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Review Article

Effects of group sports on health-related physical fitness of overweight youth: A systematic review and meta-analysis

Ana Oliveira[1,2,3], Ângela Monteiro[2], Cristina Jácome[2], Vera Afreixo[3,4], Alda Marques[2,3]

[1]*Faculty of Sports, University of Porto, Porto, Portugal,* [2]*Lab 3R – Respiratory Research and Rehabilitation Laboratory, School of Health Sciences (ESSUA), University of Aveiro, Aveiro, Portugal,* [3]*Institute for Research in Biomedicine (iBiMED), University of Aveiro, Aveiro, Portugal,* [4]*Department of Mathematics, University of Aveiro, Aveiro, Portugal*
Corresponding author: Alda Marques, PT, MSc, PhD, Senior Lecturer, School of Health Sciences, University of Aveiro (ESSUA), Agras do Crasto - Campus Universitário de Santiago, Edifício 30, 3810-193 Aveiro, Portugal. Tel: (+351) 234 372 462, Fax: (+351) 234 370 985, Email: amarques@ua.pt

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Group sports interventions have been developed to improve health-related physical fitness of overweight/obese youth. However, its benefits are not systematically documented. This study synthesizes the evidence about the effects of group sports on health-related physical fitness of overweight/obese youth. Pubmed, Web of Knowledge, Scopus, Medline, CINAHL, SportDiscus, and Academic Search Complete were searched in February 2016. Studies assessing the effects of group sports on body composition, cardiorespiratory endurance, muscle strength, flexibility, and neuromotor fitness of overweight/obese youth (aged <18 years) were included. Effect sizes (ES) were calculated with Cohen's *d* and its 95% confidence intervals (CI). Improvements were found in (i) body composition – percentage of fat body mass (pooled ES = 0.67; 95% CI = 0.24–1.10) and waist circumference (ES = 0.69; *P* = 0.004); (ii) cardiorespiratory endurance – peak oxygen consumption (pooled ES = 0.53; 95% CI = 0.13–0.92) and (iii) muscle strength – hand grip strength (ES = 0.72; *P* = 0.003). No significant effects were found for body mass index (pooled ES = 0.27; 95% CI = −0.14 to 0.69), percentage of lean body mass (ES = 0.01; *P* > 0.05), maximal power output (ES from 0 to 0.06; *P* > 0.05), sit-and-reach test (pooled ES = 0.26; 95% CI = −0.16 to 0.68) and agility test (ES = 0; *P* = 0.48). Group sports improve body composition, cardiorespiratory endurance, and hand grip strength of overweight/obese youth. Flexibility and neuromotor fitness do not seem to change following group sports.

The number of overweight/obese youth has reached epidemic proportions (Daniels et al., 2009) and it is now considered one of the main public health challenges of the 21st century (Karnik & Kanekar, 2012). Globally, the prevalence of overweight and obesity among youth in 2013 was 23% in developed countries and 13% in developing countries (Ng et al., 2014), which represents an approximate 47% increase in the worldwide prevalence between 1980 and 2013 (Ng et al., 2014).

This phenomenon has raised attention of health policy makers and organizations as it is associated with a range of adverse financial and health consequences. Currently, it is estimated that around 7% of annual national health budgets across the European Union are spent on diseases linked to obesity (European Union 2014), and this number is expected to increase if last years' trend of increasing obesity is maintained. The rise in overweight and obesity in youth is also distressing from a health-related perspective due to the strong link between excess adiposity and detrimental health and psychosocial outcomes in later life. These include, but are not limited to, cardiovascular diseases, type 2 diabetes, as well as social stigmatization and mental health problems (World Health Organization 2004). Therefore, currently there is a major research concern in developing effective and feasible interventions for the management of overweight and obesity in youth (World Health Organization 2000; Aranceta et al., 2009).

Exercise has been recommended for the prevention and treatment of overweight and obesity in youth (Kelley & Kelley, 2013; Kelley et al., 2014), as weight gain is often caused by decreased daily physical activity. Interventions showing the largest effects are often strictly structured and comprise large components of educative and supportive programs about nutrition, healthy lifestyle, and exercise. However, these interventions result in large dropout rates due to lack of enjoyment, perceptions of competence, social pressures, competing priorities, and physical factors (Crane & Temple, 2015). For these reasons, group sports have emerged as potential interventions for use with young populations as they link a variety of aerobic and resistance activities with youths' interests of entertainment, improvement in skills, and being with friends (Weintraub et al., 2008; Salvy et al., 2012).

Several group sports have been studied in the adult population, such as tennis and football, and positive associations with health benefits have been reported, including improved cardiorespiratory endurance, lipid profile, and leaner body (Pluim et al., 2007; Randers et al., 2010; Oja et al., 2015). However, much less is known about the benefits of group sports on the main components of health-related physical fitness (i.e., body composition, cardiorespiratory endurance, muscle strength, flexibility, and neuromotor) in overweight/obese youth populations. A systematic review would be valuable to provide health and sports professionals with the best evidence available on the benefits of group sports programs and guide interventions for improving health-related physical fitness of overweight/obese youth.

Thus, the present review aimed to systematically summarize experimental and quasi-experimental studies which reported the effects of group sports on health-related physical fitness of overweight/obese youth when compared to absence of an intervention or to standard interventions.

Methods

Data sources and searches

A systematic literature search, limited to articles published in English, French, Portuguese, and Spanish was conducted in February 2016 on Pubmed, ISI Web of Knowledge, Scopus, Medline, CINAHL, SportDiscus, and Academic Search Complete. A specific search was also conducted in the Cochrane Library and in the International database of prospectively registered systematic reviews (PROSPERO) to exclude the existence of reviews with the same purpose as the present one. For this review, "group sports" has been defined as "a collection of two or more individuals who possess a common identity, have common goals and objectives (...) and consider themselves to be a group," following the definition proposed by Carron et al. (2005). Health-related physical fitness was composed of five components: body composition, cardiorespiratory endurance, muscle strength, flexibility, and neuromotor fitness (Garber et al., 2011; American College of Sports Medicine 2013).

Search terms were based on a combination of the following keywords: (obes* OR overweight) AND (youth OR child* OR adolescen* OR teen*) AND ("group sports" OR "team sports" OR "collective sports" OR football OR handball OR volleyball OR rugby OR basketball OR baseball OR soccer OR "water polo" OR hockey OR badminton OR tennis). The search terms were limited to titles and abstracts. Additionally, the reference lists of the selected articles were scanned for other potential eligible studies.

Eligibility criteria and study selection

Articles were included if they: (i) involved overweight and/or obese (body mass index- BMI $\geq$25 kg/m^2 or BMI $\geq$85th percentile) (CDC/NDHS 2000) youth (<18 years old); (ii) assessed the effects of group sports interventions; (iii) were experimental or quasi-experimental (Centre for Evidence-Based Medicine 2016); (iv) were full-text articles published in scientific journals or conference proceedings; and (vi) were written in English, French, Portuguese, or Spanish. Articles were excluded if the study was conducted only in adults or if it did not provide quantitative data on health-related physical fitness. Book chapters, review articles, abstracts of communications or meetings, letters to the editor, commentaries to articles, unpublished work, and study protocols were also excluded from this study. After removing duplicates, two reviewers assessed all the potential studies identified. The studies were selected based on their titles and abstracts; when the title and abstract were relevant to the purpose of the review, the full-text article was read carefully to decide its inclusion. A third reviewer was consulted to solve any disagreements. This systematic review was reported using the systematic review method proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (Moher et al., 2009).

Quality assessment and data extraction

The quality of the included studies was assessed independently by two reviewers with a checklist adapted by Petticrew and colleagues based on the "Crombie criteria" (Petticrew & Roberts, 2006) (Crombie, 1996), according to previous systematic reviews (Barnard et al., 2010; Oliveira et al., 2014). This checklist provides a list of eight questions about the research design, recruitment strategy, response rate, sample representativeness, measures and statistics used, and power, to assess study quality.

Data from the included studies were extracted in a structured table format comprising the following topics: publication details (first author, year of publication, country); study design; characteristics of participants (total number, age, gender; BMI), intervention (type, frequency, duration, and length of intervention), measures, outcome measures and findings.

Data analysis and synthesis

The consistency of the studies quality assessment, performed by two reviewers, was explored with an inter-rater agreement analysis using Cohen's kappa. The value of Cohen's kappa ranges from 0 to 1 and can be categorized as slight (<0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8), or almost perfect (>0.81) agreement (Landis & Koch, 1977). The statistical analysis was performed using PASW Statistics (version 18.0; SPSS Inc., Chicago, Illinois, USA).

Meta-analysis was only possible to conduct with a limited number of variables due to the large diversity of outcomes and units of measurement used in the included studies. For variables that did not fit in the meta-analysis, effect sizes (ES) were computed. MetaXL 2.0 was used to calculate the individual and pooled ES. The input data were the Cohen's d value of each study and the respective standard error. The output was the pooled Cohen's d value and corresponding confidence intervals. Cohen's d ES were interpreted as a small ($\geq$0.2), medium ($\geq$0.5) or large ($\geq$0.8) (Cohen, 1988). Although comparisons between studies were possible, some differences in study designs and methodologies were observed. Therefore, statistical heterogeneity was considered and the random effect model was used to calculate the pooled effect estimates. Additionally, the quality of individual studies was incorporated in meta-analysis weights using the quality scores attributed (Doi & Thalib, 2008). A sensitivity analysis, to evaluate the robustness of the meta-analysis, was also performed by recalculating the pooled results of the primary analysis and sequentially excluding each single study (Haidich, 2010).

Results

Study selection

The databases search identified 503 records. After duplicates removal, 263 records were screened for relevant content. During the title and abstract screening, 223 articles were excluded. Thus, the full-text of 40 potentially relevant articles was assessed and 34 articles were excluded due to the following reasons: (i) were not original scientific articles (n = 5); (ii) were observational studies (n = 1); (iii) were written in Chinese, German or Serbian (n = 15); (iv) did not include group sports interventions (n = 10); (v) did not include overweight/obese participants (n = 1); (vi) did not assess health-related physical fitness components (n = 1); (vii) participants presented other significant comorbidities than obesity (n = 1, that is, participants were also smokers and alcohol consumers). Therefore, six original studies were included. Details of the search process are shown in Fig. S1.

Quality assessment

The results of the methodological quality assessment are presented in Table S1. All studies used objective measures and appropriate statistical analysis (Weintraub et al., 2008; Faude et al., 2010; Calcaterra et al., 2013; Hansen et al., 2013; Seabra et al., 2014; Vasconcellos et al., 2015). Sample representativeness was absent in all studies due to small sample sizes (Weintraub et al., 2008; Faude et al., 2010; Calcaterra et al., 2013; Hansen et al., 2013; Seabra et al., 2014; Vasconcellos et al., 2015), gender bias (i.e., samples were mainly or completely composed by males) (Weintraub et al., 2008; Hansen et al., 2013; Vasconcellos et al., 2015), lack of randomization processes (Hansen et al., 2013; Seabra et al., 2014), and no reasons given for selecting sub-samples for statistical analysis (Vasconcellos et al., 2015). Four studies did not justify their sample size (Faude et al., 2010; Calcaterra et al., 2013; Hansen et al., 2013; Vasconcellos et al., 2015), two presented inappropriate research designs (Calcaterra et al., 2013; Vasconcellos et al., 2015) to address this research question, two failed to report the recruitment strategy used (Calcaterra et al., 2013; Vasconcellos et al., 2015) and two failed to report the response rate (Faude et al., 2010; Vasconcellos et al., 2015). The agreement between the two reviewers was substantial (k = 0.702; 95% CI = 0.498–0.906; $P < 0.001$; percentage of agreement of 85.4%).

Study characteristics

Characteristics of the studies included are shown in Table S2. Studies were published between 2008 and 2015 and were experimental (randomized, controlled trial) (Weintraub et al., 2008; Faude et al., 2010) and quasi-experimental (two groups pre-post design and two-stage cluster sample design) (Calcaterra et al., 2013; Hansen et al., 2013; Seabra et al., 2014; Vasconcellos et al., 2015) studies. All studies provided information of the effects of group sports interventions on body composition (Weintraub et al., 2008; Faude et al., 2010; Calcaterra et al., 2013; Hansen et al., 2013; Seabra et al., 2014; Vasconcellos et al., 2015), three on cardiorespiratory endurance (Faude et al., 2010; Calcaterra et al., 2013; Vasconcellos et al., 2015), two on flexibility (Faude et al., 2010; Calcaterra et al., 2013), and one on neuromotor fitness (Faude et al., 2010) and muscle strength (Calcaterra et al., 2013).

In total, 141 overweight/obese participants (45% male – data gathered from 4 studies, as Weintraub et al. (2008) and Vasconcellos et al. (2015) did not report the number of males/females enrolled), with age ranging from 8 to 17 years old were enrolled in the included studies. Group sports interventions, as well as control interventions, varied among studies. Studies conducting group sports interventions included different sports (football, rugby, volleyball, and basketball), program lengths (3–6 months), session's frequencies (3–4 days/week), durations (45–90 min), and intensities (50% to higher than 80% of the maximum heart rate).

Five studies used football as their main intervention and presented similar sessions' components and organization (Weintraub et al., 2008; Faude et al., 2010; Hansen et al., 2013; Seabra et al., 2014; Vasconcellos et al., 2015). Hansen et al. (2013), Seabra et al. (2014) and Vasconcellos et al. (2015) sessions' consisted of warm up (10–20 min), small sided football games (40–60 min) and cold down (10 min), while in the study of Faude et al. (2010), the sessions consisted of warm up (6 min), small sided football games (30 min), technique training (12 min), and fitness courses with the ball (12 min). In the study of Weintraub et al. (2008), sessions began with team-building exercises followed by 15 min of warm-up and stretching. The remainder practice was devoted to learning football skills in the context of fun skill-building exercises and concluded with a scrimmage. The number of players in each team (8–10 players) and the dimensions of the court (55 × 24 m; length × width) were only reported by one study (Hansen et al., 2013). In one study, participants included in the football group also performed the mandatory physical education lessons (Seabra et al., 2014).

One study comprised a variety of group sports in their intervention including football, rugby, volleyball, basketball, and interactive video game exercises (Calcaterra et al., 2013). Each session began and finished with a 10-min warm up/cool down period followed by a combination of circuit-based aerobic exercises, strength and resistance exercises involving continuous work bouts.

Adverse effects were reported in two studies (Weintraub et al., 2008; Hansen et al., 2013). Events were not group sports-related and included foot injury, knee pain, eye pain, headaches, ingrown toenail, ear infection, and skin rash in the control group and skin rash, car collision, and newly diagnosed hypothyroidism in the group sports.

Synthesis of results

The effects of group sports interventions on the components of health-related physical fitness of overweight and/or obese youth are summarized in Table S2.

Body composition was analyzed using BMI (Weintraub et al., 2008; Faude et al., 2010; Calcaterra et al., 2013; Hansen et al., 2013; Seabra et al., 2014), waist circumference (Calcaterra et al., 2013), percentage of fat body mass (Calcaterra et al., 2013; Seabra et al., 2014), and lean body mass (Seabra et al., 2014).

All studies assessed BMI with a scale/stadiometer, however, only one found significant differences favoring participants of group sports intervention (ES = 0.75; $P = 0.002$) (Calcaterra et al., 2013). No significant differences were found between football based programs and standard interventions (ES from 0.03 to 0.13; $P > 0.05$) (Weintraub et al., 2008; Faude et al., 2010; Hansen et al., 2013; Seabra et al., 2014). The pooled Cohen's *d* estimate was 0.27 (95% CI = −0.14 to 0.69). Medium amount of heterogeneity was found among studies ($I^2 = 40\%$; $P = 0.15$; Fig. S2).

Waist circumference was measured in one study using a measuring tape and significant improvements, favoring group sports, were found (ES = 0.69; $P = 0.004$) (Calcaterra et al., 2013).

Percentage of fat body mass was measured in two studies, using a dual energy X-ray absorptiometry (Seabra et al., 2014) and a bioelectrical impedance analysis (Calcaterra et al., 2013). Significant differences, favoring group sports interventions, were observed in one study including a variety of group sports (ES = 0.81; $P = 0.001$) (Calcaterra et al., 2013). However, no significant differences were found between participants enrolled in a football-based program and those in physical education lessons only (ES = 0.28; $P > 0.05$) (Seabra et al., 2014). The pooled Cohen's *d* estimate for the percentage of fat body mass was 0.67 (95% CI = 0.24–1.10). No heterogeneity was found among studies ($I^2 = 10\%$; $P = 0.29$; Fig. S3).

The percentage of lean body mass was only assessed in one study which found no significant differences between a football based exercise program and a standard exercise program (ES = 0.01; $P > 0.05$) (Seabra et al., 2014).

Cardiorespiratory endurance was assessed with peak oxygen consumption (VO_2peak) (Vasconcellos et al., 2015) and maximal power output (PO_{max}) (Faude et al., 2010; Vasconcellos et al., 2015) during maximal cardiopulmonary tests, on a cycle ergometer (Faude et al., 2010; Vasconcellos et al., 2015) or on a treadmill (Calcaterra et al., 2013).

Conflicting findings were found for VO_2peak (Faude et al., 2010; Calcaterra et al., 2013; Vasconcellos et al., 2015). Significant differences favoring a group sports intervention where reported in two studies (ES = 0.81 and ES = 0.75; $P < 0.05$) (Calcaterra et al., 2013; Vasconcellos et al., 2015). No significant differences were found between participants whom enrolled in a football-based program and those enrolled in physical education lessons only (ES = 0; $P = 0.98$) (Faude et al., 2010). The pooled Cohen's *d* estimate for VO_2peak was 0.53 (95% CI = 0.13–0.92), however, moderate evidence of heterogeneity was found between studies ($I^2 = 34\%$; $P = 0.22$; Fig. S4).

No significant improvements were found for PO_{max} (Faude et al., 2010; Vasconcellos et al., 2015) (ES = 0 and ES = 0.06; $P > 0.05$) following group sports interventions. Due to the different units of measurement used to report PO_{max} (i.e., Watts vs Watts/kg), it was not possible to calculate the pooled Cohen's *d*.

Flexibility was assessed in two studies using the sit-and-reach test. Both studies reported no significant improvements following group sports interventions (ES = 0.25 and ES = 0.28; $P > 0.05$) (Faude et al., 2010; Calcaterra et al., 2013). The pooled Cohen's *d* estimate for the sit-and-reach test was 0.26 (95% CI = −0.16 to 0.68). No heterogeneity was found among studies ($I^2 = 0\%$; $P = 0.94$; Fig. S5).

Neuromuscular fitness and muscle strength were assessed by Faude et al. (2010) and Calcaterra et al. (2013), respectively. Faude et al. (2010), using the agility test, found no differences between a group sports intervention and a standard intervention (ES = 0; $P = 0.48$). Calcaterra et al. (2013), using a hand grip dynamometer, found significant muscle strength differences on a pre–post intervention (ES = 0.72; $P = 0.003$).

The sensitivity analysis showed robustness for all variables included in the meta-analysis.

Discussion

This systematic review and meta-analysis found that group sports interventions were effective in improving body composition, cardiorespiratory endurance, and muscle strength health-related physical fitness components of overweight/obese youth Flexibility and neuromotor fitness did not change after group sports interventions. Significant adverse effects were not reported in control or group sports interventions.

Body composition was mainly assessed using BMI and percentage of body fat. Robust and moderate evidence of improvement was observed for percentage of body fat and no improvements were found for BMI. These results are similar to what has been found in adults (Krustrup et al., 2010) and in other well established programs for weight loss in youth (Korsten-Reck et al., 2005; Brown & Summerbell, 2009; Kelley & Kelley, 2013; Kelley et al., 2014). Four reasons may explain the lack of BMI change. Firstly, the age range examined in the studies is associated with major growing developments, in which significant gains in weight and height may result in negligible changes in BMI (Malina et al., 2004). Secondly, BMI reflects both lean and fat mass, thus, similar increases in muscle mass and losses in fat mass following an intervention may also result in negligible changes in BMI (Aasheim et al., 2011). Thirdly, the interventions assessed were limited to group sports exercise programs, neglecting educational and psychoeducational components. It has been suggested that more marked effects of activity interventions on body composition would be achieved with multicomponent interventions, including diet and behavior modification (Nemet et al., 2005). Fourthly, it has been reported that BMI lacks sensitivity to change following exercise programs (Watts et al., 2005; Krustrup et al., 2010) and that percentage of body fat and H_2O, fat mass index, and skinfolds are more sensitive measures of body composition (Watts et al., 2005; Krustrup et al., 2010; Aasheim et al., 2011). Finally, these results should be interpreted with caution, as moderate heterogeneity was found among studies. Such heterogeneity may be due to methodological differences (i.e., study designs and sample sizes) and different intervention designs among studies (i.e., different sports, program's lengths and intensities). Therefore, results from BMI should not be overvalued. In fact it has been found that exercise improves health even if no weight is lost (Shaw et al., 2006). Moreover, improved health and fitness may increase daily physical activity and compliance with exercise programs which ultimately will lead to long-term weight reductions.

Significant and medium effects were found following group sports interventions on cardiorespiratory endurance of overweight and obese youth assessed with VO_2peak. Most studies comprised group sports mainly focus on aerobic activities (e.g., football, basketball) with moderate to high intensity, which are beneficial in increasing energy expenditure and weight loss (Goran et al., 2000), hence improving VO_2peak (American College of Sports Medicine 2013). Although these results are in line with other exercise programs developed for untrained adults (Milanović et al., 2015; Oja et al., 2015) and overweight and obese youth (Kelley & Kelley, 2013; Kelley et al., 2015), their interpretation should be carefully assessed as, similar to body composition, moderate heterogeneity was found among studies. Additionally, while VO_2peak (i.e., the highest value of VO_2 attained on an incremental or high-intensity test, designed to take an individual to his/her limit of tolerance) was the most used measure to assess cardiorespiratory endurance (probably due to its easiness to define and determine), maximum oxygen consumption (VO_2max *–the oxygen intake during an exercise intensity at which actual oxygen intake reaches a maximum beyond which no increase in effort can raise it*; Hill & Lupton, 1923) is the single best indicator of cardiorespiratory endurance according to the World Health Organization (Shephard et al., 1968). Thus, it would be valuable if future studies could focus in this variable to produce more secure and reliable information about the benefits of group sports on the cardiorespiratory endurance of overweight and obese youth.

No evidence of improvements in flexibility and neuromotor fitness following group sports interventions were found. This was expected, as the group sports reviewed in this meta-analysis did not incorporate specific training modules for these fitness components. Also, recent studies have been reporting no differences among normal weight, overweight, and obese youth in flexibility and neuromotor fitness (Fogelholm et al., 2008; Dumith et al., 2010; Đokić & Međedović, 2013). Thus, although aerobic activities are important for cardiorespiratory and body composition health (American College of Sports Medicine 2013), it may be valuable to also include flexibility and neuromotor components in exercise programs. This may encourage overweight/obese youth to develop positive experiences from physical activities that are not as affected by excess weight as aerobic activities.

Only one study assessed the effects of group sports interventions on muscle strength, and reported significant and large improvements in this fitness component. Strength is of particular importance as the ability of overweight/obese youth to produce strength during field tests does not only solely reflect muscle capacity but also relies on other musculo-skeletal health factors such as range of motion, flexibility, balance, and coordination (Thivel et al., 2016). Additionally, it has been reported that muscle strength is often the only health-related physical fitness component that is improved in overweight youth (Dumith et al., 2010). Therefore, similarly to flexibility and neuromotor activities, strength activities must be integrated in group sports exercise programs, not only to preserve the strength component but also to highlight youths' abilities in these activities when compared to normal weight peers (Dumith et al., 2010). Such strategy may be of value to further motivate and commit overweight/obese children and adolescents to the intervention program.

Health professionals often raise the objection that some group sports, namely European and American football, are not appropriate for overweight/obese youth as the relative risk for injuries in obese football players are 2.5 times higher than in healthy peers (Kaplan et al., 1995). In the present review only two studies, which included European football as the main intervention, reported incidence of adverse effects, and no significant football-related injuries were reported. Conversely to professional football trainings, the interventions of the included studies were not focused in improving sports technical gestures, thus, the high mechanical stresses and repetition movements, which often led to injuries (Caine et al., 2006), were reduced. Nevertheless, future studies should investigate the incidence of adverse events in overweight/obese youth per group sport, so that health and sports professionals could choose and adapt their group sports interventions attending to injury prevention.

Finally, it should be noted that only six studies with different research designs, small sample sizes, and interventions mainly based on football were included, demonstrating that the evidence about the effects of group sports on health-related physical fitness of overweight/obese youth is still limited. This was unexpected, considering that group sports are often popular among children/adolescents; and that health institutions and policy makers worldwide are continuously calling attention for the need to develop effective interventions for the management of overweight and obesity in youth (World Health Organization 2000; Aranceta et al., 2009). This review has presented the positive results that can be achieved with group sports interventions and may serve as motivation and rationale for further studies and funding opportunities currently emerging in this field. This would largely contribute not only to increase the evidence of group sports interventions but, together with nutritional and psychoeducational programs, may also help to develop an effective and feasible intervention to tackle youth obesity.

Limitations

This systematic review and meta-analysis has a number of limitations that should be considered. Firstly, during the databases search, only titles and abstracts were searched for the selected keywords, and no specific health-related fitness terms, such as cardiorespiratory endurance or muscle strength, were included. Although this could have influenced the studies found, the broad terms used allowed to find a larger number of studies in a preliminary phase and thus, reduce the searching bias. Additionally to the search in the databases, the reference lists from the studies included were reviewed. Thus, it is believed that this systematic review contains the most relevant studies on the proposed topic. Secondly, only six studies with different research designs and methodologies were found. Therefore, the extent to which the conclusions of this review can be generalized to different group sports remains unclear. Lastly, it was not possible to categorize children/adolescents into subgroups (e.g., infants, children, and adolescents) due to the limited number of studies found and lack of detailed information about age in the included studies. Future studies should further investigate the ES by age groups and in adult and senior populations, to capture the developmental differences in performing group sports.

Perspectives

It is well known that overweight/obese youth have reduced health-related physical fitness compared with healthy peers. These findings are alarming as it is also known that poor health-related physical fitness leads to cardiovascular diseases and obesity, increasing morbidity and mortality risks. Therefore, it is imperative to design effective interventions to increase physical fitness among youth.

Group sports interventions are often popular among youth, do not require specialized equipment and or/infrastructures and have shown to be effective in improving body composition, cardiorespiratory, and muscle strength in overweight/obese youth. Nevertheless, current studies using this intervention have overlooked health-related physical fitness components in which overweight/obese youth have similar or better performances than their normal weight peers (i.e., muscle strength, flexibility, and neuromotor components). Therefore, it is suggested that health and sports professionals adapt group sports interventions to include these fitness components in order to match youth's expectations without compromising the desired outcomes.

Key words: Team sports, physical fitness, children, adolescents, obese.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article:

Figure S1. PRISMA Flowchart of the included studies.

Figure S2. Forest plot for point estimate changes in body mass index (BMI).

Figure S3. Forest plot for point estimate changes in percentage of body fat.

Figure S4. Forest plot for point estimate changes in peak oxygen consumption (VO_2peak).

Figure S5. Forest plot for point estimate changes in the sit-and-reach test.

Table S1. Quality assessment of the included studies (n = 6) based on the "Crombie criteria."

Table S2. Effects of group sports interventions on health-related physical fitness outcomes of overweight/obese youth.

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