI 12 mo after baseline measurement. Mean weight loss in the intervention group fell almost 5% and is likely to be of clinical benefit</td>
</tr>
<tr>
<td>Barene, Krustrup, Brekke, Holtermann⁵⁵</td>
<td>Male and female</td>
<td>45.8 ± 9.3</td>
<td>118</td>
<td>Norway</td>
<td>RCT; 40-wk intervention; football, Zumba vs control group</td>
<td>Participants were hospital employees. 1-2 sessions/wk (1 h)</td>
<td>VO_max, blood pressure, BMI, % body fat (DXA), heart rate, bone mineral content</td>
<td>Intervention groups (football and Zumba) significantly reduced total body fat mass and fat percentage compared to the control group</td>
</tr>
</tbody>
</table>

(Continues)
of intense actions (eg, dribbles, shots, tackles, turns, jumps) in training sessions can increase lean body mass.\textsuperscript{48}

### 4.3 Type 2 diabetes

Diabetes is a metabolic disease characterized by hyperglycemia (increased blood glucose concentrations), as well as elevated non-esterified fatty acid concentrations. There is evidence to support that environmental influences are important determinant factors of T2DM risk.\textsuperscript{9} These risk factors include physical inactivity.\textsuperscript{60,61} Epidemiological evidence suggests that physically active individuals have lower risk of developing T2DM than their sedentary counterparts.\textsuperscript{62,63} More specifically, T2DM is characterized by hyperglycemia, fasting hyperinsulinemia, and insulin resistance in peripheral tissues.\textsuperscript{26} The positive impact of RF on lowered total body and android mass in middle-aged men with T2DM was demonstrated previously.\textsuperscript{26} These changes in body composition can impact insulin sensitivity and glycemic control, as changes in visceral adipose tissue are positively related to changes in homeostatic model assessment of diabetes insulin resistance. Additionally, RF was associated (in middle-age and older people) with decreased cholesterol and triglycerides levels, plasma glucose and IGFBP-3 levels (contributing to higher insulin sensitivity), decreased ammoniagenesis, and increased lipolytic activity and IGF-1/IGFBP-3 ratio, all indicative of attenuated catabolism.\textsuperscript{27,28} More recently, Skoradal et al\textsuperscript{64} also demonstrated that a program of 16 weeks of football training and dietary advice has positive effects on metabolic and cardiovascular health profiles, with greater overall effects than professional dietary advice per se for 55- to 70-year-old women and men with prediabetes.

Diabetes mellitus is a worldwide health problem, and the cost of treating this chronic disease and its related complications is high.\textsuperscript{27} Because of its increasing prevalence, due to both aging and increasing levels of obesity, the prevention and treatment of this disease are urgent. The reviewed studies demonstrated that RF is a fun activity that can be an attractive contribution to the treatment and prevention of T2DM in adult, middle-age, and elderly individuals.

### 4.4 Cancer

The reviewed studies\textsuperscript{36,38} were focused exclusively on prostate cancer in elderly men who were undergoing treatment. The purpose of those studies was to investigate the potential benefits of RF intervention aiming to avoid or reduce the effects of androgen deprivation treatment. Regarding the effects on cancer, it was found that 12 weeks of RF intervention was enough to improve bone mineral density (BMD) and also to elevate...
### Table 4: Characteristics of included studies on cancer

<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age range (mean)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Main outcome measured</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uth, Früstrup, Haahr, Brasso, Helge, Rorth, Midtgaard, Helge, Knustup</td>
<td>Male</td>
<td>71.3 ± 3.8</td>
<td>22</td>
<td>Denmark</td>
<td>Randomized controlled trial. Two groups were compared: football and control (5-yr follow-up assessments)</td>
<td>Body composition; bone mineral density; blood pressure; resting heart rate; plasma cholesterol; flexibility; balance; maximal oxygen uptake; muscle strength</td>
<td>Higher beneficial changes on right femoral neck bone mineral density in the football group. It was also found that long-term adherence to self-organized recreational football in men with androgen deprivation therapy may better preserve bone mineral status. However, no associations were observed on body composition, fitness, or physical functioning</td>
</tr>
<tr>
<td>Uth, Horstup, Christensen, Christensen, Jorgensen, Schmidt, Brasso, Jakobsen, Sundstrup, Andersen, Rorth, Midtgaard, Knustup</td>
<td>Male</td>
<td>EG—67.1 ± 7.1</td>
<td>57</td>
<td>Denmark</td>
<td>Randomized controlled trial. Two groups were compared: 32-wk football group and control (usual care)</td>
<td>Bone mineral density; physical activity; body composition; physical functioning</td>
<td>Football training group improved bone mineral density of the total hip and femoral shaft compared to the control group. Moreover, greater improvements of femoral neck and lumbar spine bone mineral density and plasma osteocalcin were found in the recreational football group. Greater improvements in lower-limb power were found in the recreational football group</td>
</tr>
<tr>
<td>Uth, Horstup, Christensen, Christensen, Jorgensen, Helge, Schmidt, Brasso, Helge, Jakobsen, Andersen, Rorth, Midtgaard, Knustup</td>
<td>Male</td>
<td>EG—67 ± 7</td>
<td>57</td>
<td>Denmark</td>
<td>Randomized controlled trial. Two groups were compared: 12-wk football group and control (usual care)</td>
<td>Body composition; postural balance; activity profile; bone mineral density</td>
<td>Recreational football promoted a high intermittent activity in participants. Moreover, the 12-wk football intervention elevated markers of bone formation and helped to maintain body composition</td>
</tr>
<tr>
<td>Uth, Horstup, Schmidt, Christensen, Frandsen, Christensen, Helge, Brasso, Rorth, Midtgaard, Knustup</td>
<td>Male</td>
<td>EG—67.1 ± 7.1</td>
<td>57</td>
<td>Denmark</td>
<td>Randomized controlled trial. Two groups were compared: 12-wk football group and control (usual care)</td>
<td>Body composition; heart rate during training intervention; maximal oxygen uptake; muscle strength; flexibility</td>
<td>The 12-wk football intervention resulted in improvements in lean body mass in comparison with the control group. Moreover, an increase in knee-extensor muscle strength was also found in the football group</td>
</tr>
</tbody>
</table>

Abbreviations: CG, control group; EG, experimental group.
<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Age range (mean)</th>
<th>n</th>
<th>Country</th>
<th>Design</th>
<th>Observation</th>
<th>Main outcome measured</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skoradal, Weihe, Patursson, Mortensen, Connolly, Krustup, Mohr</td>
<td>Male and female</td>
<td>60.5 ± 8.5</td>
<td>50</td>
<td>Faroe Islands</td>
<td>RCT; 16-wk intervention</td>
<td>2 sessions/wk (30-60 min)</td>
<td>BMI, bone mineral content, bone mineral density</td>
<td>Football training provides a powerful osteogenic stimulus and improves bone health in people diagnosed with prediabetes</td>
</tr>
<tr>
<td>Vlachopoulos, Barker, Ubago-Guisado, Ortega, Krustup, Metcalf, Castro Pinero, Ruiz, Knapp, Williams, Moreno, Gracia-Marco</td>
<td>Male and female</td>
<td>13.1 ± 0.1</td>
<td>116</td>
<td>United Kingdom</td>
<td>RCT, 1-yr intervention; football, swimming, and cycling vs active control group</td>
<td>Adolescent involved in football, swimming, and cycling</td>
<td>Bone mineral content</td>
<td>After 12 mo, footballers had significantly higher BMC and bone stiffness gains compared to swimmers and cyclists, and higher but non-significant BMC and bone stiffness compared to active controls</td>
</tr>
<tr>
<td>Hagman, Helge, Hornstrup, Fristrup, Nielsen, Jørgensen, Andersen, Helge, Krustup</td>
<td>Male</td>
<td>Elite football players—22.1 ± 3.4; Football-trained elderly—71.9 ± 2.8; Lifelong football players</td>
<td>140</td>
<td>Denmark</td>
<td>Cross-sectional; football vs control group</td>
<td>Participants were non-smoking men without chronic diseases</td>
<td>Bone mineral density, bone mineral content, lean body mass</td>
<td>Trained football players aged 65-80 y and young elite players aged 18-30 y have proximal femur and whole-body bone mineral density that are markedly higher than in age-matched untrained men</td>
</tr>
<tr>
<td>Larsen, Nielsen, Helge, Madsen, Manniche, Hansen, Hansen, Bangsbo, Krustup</td>
<td>Male and female</td>
<td>8-10</td>
<td>295</td>
<td>Denmark</td>
<td>RCT; 10-mo intervention; small-sided football game, circuit strength training group vs control group</td>
<td>3 × 40 min/wk</td>
<td>Bone mineral density, bone mineral content, lean body mass</td>
<td>3 × 40 min/wk of small-sided football game over a full school year improves bone mineralization</td>
</tr>
<tr>
<td>Helge, Andersen, Schmidt, Jørgensen, Hornstrup, Krustup, Bangsbo</td>
<td>Male</td>
<td>68.2 ± 3.2</td>
<td>32</td>
<td>Denmark</td>
<td>RCT; 1-y intervention; football, resistance training vs control group</td>
<td>Physical inactive in the past 5 y</td>
<td>Bone mineral density, bone turnover marker</td>
<td>Football participation 2 times/wk (45-60 min per section) resulted in an increase in BMD. Resistance training had no effect</td>
</tr>
<tr>
<td>Helge, Randers, Hornstrup, Nielsen, Blackwell, Jackman, Krustup</td>
<td>Male</td>
<td>39.55 ± 9.25</td>
<td>22</td>
<td>Denmark</td>
<td>RCT; 1-y intervention; football vs control group</td>
<td>Homeless people</td>
<td>Bone mineral density, bone turnover marker, fat-free mass</td>
<td>Football participation 3 times/wk (45-60 min per section) modestly increased trunk BMD</td>
</tr>
<tr>
<td>Mohr, Helge, Petersen, Lindenskov, Weihe, Mortensen, Jørgensen, Krustup</td>
<td>Female</td>
<td>45 ± 6</td>
<td>83</td>
<td>Denmark (Faroe Islands)</td>
<td>RCT; 15-wk intervention; football, swimming vs control group</td>
<td>~3 sessions/wk, 1 h/session</td>
<td>Bone mineral content, bone turnover markers</td>
<td>Training for 15 wk increases plasma turnover markers of bone formation and increases total leg and femur bone mineral content</td>
</tr>
</tbody>
</table>
appropriate nutrition and regular physical activity helps to
augment mechanical stress and inducing the stimulation of
accelerations, jumping, and speed running, thus contributing to an
some mechanical stress by its emphasis on accelerations/decel-
cytes through mechanical stress. In particular, RF may provide
some mechanical stress by its emphasis on accelerations/decel-
ments can be caused by a combination of exercise loading and
body conditions, namely stimulating the role of osteo-
cytes through mechanical stress. In particular, RF may provide
some augmented mechanical stress and inducing the stimulation of
the bone and thus osteogenesis.

4.5 | Osteoporosis

Osteoporosis is characterized by decreased bone mineral
density and increased risk of fractures. The reviewed stud-
ies demonstrated a positive and significant association be-
tween bone health and RF among adolescents, adults, and
older adults. Football participation resulted in improved bone
mineralization, enhanced bone mineral content, and as a stimulus for
osteogenesis. These results are in line with previous find-
ings, showing that active people have better bone health than
less active people. Bone is a tissue that remodels during the
course of life. Although skeletal characteristics are in-
fluenced by genetic factors, a healthy lifestyle including
appropriate nutrition and regular physical activity helps to
improve bone health, and strengthen weak bone.

During activities that involve changes of direction, such as football, mechanical forces are exerted on bones in varied
and unusual directions through reaction forces and contractile forces from muscles. The intense movements involved in
football, characterized by accelerations, decelerations, jumps, change of directions, and rapid side-cutting movements, con-
tribute to the improvement of bone mineral content, bone
mineral density, and osteogenesis. For children and adolescents, football is an osteogenic activity that can augment bone mineral content and bone
mineralization at the loaded sites of the skeleton. For adults, football is also an osteogenic activity and can improve bone health while reducing the risk of age-related
bone loss and osteoporosis. For older adults, among
other health outcomes, it can be a preventive strategy to reduce the risk of hospitalization because of traumas and fractures.

4.6 | Limitations

A possible limitation of this systematic review is that it only includes studies in English from specific selected
databases, thereby potentially overlooking other relevant publications, namely “grey literature.” To reinforce the evi-
dence observed in the present review, future studies should
endeavor to perform meta-analytic analyses. This type of analysis was not possible herein, as the studies reviewed
possessed a wide range of metrics and outcomes, which
precluded the possibility of creating a coherent analytical
strategy.

5 | PERSPECTIVES

This systematic review demonstrates that RF interventions
seem to decrease blood pressure and resting heart rate, and
improve cardiac structure and functioning, while increasing
maximal oxygen uptake in both sexes. Additionally, football
practice lowers cholesterol and triglyceride levels, increases
insulin sensitivity, and has a positive impact on glycemic
control. Therefore, RF may have an important role in the pre-
vention and treatment of T2DM.

There exists a significant association between improved
bone health and RF among adolescents, adults, and older
adults. Football participation results in enhancements of
bone mineralization and increases in bone mineral density
and bone mineral content, while also being a stimulus for
osteogenesis. In this sense, RF can play a role in osteo-
porosis prevention. In adults with prostate cancer, RF in-
tervention seems to be beneficial for bone health, slightly
beneficial for body composition, muscle strength, and max-
imal oxygen uptake and without meaningful benefits for
balance, although further studies are required. Moreover,
further research on the health benefits of walking football
is required, as this is a developing sport with an increasing
participation rate.

NCDs have globally shown increasing impact on health
status in populations and are the leading cause of mortality
worldwide. An important way to control this type of dis-
ases is to focus on reducing the associated risk factors (eg,
raised blood pressure, overweight/obesity, hyperglycemia, physical inactivity). The reviewed studies showed that RF
is an effective and engaging activity that presents itself as
a low-cost solution in the prevention and treatment of some
NCDs.
REFERENCES


3. WHO. Global recommendations on physical activity for health; 2010.


