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Liliana Beirão Neto de Sousa

Será a promoção da prática de Futebol uma forma de prevenir a obesidade em crianças escolares?

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SERÁ A PROMOÇÃO DA PRÁTICA DE FUTEBOL UMA FORMA DE PREVENIR A OBESIDADE EM CRIANÇAS ESCOLARES?

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Título abreviado: O futebol na prevenção da obesidade

Title: Is the promotion of soccer a new approach to childhood obesity prevention?

Short title: Soccer in childhood obesity prevention

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LIST OF ABBREVIATIONS AND ACRONYMS

BMI - Body mass index

BMIz - Age- and sex-standardized Body Mass Index

BC – Body Composition

BFM – Body Fat Mass

BP – Blood Pressure

COSI - Childhood Obesity Surveillance Initiative

CMRF – Cardiovascular and Metabolic Risk Factors

DBP – Diastolic Blood Pressure (DBP)

FFM – Fat Free Mass

HDL-c - high-density lipoprotein-cholesterol

HOMA-IR - Homeostatic model assessment for insulin resistance

HR – Heart Rate

IOTF - International Obesity Task Force

LDL-c - Low-density lipoprotein-cholesterol

MS - Metabolic Syndrome

PA -Physical Activity

SBP – Systolic Blood Pressure

SD - Standard deviation

SPEO - Sociedade Portuguesa para Estudo da Obesidade

TC – Total cholesterol

TG - Triglycerides

WC – Waist circumference

WHO - World Health Organization

WtHR – Waist to Height Ratio

TITLE

Is the promotion of soccer a new approach to childhood obesity prevention?

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KEY-WORDS: OBESITY, PREVENTION, SOCCER

ABSTRACT

BACKGROUND The role of physical activity (PA) in treatment of childhood obesity is recognized. Soccer is the most played sport in Portugal.

AIM Understand the effect of soccer practice as highly-effective treatment-program and evaluate its influence on obesity-related cardiometabolic comorbidities.

SUBJECTS AND METHODS Sixty-five overweight/obese males [10(1.4)years] were divided in three groups: soccer (G1;n=25), individual sport-program (G2;n=20), control (G3;n=20). Training sessions were carried out three days-week during 6 months by specially-trained professionals. Baseline and 6 months anthropometry, BMI, WtHR, body composition, blood pressure, lipid profile and HOMA IR were evaluated.

RESULTS It was a severe obese sample (BMIz-sc=2.5±0.7; BFM%=35.5±7.0) with high cardiovascular-risk profile (WtHR=0.58±0.06; SBP=110.6±11.8%90th percentile). PA was associated with a decrease in BMIz-sc (G1 p=0.001; G2 p=0.000), BFM (G1 p=0.036; G2 p=0.000), WtHR (G1 p=0.000; G2 p=0.000) and an increase in FFM (G1 p=0.023; G2 p=0.000).

CONCLUSION Six-month exercise-program coordinated by specially-trained professionals improves nutritional status, body composition, blood-pressure and lipid profile in severe obese children/adolescents. Soccer should be implemented as an innovative PA program to treat childhood obesity.

INTRODUCTION

Obesity, according to the World Health Organization (WHO), is the greatest epidemic disease of the XXIth century. Defined as a chronic disorder, obesity has a multifactorial etiology, where excess body fat has an adverse effect on health (WHO, 2000). The worldwide exponential increase in the incidence of obesity turned it into a major public health problem.

The International Obesity Task Force (IOTF) estimates that, approximately, one in five children is overweight and there are a total of 3 million obese children in Europe (Lobstein and IOTF Report for WHO, 2004). The situation in Portugal is also of concerned. According to the WHO European Childhood Obesity Surveillance Initiative (COSI), 18.1% and 13.9% Portuguese children aged 6 to 10 are overweight or obese, respectively (RITO A, 2012). Portuguese Society for the Study of Obesity (SPEO), in a study conducted at the same time as COSI, reports almost the same prevalence values, transversal to the pediatric age (Galvão-Teles A, 2009). In fact, between 2 and 5 years, this study defends values of 29% to overweight and 12.5% to obesity, while in ages between 11 and 15 the values reported are 28.2% and 11.3% respectively. Finally, according to EPACI Portugal 2012 (unpublished data), in a representative sample of younger children, aged from 12 to 36 months, an off concerned high prevalence of overweight and obesity (31. 4% and 6. 5%, respectively) was observed (EPACI, 2012).

Linked to the high prevalence, the concern has been increasing due to its association with cardiovascular and metabolic risk factors (CMRF) such as diabetes mellitus type 2, systemic arterial hypertension and dislipidemia (Rêgo C, 2008). In fact, it's well known the relationship between obesity and Metabolic Syndrome (MS) (Alberti KG, 2005). MS comprises specific cardiovascular risk factors, such as central deposition of body fat, arterial hypertension, dyslipidemia and insulin resistance (Alberti KG, 2005). This clustering has been shown to occur not only in adults but also in children and adolescents (Rêgo C, 2008; Weiss R, 2004; Zimmet P, 2007). Obesity is also associated with a higher risk of developing gallbladder disease, osteoarthritis, cancer, and mental disorders (WHO, 2000).

Given this background, it becomes urgent to promote the awareness of the population regarding the emerging problem and the adoption of effective strategies in combating the disease.

Physical activity (PA) is widely recognized as an essential component of obesity prevention (WHO, 2000). Nevertheless, it is also known that PA levels track from early childhood, with highest benefit (Telama R, 1997). Current literature demonstrates inconclusive results about the impact of PA on obesity (Sluijs E, 2007). Even so it was recently demonstrated that this may be due to the frequent use of absolute value of Body Mass Index (BMI) and not to the absence of an effective change in body composition (Lavelle H, 2012; George A, 2013). Furthermore, BMI may not be the best measure of childhood adiposity neither the best predictor of adult obesity (Prentice A, 2001). On the other end it's the amount of fatness that is associated with cardiometabolic comorbidities and it´s already well-documented the efficacy of PA on modifying body composition percentages (Farias ES, 2009). In addition, it's recognized the influence of PA interventions on preventing cardiometabolic risk in children (Meyer A, 2006). Recently, was also suggested the mean of a multiple-step PA strategy in children and adolescents at risk for MS, by considering PA as one main tool in treatment of MS (Brambilla, 2010). It is important to say that the inconsistency of available data involved many limitations of the existent studies, namely a wide range in sample sizes and PA programs with different intensities, durations, frequencies and types of activities. Intervention PA programs for obese children are mostly based on a variety of aerobic and resistance activities, accommodating individual differences in PA interests (running and walking), and rarely link children´s interests to team-games and sport activities (Meyer A, 2006; Brambilla, 2010).

According to WHO 2010 Global Recommendations on Physical Activity for Health, children and youth aged 5–17 should accumulate at least 60 minutes of moderate- to vigorous-intensity physical activity daily. Amounts of physical activity greater than 60 minutes provide additional health benefits and most of the daily physical activity should be aerobic. This document also recommends that vigorous intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week (WHO, 2010). However, most of the children didn't reach these goals. There are some possible hypotheses trying to explain the low compliance. A possible explanation is linked to limited possibilities of undertaking recommended PA (type, duration, frequency and intensity) in many schools. Another possible explanation is that children perceive prescribed PA as not enjoyable because it is superimposed by others and not self-chosen. Heart-rate (HR) studies demonstrate that children spontaneously perform only short bouts (<5 min) of activities and seldom participate in long sustained (>20 min) activities (Amstrong N, 1991).

Soccer is one of the most popular, affordable, widely practiced team-sports worldwide. Soccer it is associated with relatively high energy expenditure and has a high aerobic component (HR>75 max) (Amstrong N, 1991). Recent data suggests that carrying out regular soccer training organized as small sided drills causes significant cardiovascular and muscle adaptations including muscle growth and elevated muscular strength (Randers MB, 2010). Soccer has been recently suggested as a very effective "tool" in reducing CMRF in adults (Krustrup P, 2010). Two recent studies analyzed the efficacy of a recreational soccer program on the health and fitness of overweight children (Weintraub D, 2008; Fraude O, 2010). While CMRF were not assessed, this data suggested that soccer had a strong positive effect on weight control. Given this novelty, soccer interventions may also function as highly effective therapeutic approach for CMRF prevention/reduction in obese children.

Thus, intervention programs including soccer need to be investigated in order to arrive at evidence-based recommendations for its implementation on the early treatment of obesity and related comorbidities in childhood.

The aims of this study are: to understand the efficacy of a systematic practice of recreational soccer as an innovative and highly-effective treatment program for adolescent obesity; to evaluate its influence on the improvement of obesity-related cardiometabolic comorbidities.

METHODS

This is a prospective (September 2013 to March 2014), randomized controlled trial of a soccer intervention program entitled "*Soccer as a novel therapeutic approach to pediatric obesity. A randomized controlled trial and its effects on fitness, body composition, cardiometabolic and oxidative markers"* supported by UEFA.

Participants

To be eligible for recruitment and participation, children had to be 8 to 13 years of age and be overweight or obese, using a body-mass index (BMI) ≥ 85th percentile for age and gender, according to the WHO cut-off point (Onis M, 2007). Only boys were recruited. Were invited all children from a school in Perafita who met the inclusion criteria (n=65); a total of 45 accept to participate as intervention group. From all children in this age-interval followed in a pediatric outpatient clinic of obesity in a Porto city Hospital, we have alleatory selected 20, the control group. A total of 65 participants were included in the study.

Children were excluded if they use medication or if they have any serious medical condition, such as, cardiovascular disease, type I diabetes, endocrine disease (thyroid, suprarenal) as also hepatic disease. Participation in structured exercise or weight loss programs in the last year was also considered exclusion criteria.

The study was carried out in accordance with the Declaration of Helsinki (2000). Ethical approval was obtained from the Faculty of Sport of Porto Ethics Committee. All Children and their parents were fully informed about the study participation and given their written informed consent. The study staff was trained prior to the data assessments, and was guaranteed a total respect and privacy to the participants involved.

Study design and training interventions

After completing the baseline measures according to a study protocol, children from Perafita school were randomly assigned to two different training groups [G1: soccer program (n=25); G2: individual sport program (n=20)]. Training sessions for both groups were carried out three days per week (Monday, Wednesday, Friday, 18:00-19:30 hour) and were conducted by professors from the Faculty of Sport of Porto University. The “soccer program” consisted of a warm-up (10min), different technical exercises and small-sided games (40-50min) and a cool-down (10min). The "individual sport program" included a warm-up (10-20min), different kind of activities such as walking, running, and exercises to improve coordination and strength (40-50min) and a cool-down (10min).

The control group (G3) (n=20) comprised children whose physical activities were limited to those included in the compulsory physical education curriculum (2 sessions per week, 45-90 minutes each).

Study Protocol

All evaluations were taken at baseline (before randomization) and after 6 months (post-intervention), using the same standardized protocol. A study protocol was used from whom, for this study, we have analyzed the following variables:

Anthropometric and nutritional status characterization

The assessment of all anthropometric values followed both methodology and techniques internationally recommended (Jelliffe DB, 1989). All measures were made with every child/adolescent being barefoot and on underwear.

Weight evaluation was obtained using the InBody® 230 device 0.1kg precision and the results obtained were expressed in kilograms. To obtain the standing-height values, a fixed stadiometer (Holtain Ltd.) with 0.1cm precision was used and the results were expressed in meters.

Body-mass index (BMI) was directly calculated by the InBody® 230 software. It was expressed in kilograms per square meter. To define excess weight and obesity it was assumed a z-score value equal or higher than 1.0364 (which is equivalent 85th percentile) and equal or higher than 1.6449 (which is equivalent to 95th percentile). The z-score values of all anthropometric variables were calculated using the WHO AnthroPlus® software (WHO anthro).

To evaluate waist circumference (WC) a 150cm flexible measuring tape (Holtain, Lda) with 0.1cm precision was used and the measurement was performed on bare skin at the umbilical scar level. The results are expressed in centimetres. These values together with height in centimetres allowed the establishment of the ratio between waist circumference and height (WtHR). The cut-off used to represent cardiovascular risk was 0.500 (McCarthy HD, 2006).

Body composition

Body composition was assessed by direct segmental multi-frequency bioelectrical impedance using InBody® 230 device, able to predict fat mass excess in a way similar to DEXA (203). The values obtained were expressed in percentage for fat mass (%BFM, 0.1% precision) and in kilograms for muscle mass (MM, 0.1kg precision). Percentage of FFM (%FFM) was calculated using both values of muscle mass and weight in kilograms.

Biological Maturity status

Stage of pubic hair (PH) was the indicator of biological maturity status. Stage of PH based on the criteria of Tanner (1982) was evaluated at clinical examination by a pediatrician experienced in the assessment of secondary sex characteristics (Tanner

J, 1962). It was stratified as Tanner 1: prepubertal, Tanner 2 and 3: medium puberty and Tanner 4 and 5: final puberty.

Blood pressure

Resting blood pressure (BP) evaluation was determined in a comfortable and quiet room, by oscilometric method and using a Philips® VM6 device with a 0.1mmHg precision. The measurement was made according to international recommendations (National Heart, Lung and Blood Institute, 2004). The cuff was correctly chosen for each participant. We registered three measures with an interval of 2-3 minutes and the lower one was the final value. Systolic (SBP) and diastolic (DBP) values obtained were expressed in millimetres of mercury. According to international recommendations, “normal BP” is defined as SBP and DBP less than 90th percentile for age, sex and height, whereas “hypertension” is defined for values persistently equal or above the 95th percentile, measured on at least three separate occasions. Children with SBP or DBP equal or greater than 90th but less than 95th percentile are classified as having “high-normal BP”. Adolescents with BP 120/80 mmHg or more even if less than 90th percentile are also considered as having “high-normal BP”.

Biochemistry

After an overnight fast, between 8.00 and 10.00 a.m., blood samples were collected by venipuncture in EDTA containing tubes and processed within 2 hours of collection, from all participants at baseline and after six months. Aliquots of plasma were made and stored at -80^{o}C until assayed. Analysis of baseline and follow up samples were performed in the same day.

Blood samples were analyzed for total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-c), triglycerides (TG), glucose (G) and plasma insulin. TC and TG concentrations were determined by enzymatic colorimetric tests (CHOD-PAP and GPO-PAP methods, Roche, respectively). HDL-c was measured using a specific enzymatic colorimetric test (Direct HDL cholesterol, Roche). Low-density lipoprotein-cholesterol (LDL-c) concentration was calculated using Friedewald formula (Friedewald, 1972). The determination of circulating levels of glucose and insulin was performed by using routine automated technology (Roche).

The following scores were defined based on the level of cardiovascular risk: *Score 1* - without risk [TC < 170 mg/dl; TG < 90 mg/dl; LDL-c < 110 mg/dl; HDL-c > 45 mg/dl]; *Score 2* - average risk [TC≥ 170 <200 mg/dl; TG≥ 90 <130 mg/dl; LDL- c ≥ 110 <130 mg/dl; HDL-c ≥40 ≤45 mg/dl]; *Score 3* - high risk [TC ≥ 200 mg/dl; TG ≥ 130 mg/dl; LDL-c ≥ 130 mg/dl; HDL-c < 40 mg/dl]. *Score 3* corresponds to the 95^{th} percentile score for TC, TG and LDL-c and the 5^{th} percentile for the HDL-c (National Heart, Lung and Blood Institute, 2011).

The degree of insulin resistance was estimated with the use of the homeostatic model assessment for insulin resistance (HOMA-IR) and calculated as the product of the fasting plasma insulin (µU/ml) and the fasting plasma glucose (mg/dl) divided by 405 (Matthews DR, 1985). Insulin-resistance was defined for HOMA-IR values equal or greater than 2.67 and 5.22 for pre- and pubertal adolescents, respectively (Kurtoğlu, 2010).

Statistical analyses

Descriptive statistics (means and standard deviations) were calculated for both groups at the baseline and at the conclusion of the study. None of the anthropometric, body composition and cardiometabolic risk factors measures showed significant deviations from a normal distribution (Kolmogorov-Smirnov normality test). Baseline differences in mean anthropometric and body composition characteristics between groups were tested with one-way analysis of variance (ANOVA). The intervention effects were evaluated with repeated measures ANOVA. The significance level in all analyses was set at 0.05. Statistical analyses were conducted using SPSS version 21.0.

RESULTS

In the present study, 65 children and adolescents aged 8-13 years old (mean age of 10.6±1.2 years) were enrolled. All of them are males and more than half of them are classified as at medium-phase of puberty (Tanner stage 2-3= 56.2%) (Table I).From all sample, 63 (97 %) have completed baseline and 6-month measurements, the two drop-out belonging to both exercise-groups (G1 and G2). Children with only one measurement (either baseline or post-intervention) did not differ from the remaining in terms of outcome variables (data not shown).

The anthropometric and body composition characteristics at baseline and after 6 months are shown in Table I. No statistical differences between groups were observed at baseline ($p>0.05$). However, after 6 months intervention, exercise-groups G1 and G2 showed a significant improvement in BMI z-score, WC and WtHR compared to G3-control group. In addition, BFM and FFM percentages were respectively significantly lower and greater after the intervention in both exercise-groups (G1 and G2), in contrast with a significant increase in the percentage of BFM ($p=0.005$) and no changes in FFM ($p=0.032$) observed in G3-control group (Table I).
Regarding blood-pressure, no statistical differences between groups were observed at baseline ($p>0.05$). Beside this, the medium value for SBP for all groups, at baseline and after 6 months, is greater than the 90th percentiles, which define an "at risk" population (Table I). With the exception of DBP in G1, changes in SBP and DBP after the intervention period did not differ between groups at 6 months (Table I).

In Table II we can observe the WHtR behaviour. In fact, only in both exercise-groups G1 and G2 we find a decrease in the number of children and adolescents with an at-risk WHtR, after 6 months intervention.
Characterization of the lipid profile, glucose and insulin metabolism as also insulin resistance (HOMA-IR) was summarized in Table III. The medium value for studied lipid profile variables were between normal ranges, when considered all sample. After intervention (T1), whereas TC and LDL-c decreased only in the G1 and TG decreased only in the G2, HDL-c increased in both groups. No significant changes were observed in G3. HOMA-IR was between normal range for the studied population and no significant changes were observed in intervention groups.

As DBP expressed as % 90th percentile show a mean value between normal ranges (Table I), we consider only SBP for the stratification of all sample according to risk-score for BP. On Table 4 we can observe a considerable decrease in the prevalence of High-BP after intervention on both PA groups, G1 and G2.

On Table 5 we can observe lipid profile variables grouped according to the score of risk. Only exercise groups G1 and G2 show a decrease prevalence of risk-score 3 after intervention, with significant differences for TC (p=0.002) and LDL-c (p= 0.001) for G1 and TG (p= 0.008) and HDL-c (p= 0.033) for G2. No differences in the prevalence of at-risk HOMA IR values were observed after intervention in all groups.

DISCUSSION

Obesity is now widely accepted as a multifactorial disease where diet and physical activity play an essential key-role, not only in prevention, but also in treatment.

A sedentary lifestyle affected by urbanization as well the increasing lack of motivation to participate in organized physical activity that occur through childhood and adolescence, are some of the factors who can justify the great difficulty to meet the recommendations concerning PA practice in pediatric ages (Santaliestra, 2013). The synergism between lower performance and easy fatigability observed in obese children/adolescents increases this difficulty and results in a decreased motivation to participate in any physical activity program, or even in any sports-team.

Taking into account these considerations, if the aim is the promotion of PA in pediatric age, especially in those with overweight/obesity, it is crucial to find an enjoyable and popular sport. The involvement with pleasure and fun, increases motivation and self-esteem and acts as a guarantee of success. Soccer, as previously referred, is one of the most popular team-sports in Portugal, reason that supports their choice for an intervention program with Portuguese obese children and adolescents, named *"Soccer as a novel therapeutic approach to pediatric obesity".* This project, supported by UEFA Research Grant Programme Application (ref NASP/jud, 16 May 2013), is a controlled trial, with 6-month follow-up, were the practice of recreational soccer as a new and highly-effective treatment program for childhood obesity was encouraged. In fact, we want to analyze the influence of exercise, in particular soccer practice, on the improvement of nutritional status, body-composition as also obesity-related cardiometabolic comorbidities. Because in our country soccer is most frequently played by boys, we have decided, in this first study, only to select males.

For that, 45 school-children between 8-13 years (mean: 10.6 y) previously diagnosed as overweight/obese, were randomly incorporated in two different groups [G1: soccer program (n=25); G2: individual sport program (n=20)]. A group of overweight/obese patients followed in an outpatient clinic of obesity in a Porto city Hospital were enrolled for the control group (G3: n=20). An equal nutrition intervention was developed for the three groups at baseline.

A great magnitude of obesity can be observed at baseline (BMI z-sc= 2.53 ± 0.7; BFM %= 35.5±7.0), with no differences between groups (Table I). The literature is not consensual regarding the effect of PA on nutritional status (Jovanović R, 2010), being one of the major reason for the lack of consensus the variability of measures used by different authors (WHO, 1995). In fact, different method creates some difficulty to analyze the results, as some of them have different interpretations. Usually, and given its simplicity, BMI is the most frequent measured used as it is accepted as a universal method for assessing nutritional status as also adiposity in children and adolescents (Cornier MA, 2011). Even so, if we consider that calculation of BMI takes into account two index with a highly variability in the pediatric age (height and weight), the use of absolute BMI, as seen in the mostly previous data, decrease its sensibility. On the other side, the use of BMI z-sc for age and sex increases sensibility. In our sample, we had a significant reduction in obesity levels for both exercise groups and an increase in control group (BMI z-sc: T0=2.5(0.9) and T1=2.7(0.9) (Table I). Despite the significant decrease of BMI z-sc in G1 and G2, children`s maintains an obese status (BMI z-sc = 2.2±0.5 and 2.3 ±0.8 respectively) (Table I). It's also well known the limitation of BMI as a measure of body composition as it reflects both fat and fat-free components of body weight (Prentice A, 2001). It is acceptable that PA could increase lean muscle mass and decrease fat component with no overall change or even with an earlier increase in BMI. In fact, even BMI is easier to evaluate, body composition rather than body weight or body-mass, might be more appropriate as more accurate. In our population we can observe that physical activity was significantly associated with de decrease in BFM as also intra-abdominal deposition of fat (WC) and an increase of FFM (Table I). In accordance with previous data our study have shown the effects of PA on body composition suggesting that a reduction in adiposity can occur while maintaining or even increasing FFM in children (Farias ES, 2009; Lazzer S, 2008). The treatment of obese children should aim a decrease in FFM, instead of lost FFM. In order to ensure the adequate growth and development, and, at same time, prevent cyclic weight regain. Notably, a decrease in FFM can result in subsequent reduction in basal metabolic rate, which then becomes a major risk factor for weight gain (Wong PC, 2008). Regarding that, we consider that the use of BMI z-score instead absolute BMI, as also the use of the high-sensitive InBody ® to characterize body compositions are two of the strengths of our study.

Recent studies defend also the use of indexes such as WC and WtHR as highly sensitive and specific markers of upper body fat accumulation in children (McCarthy HD, 2001; McCarthy HD, 2006). WC measurements could offer a more sensitive means than BMI for identifying overweight and obese children who might be at an increased risk for developing metabolic complications (McCarthy HD, 2001). Even so, it's difficult to precise the influence of height in WC (McCarthy HD, 2001). WtHR takes height into account and has been proposed as an indicator of the excessive amount of upper body fat comprising several health risks (McCarthy HD, 2006). A WtHR cutt-off point was already established for adults (higher than >0,500) (Ashwell MA, 1996) and recent data propose the use of the same value for children (McCarthy HD, 2006). Beside that recent proposition regarding the use of the adult cut-off point in pediatric age, this has not yet validated in children and in fact it might over-estimate the number of children considered at-risk. In our study, the medium value for WtHR for all sample is greater than 0.500 (Table I) and with almost all overweight/obese boys showing a value greater than 0.500 at baseline (Table II), which should be a cause for concern as define this population as at high-risk of cardiometabolic comorbidities. We can observe a positive influence of PA on WC (Table I) and WtHR (Tables I and II), but without differences between the exercise-groups G1 and G2 (Table II). Anyhow, the both groups, when compared to control group, demonstrated a significant effect on module these two central-adiposity markers as G3 show no changes, after 6 months follow-up (Tables I and II) . Even knowing that decrease of central adiposity is more slowly and difficult than total adiposity, the decrease of WC and WtHR verified in present data demonstrate that exercise of moderate-high intensity is associated with significantly reduction on this markers and contribute for lowering the risk to develop cardiovascular comorbidities and acute coronary events later in life (Miller, 2005). In addition, we consider the use of the WtHR instead the measure of the waist alone, is one more strength of our study.

Furthermore, the strong positive relationship between BMI and BP in children and the association between BMI z-score values higher than 1.0 (matching 85th percentile) with the expression of elevated blood pressure values are supported by literature (Falkner B, 2006; Guimarães IC, 2008). In fact, increase in pediatric hypertension growth in parallel with increasing prevalence of pediatric obesity worldwide (Muntner P, 2004). Otherwise, it seems that expression of high-blood pressure as a consequence of obesity needs time, being the adolescence-age associated with duplication in hypertension prevalence (Rêgo C, 2008). Our obese population (mean BMI z-score 2.5), with a mean age of 10.6 years and almost all of them at Tanner stage 2-3, shows a mean value for SBP greater than the 90th percentile at baseline (Table I), which indicates a high-risk to become hypertensive adults (Lurbe E, 2009 ; Bao W, 1995). Hypertension associated with pediatric obesity is usually a systolic-hypertension, and that fact is well documented in our population as mean value for DPB at baseline is lower than 90th percentile (Table I). According to our data, it is not possible to proof that PA (either G1 or G2) has an influence on SBP when compared to control group (G3) or when we compare the two intervention groups alone (G1 vs G2). The absence of improvement in SBP may be due to the short time of intervention. However, when we stratify the population in each intervention-group according to the classification in “Normal”, “Normal-High” or “High” BP, we can observe, in both exercise groups (G1 and G2), a tendency toward a decrease in the prevalence of high SBP that was not observed in G3 (Table IV). Finally, only the G1 had a significant improvement on DBP values (Table I).

However, PA is well recognized as tool in the prevention and treatment of high blood pressure in adults, including the obese population (Hagberg JM, 2000). In accordance, the effects of PA have been also benefic in the overweight children or adolescents (Torrance B, 2007). A recent study provides further evidence to support a causal relationship between higher levels of PA and lower DBP (Knowles G, 2013). Although this effect might look small (2 mm Hg lower DBP), this reduction in BP at adult-age is associated with a 6% reduction in CHD and 15% reduction in stroke-related events (Cook NR, 1995). With this knowledge, we support that PA and particularly soccer could be efficient tools in BP maintenance, and consequently in the prevention of complicated diseases, even in obesity children.

Cardiovascular risk is associated with obesity dyslipidemia, characterized by lower levels of HDL-c concomitantly with an increase in TC, TG and LDL-c (Miller WM, 2005). A strong stability in the risk of lipid profile in pediatric age could predict the adult’s levels, even considering the variability of lipid profile during child development (Rêgo C, 2008). Obesity, even at pediatric age, is associated with increased risk of an atherogenic lipid profile (Horri M, 2006; Rêgo C, 2008).However, and on contrary of blood-pressure behavior, it seems that genetic predisposition is more important on the clinical expression of the disease than age or duration of obesity (Rêgo C, 2008). In our study we did not investigate family history of cardiovascular disease and this may be a weakness of our work. Regarding our results, we observe that our extremely obese children`s and adolescents shows a lipid profile at baseline with medium values between normal ranges, what means that can be classified as a “no risk” population (Table III).However, important improvements in lipid profile were observed after intervention in both exercise-groups G1 and G2 with no changes from baseline to 6 months follow-up on G3 control-group (Table III).Current recommendations about cardiovascular risk centered their concern on LDL-c levels, showing that a reduction on it level decreases the risk of cardiovascular events and lowered mortality (Institute, 2011). On our study, only soccer training was responsible for a significant decrease in LDL-c, as no changes were observe in G2 and G3 control-group (Table III). However, when we stratify our sample according to score of-risk of each variable, soccer showed a higher effect in reduce the prevalence of all CMRF with score 3, classified as "high risk", when compared to G2 and G3 (Table V). One possible explanation for that it's the fact that soccer training were predominantly aerobic, the muscle metabolism more strongly associated with improvement on lipid profile (Randers B, 2010). In addition, objective differences reflecting the influence of PA on Insulin Resistance (IR) weren't reported in our study. However, the fact that we have an early-aged population associated with the predominant absence in IR at baseline probably explains the lack of effect (Table V).

At last it is important to state that our study supports the growing evidence of the benefits of PA (soccer program and individual sport program) in reducing BMI and improve body-composition, as also lipid profile and blood-pressure, in overweight/obese children`s and adolescents. We do not find significant differences between soccer and individual sport program (G1 vs G2). As we mentioned, all PA classes were given to G1 and G2 by teachers from Sports faculty who are strongly engaged with children's and works hard to improve motivation in order to increase the success of intervention program. Taking into account that "Enjoy and have pleasure. Feel good. Be motivated. Work hard" are the main propose of both exercise-groups (G1 and G2), probably the great commitment of all teachers can explain the lack of differences between exercise-groups (Tables I, II, III).

CONCLUSION

Soccer training, as also individual sport program, maintained during 6 months, was associated with significant decrease in BMI z-score, central adiposity (WC and WtHR) and body fat-mass, concomitantly with an increase on FFM, in a severe obese pediatric population. Significant changes were also observed regarding lipid profile in association to PA, whereas only SBP in soccer group show an improvement after 6 months intervention. A reduction in the prevalence of “High” SBP and an at-risk score for lipid profile were observed in both exercise groups.

The healthy-related improvements observed in both exercise groups as also the small number of “drop-outs” may be explained by the fact that all PA classes were coordinated by a high-motivated professional.

As a pilot study, the current study was carried out in a small sample of children and adolescents and only dated 6 months, which hampered the finding of statistical significant differences. Longer studies, with greater samples and using the same methods are needed, to reinforce these results.

However, our results help us to reinforce the importance of physical activity in the promotion of healthy lifestyle as also in prevention and treatment of childhood obesity. In addition, results from this study encourage us to guide future researches around soccer as an innovative and potential type of successful PA proposal for obese children`s and adolescents.

Declaration of interest

The authors report no declarations of interest.

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Table I. Characterization of the sample at baseline (TO) and after 6 months intervention (T1), according to intervention group: nutritional status [m (dp)], body composition [m (dp)], blood pressure [m (dp)] and Tanner Stage [n (%)].

	All Sample	G1			G2			G3		
	T0	**T0**	**T1**	**p**	**T0**	**T1**	**p**	**T0**	**T1**	**P**
CA (years)	10.3 (1.4)	10.5 (1.5)	10.9 (1.6)	**0.000**	10.7 (1.2)	11.3 (1.1)	**0.000**	9.7 (1.3)	10.3 (1.3)	**0.000**
Height (z-score)	1.0 (1.1)	1.1 (1.1)	0.8 (1.0)	**0.030**	0.6 (0.7)	0.5 (0.7)	**0.136**	1.2 (1.3)	1.0 (1.3)	**0.239**
BMI (z-score)	2.5 (0.7)	2.4 (0.5)	2.2 (0.5)	**0.001**	2.5 (0.8)	2.3 (0.8)	**0.000**	2.5 (0.9)	2.7 (0.9)	**0.145**
WC (90th percentile)	88,9 (10.6)	82.7 (9.7)	80.0 (9.5)	**0.001**	90.2 (9.4)	85.2 (8.2)	**0.000**	85.8 (12.1)	85.5 (12.3)	**0.740**
WtHR	0.58 (0.06)	0.56 (0.4)	0.54 (0.04)	**0.000**	0.61 (0.06)	0.57 (0.06)	**0.000**	0.59 (0.06)	0.58 (0.07)	**0.196**
BFM (%)	35.5 (7.0)	34.2 (5.6)	32.3 (5.5)	**0.036**	38.3 (7.8)	34.2 (10.1)	**0.000**	34.4 (7.6)	37.5 (10.5)	**0.005**
FFM (%)	34.7 (7.2)	34.4 (7.6)	35.6 (8.0)	**0.023**	34.3 (6.8)	36.9 (7.6)	**0.000**	35.5 (7.3)	34.9 (6.9)	**0.332**
SBP (%90th percentile)	110.6 (11.8)	110.3 (12.4)	113 (12.0)	**0.292**	110.5 (7.0)	114.7 (11.8)	**0.151**	111.3 (15.3)	110.5 (8.9)	**0.782**
DBP (% 90th percentile)	56,8 (9.0)	57,4 (8.8)	54 (7.7)	**0.014**	56,7 (.,2)	52,9 (7.7)	**0.153**	56 (10.6)	56,7 (6.2)	**0.799**
Tanner Stage [n(%)]	**T1** 23(40.4) **T2-3** 31(54.4) **T4-5** 3(5.3)	**T1** 12(50) **T2-3** 11(48.8) **T4-5** 1(4.2)	**T1** 8(33.3) **T2-3** 15(62.5) **T4-5** 1(4.2)	**0.082**	**T1** 3(18.8) **T2-3** 11(68.8) **T4-5** 2(12)	**T1** 2(12.5) **T2-3** 11(68.8) **T4-5-**3(18.2)	**0.112**	**T1** 8(47.1) **T2-3** 9(53) **T4-5** 0(0)	**T1** 5(29.4) **T2-3** 12(70.6) **T4-5** 0(0)	**0.083**

G1: soccer program; G2: individual sport program; G3: control group

CA: Chronological Age; BMI: Body Mass Indez; WC: waist circumference; WtHR: waist to Height Ratio; BMF: Body Fat Mass; FFM: Fat-Free Mass; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure

Table II WHtR risk of cardiometabolic comorbidity: characterization of the sample at baseline (TO) and after 6 months intervention (T1), according to intervention group [n (%)].

	All Sample	G1		G2		G3	
	T0	**T0**	**T1**	**T0**	**T1**	**T0**	**T1**
WHtR < 0.500	1(1.8)	0(0)	4(17.4)	0(0)	3(17.6)	1(5.9)	1(6.3)
WHtR ≥ 0.500	56(98.2)	23(100)	19(82.6)	(17)100	14(82.4)	16(94.1)	15(93.8)

G1: soccer program; G2: individual sport program; G3: control group
WHtR < 0.500: without cardiometabolic risk; WHtR ≥ 0.500: high cardiometabolic risk

Table III Lipid profile (mg/dl), glucose (mg/dl), insulin (µU/mL) and insulin resistance (HOMA-IR): characterization of all sample and according to intervention group at baseline (TO) and after 6 months intervention (T=1) [m(dp)].

	All sample	G1			G2			G3		
	T0	**T0**	**T1**	**p**	**T0**	**T1**	**P**	**T0**	**T1**	**P**
TC	166.9 (36.5)	174.2 (45.3)	163.39 (32.8)	**0.023**	156.6 (28.4)	150.2 (25.7)	**0.264**	166.1 (23.6)	176.7 (25.8)	**0.110**
TG	76.4 (43.6)	70.8 (33.4)	54.61 (16.6)	**0.062**	93.8 (60.7)	64.1 (28.8)	**0.007**	64.3 (29.8)	77.3 (50.7)	**0.282**
LDL-c	100.6 (34.9)	105.6 (44.6)	92.8 (33.8)	**0.007**	89.3 (23.6)	84.2 (26.1)	**0.353**	105.5 (22.7)	109.9 (28.5)	**0.490**
HDL-c	51.1 (11.2)	54.4 (9.2)	59.6 (11.7)	**0.003**	48.5 (14.7)	53.2 (13.4)	**0.025**	47.7 (8.2)	51.3 (9.8)	**0.137**
Glucose	82.9 (5.8)	80.7 (4.9)	84.67 (9.84)	**0.030**	85.5 (4.5)	89.7 (7.3)	**0.059**	84.0 (7.5)	83.7 (5.6)	**0.893**
Insulin	9.1 (4.4)	8.4 (3.4)	8.06 (3.21)	**0.794**	10.4 (6.3)	9.5 (3.9)	**0.568**	8.7 (2.8)	10.9 (3.3)	**0.225**
HOMA-IR	**1.9 (1.0)**	**1.7 (0.7)**	**1.72 (0.82)**	**0.903**	**2.2 (1.4)**	**2.1 (0.9)**	**0.782**	**1.8 (0.6)**	**2.2 (0.7)**	**0.284**

G1: soccer program; G2: individual sport program; G3: control group
TC: Total Cholesterol; TG: Triglycerides; LDL-c: Low density lipoprotein cholesterol; HDL-c: High Density lipoprotein cholesterol

Table IV. Systolic Blood Pressure (SBP): characterization of the sample at baseline (TO) and after 6 months intervention (T1), according to intervention group. [n (%)]

	All Sample	G1		G2		G3	
	T0	T0	T1	T0	T1	T0	T1
Normal SBP	31 (59.6)	14 (58.3)	21 (87.5)	6 (46.2)	11 (84,6)	11 (73.3)	13 (86.7)
Normal-High SBP	4 (7.7)	2 (8.3)	1 (4.2)	1 (7.7)	0 (0)	1 (6.7)	0 (0)
High SBP	17 (32.7)	8 (33.3)	2 (8.3)	6 (46.2)	2 (15.4)	3 (20.0)	2 (13.3)

G1: soccer program; G2: individual sport program; G3: control group
Normal BP: < 90th percentile; Normal-high BP: ≥ 90th percentile < 95th percentile; High BP: ≥ 95th [25]

Table V. Prevalence of each CMRF according to score of risk of all sample and according to intervention group at baseline (TO) and after 6 months intervention (T=1). . [n(%)]

	All sample	G1			G2			G3		
	T0	T0	T1	p	T0	T1	P	T0	T1	p
TC										
Score 1	30 (62.5)	13 (59.1)	15 (68.2)		10 (71.4)	12 (85.7)		7 (58.3)	5 (41.7)	
Score 2	11 (22.9)	4 (18.2)	4 (18.2)	**0.002**	3 (21.4)	1 (7.1)	**0.233**	4 (33.3)	5 (50)	**0.002**
Score 3	7 (14.6)	5 (22.7)	3 (13.6)		1 (7.1)	1 (7.1)		1 (8.3)	1 (8.3)	
TG										
Score 1	40 (83,3)	18 (81.8)	21 (95.5)		11 (78.6)	13 (92.9)		11 (91.7)	9 (75)	
Score 2	3 (6.3)	2 (9.1)	1 (4.5)	**0.227**	1 (7.1)	0 (0)	**0.018**	0 (0)	2 (16.7)	**0.264**
Score 3	5 (10,4)	2 (9.1)	0 (0)		2 (14.3)	1 (7.1)		1 (8.3)	1 (8.3)	
LDL-c										
Score 1	34 (70,8)	16 (72.7)	19 (86.4)		11 (78.6)	13 (92.9)		7 (58.3)	6 (50)	
Score 2	8 (16,7)	1 (4.5)	0 (0)	**0.001**	3 (21.9)	0 (0)	**0.588**	4 (33.3)	4 (33.3)	**0.001**
Score 3	6 (12,5)	5 (22.7)	3 (13.6)		0 (0)	1 (7.1)		1 (8.3)	2 (16.7)	
HDL-c										
Score 1	35 (72.9)	18(81.8)	16 (86.4)		9 (64.3)	8 (57.1)		8 (66.7)	9 (75)	
Score 2	5 (10.4)	1 (4.5)	1 (4.5)	**0.277**	1 (7.1)	4 (28.6)	**0.033**	3 (25)	2 (16.7)	**0.046**
Score 3	8 (10.7)	3 (13.6)	2 (9.1)		4 (28.6)	2 (14.3)		1(8.3)	1(8.3)	
IR										
No	46 (96.0)	22 (100)	22 (100)	**-**	13 (92.9)	13 (92.9)	**0.773**	12 (100)	12 (100)	-
yes	2 (4.0)	0 (0)	0 (0)		1 (7.1)	1 (7.1)		0 (0)	0 (0)	

G1: soccer program; G2: individual sport program; G3: control group
TC:Total Cholesterol; HDL-c: High-Density Lipoprotein cholesterol; LDL-c: Low-Density Lipoprotein cholesterol; TG: Triglycerides; IR: Insulin-resistance defined according to HOMA-IR values [23]

ANNEXES

Annals of Human Biology

Instructions for Authors

About the Journal

Aims and Scope

Annals of Human Biology is an international, peer-reviewed journal published six times a year in simultaneous print and electronic editions. ***Annals of Human Biology*** is an important vehicle for the dissemination of papers concerning research into human population biology, reporting investigations on the nature, development and causes of human variation, embracing the disciplines of human genetics, auxology, environmental physiology, ecology, epidemiology ageing and global health.

Annals of Human Biology has a wide readership of human biologists, epidemiologists, auxologists, paediatricians, population geneticists, biological and physical anthropologists, gerontologists, physiologists and public health workers. ***Annals of Human Biology*** is the official journal of the Society for the Study of Human Biology.

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- Research Papers
- Review Articles
- Short Reports
- Human Biological Surveys
- Book Reviews

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