

Case report

Futsal improve body composition and cardiorespiratory fitness in overweight and obese children. A pilot study

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Abstract — Aims: The aim of this study was to verify body composition, cardiorespiratory fitness, and biochemical markers of prepubertal overweight and obese boys to a 16-week futsal training program. **Methods:** Sixteen boys (age: 7-10 y, body mass index > than 95th percentile according to Center for Disease Control and Prevention; 35.5 ± 7.4 percent fat) participated to futsal training program. The assessment of body composition was estimated using skinfold thickness, and the following variables were evaluated: total body mass, body mass index, body fat percentage, and lean body mass. Aerobic fitness measurement was performed by gas exchange analysis in treadmill. In addition, an evaluation of the biochemical profile was conducted: triglycerides, total cholesterol, low density lipoprotein cholesterol, high-density lipoprotein cholesterol, plasma concentrations of glucose, and insulin. The futsal intervention included 60-min sessions performed two times/week. The mean intensity during training was between 57 to 88% of maximal heart rate of the age-predicted. Individual portable heart rate monitor controlled training intensity. **Results:** Significant increases in total body mass (4%), height (3%), lean body mass (8%), and significant 6%-decrease in body fat percentage was observed. Body mass index remained unchanged. Maximal oxygen uptake was elevated ($p < 0.018$) by 11%. Biochemical markers were not modified after intervention. No association was found between body composition and metabolic variables. The effect size of futsal training on most variables was small (< 0.5). **Conclusion:** Controlled intensity and adherence to this 16-week futsal training program were determinant to enhance body composition, and cardiorespiratory fitness in this group of prepubertal boys.

Keywords: maximal oxygen uptake, lean body mass, fat mass percentage, overweight.

Introduction

Futsal and soccer are two sports with many similarities, but the striking difference between them is the size of the field, rules of the game, and tactical actions¹. Soccer is a sport that beyond the force of social inclusion is a powerful tool for health in all ages including a reduction in the risk of cardiovascular diseases, falls, and fractures². Soccer affects positively numerous cardiovascular risk factors such as oxygen uptake, heart function, blood pressure, insulin resistance, cholesterol, and fat mass far more than strength training, and just in as much as running³.

Nevertheless, several studies have investigated the effects of recreational soccer but almost none have addressed the futsal play on lipid and cardiovascular risk markers in overweight and obese children. Moreover, most of the applied research programs are not exclusively based on soccer practice⁴ and even more difficult with futsal, since markers are very restricted in cardiovascular risk⁵.

In brief, there is a lack of research on the efficacy of health-oriented sports programs for overweight and obese children with health markers, and that is one reason why we use futsal as this sport is widely practiced in school. According to Hallal,

Andersen, Bull, Guthold, Haskell, Ekelund⁶, approximately four in five adolescents do not achieve the recommended quantity and quality of daily exercise for health. Therefore, futsal may be the additive to activate metabolism and act as a cofactor to fight against overweight and obesity⁷. In relation to the higher contribution in futsal, we hypothesize that it is at least as efficacious as a standard exercise program in improving health and fitness in overweight and obese children. Thus, the aim of this study was to determine whether a recreational futsal training program would induce any chronic effects on total body mass, body fat percentage, lean body mass, maximal oxygen uptake (VO₂max) performance, and biochemical markers modification.

Materials and Methods

Participants and study design

Participants were recruited from the outpatient clinic of the pediatric endocrinology department of the Children's Institute

of the Hospital das Clínicas de São Paulo. This research follows a one-group pre and post-interventional design for 16-week for recreational futsal training. After explaining the objectives of the study, the parents of the children signed the informed consent form for participation. University of São Paulo, School Medicine Ethics Committee approved this study for Research on Human subjects (local protocol case 303/15 and Brazil platform CAAE number: 47882615.8.0000.0065). The study followed the recommendations of Declaration of Helsinki (1975) for the study in humans and follow ethics, consent and permissions practices. Sixteen overweight and obese boys (age: 7-10 y, body mass index (BMI) > than 95th percentile according to Center for Disease Control and Prevention (CDC); 35.5 ± 7.4 body fat percentage) were submitted to study⁸. The participants were without medications. The physical examination of the children included evaluation of total body mass, height, BMI, and pubertal stage. All exercise tests were performed on separate days (day 1: blood analysis measurements and skinfold assessment; and (day 2: cardiopulmonary exercise test). The inclusion criteria for the participants were: (i) to be overweight or obese, (ii) to be between the ages of 7 and 10 years old; (iii) to perform all assessments; (iv) parents' consent to participate in the study. Exclusion criteria were: (i) individuals with diabetes (type 1 or 2); (ii) renal dysfunction; (iii) hypertension; (iv) inability to perform physical exercise due to orthopedic lesions.

Anthropometric assessment

Measurements of weight and height were carried out according to described standard techniques⁹, with the participants in light clothes and barefoot. Weight was measured to the nearest 0.05 kg and height (cm) was measured to the nearest 0.1 cm by using a scale balance with incorporated stadiometer (FilizolaTM, Brazil). Body mass index (BMI) was calculated from weight and height measurements according to the formula: $\text{BMI kg/m}^2 = \text{weight}/(\text{height}^2)$ and classified according to the CDC/National Center for Health Statistics (NCHS) BMI chart for boys (2 to 20 years).

Body composition assessment was accomplished using a Lange skinfold caliper (Cambridge Scientific IndustriesTM, Cambridge, Massachusetts, USA) for measurements of triceps, biceps, subscapular, and suprailiac skinfolds. Skinfold thickness was measured on the right side of the body to the nearest 0.1 mm in triplicate. Body fat and fat-free masses were estimated using the equations of Brook¹⁰ for body density of children from 1 to 11 years old and the following equation of Siri¹¹ to calculate body fat percent of total body weight: $\% \text{ body fat} = [(4.95/\text{density}) - 4.5] \times 100$. Lean body mass was calculated subtracting fat mass from total body weight. All skinfold thickness measurements were carried out by the same trained investigator. Intraobserver technical errors of measurement were smaller than 1 mm and reliability greater than 95%.

Biochemical analysis

Blood tests assessments were performed before the beginning of intervention and within 48-72 h after last training session.

Blood samples for assessing haematological and biochemical parameters were collected in plain vacuum tubes from a forearm vein with minimum stasis. The individuals were in a seated position during this procedure, and had previously remained at rest for approximately 15-min. The samples were taken between 8:00 and 9:30 am, after overnight fasting and at least 24 hours since the last workout. An aliquot of 20 ml from the venous blood sample was immediately mixed with Ethylenediaminetetraacetic acid (EDTA) solution to prevent clotting, for blood testing. The rest of the sample was left to coagulate for 30-min at room temperature and was centrifuged at $1500 \times g$ for 10 min in order to separate the serum for biochemical analysis. The serum was stored at -20°C in our hospital laboratory. We performed all assays by means of commercially available diagnostic kits and using worldwide accepted techniques¹².

Cardiorespiratory fitness

Cardiopulmonary exercise testing was assessed on a motor-driven treadmill (h/ p/cosmosTM, pulsar, Nussdorf-Traunstein, South of Germany) before and after completed futsal training program using a ramp-incremental modified Heck protocol. After two pilot tests with different speeds (3.6, 4.8, 6, 6.5, and 7.2 $\text{km}\cdot\text{h}^{-1}$) the test treadmill speed remained constant at a speed selected by the subject, and slope increments at the rate of 2% per minute¹³. Once speed had been selected, individuals remained for 2-minute at rest and shortly thereafter began the protocol at the previously chosen and tested speed. During the 6-minute recovery phase, starting immediately after the end of the examination, the speed and incline gradually decreased until the third minute, and from the fourth to the sixth minute the treadmill remained stationary. Minute ventilation (V_E), respiratory exchange ratio and oxygen consumption (VO_2) were measured using an oxygen analyser monitored by a breath-by-breath system (CPX, Ultima, Medical GraphicsTM, St Paul, MN, USA). This metabolic cart measures expired airflow by means of a pneumotach connected to the mouthpiece. A sample line is connected to the pneumotach from which air is continuously pumped to O_2 and CO_2 gas analyzers. Prior to testing, the pneumotach was calibrated with ten samples from a 3-L calibration syringe. The gas analyzers were also calibrated before each test to room air and medically-certified calibration gases (12.0% O_2 and 5% CO_2 , respectively). An electrocardiographic signal (ECG) was recorded throughout the test. VO_2 max was assessed by the attainment of the following criteria: (a) presence of VO_2 plateau (ΔVO_2 between two consecutive stages of less than $2.1 \text{ mL}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$); (b) terminal Heart rate (HR) $\geq 90\%$ of the age-predicted HRmax by Tanaka equation [$208 - (0.7 \cdot \text{age})$] compared with symptom-limiting termination of the test; (c) maximal respiratory exchange ratio ($\text{RER}_{\text{max}} = \text{VCO}_2/\text{VO}_2$) ≥ 1.05 at peak exercise; (d) maximum voluntary exhaustion defined by attaining score ≥ 18 on Borg scale⁶⁻²⁰ rating. All subjects met the first three criteria. In addition, data from the VO_2 max tests were time-averaged using 30-s intervals.

Training follow-up and training intervention

The intervention consisted of 16-weeks of supervised indoor recreational futsal training and was inspired by previous studies showing comparable effects of 12-weeks of football (soccer)¹⁴⁻¹⁵. During the 60 minutes of training, the exercises were 100% performed with ball. Futsal training consisted of warm-up (5-min) in displacements with ball, main session (50-min) and cool-down (5-min). The futsal coach used a lot of strategy to encourage relaxing and at the same time leave the children concentrated in the exercises with the ball. The quantity of training was decisive for this outcome, i.e. the frequency, duration and the volume of training.

Heart Rate Monitoring

An adequate cardiac output must be sustained to provide sufficient blood flow throughout the body. The HR control of the child was continuously monitored in real-time using a wireless HR monitoring system. The data were archived from the heart rate monitoring system, Polar RS300X (Polar Electro™, Kempe, Finland). Each child was assigned to a numbered chest strap transmitter from the Polar Team system. All training sessions were recorded and stored on each individual heart rate transmitter until the data was uploaded. The participants were only expected to wear their assigned chest strap monitor while performing their sport required trainings. At the end of each week, an exercise physiologist would examine the physiological responses for each individual and determine how to progress the training for the subsequent week. The heart rates of children's futsal players were recorded during: first phase for specific exercises (5-minutes that served as warm-up performed with low intensity exercise using the ball); second phase during games with official rules, played 4 vs 4 (10 minutes), 3 vs. 3 and 2 vs. 2 (4 minutes), with a 4-minute pause between each repetition for physical recovery and hydration. The last 5-minutes of session were a cool-down, during which the children played low-intensity games. Therefore, it was possible in each 60-minute session to repeat two passages of the procedures. During the training exercises, the coach guided the actions of the players, allowing occur little breaks so players were not induced fatigue state. Training program consisted of two sessions/week with average intensity $76 \pm 6\%$ (range: 57-88%) of the age-predicted (HRmax) adopting a structure of high-intensity interval training program for pediatric population. Individual portable HR monitor controlled training intensity according to the determined heart rate target calculated from Tanaka equation¹⁶. A trained futsal coach was present during all sessions in order to control the duration of the training and to ensure games exercises. Brief passive rest recovery (<30-s) was incorporated intermittently to allow the coach's instructions on exercises could be improved.

Statistical analyses

The Gaussian distribution (normality) for the data was verified

by the Kolmogorov–Smirnov goodness-of-fit test (Z value < 1.0). Paired Student t -test for pre and post-training comparison with significance level at $p < 0.05$. Pearson's correlation coefficient (r) was used to verify association between metabolic and lipid profiles and body composition. Cohen's d effect sizes (ES) thresholds values were classified as (small 0.2–0.4, moderate 0.5–0.7, large 0.8–1.1, very large 1.2–1.8 and extremely large ≥ 4.0 , respectively) were used for compare the variables after intervention. Defined d as the difference between the means, $M1 - M2$, divided by standard deviation, SD ($d = M1 - M2 / SD$), of either group. Cohen argued that the standard deviation of either group could be used when the variances of the two groups are homogeneous. Data are presented as mean \pm standard deviation (SD); Statistical analyses were performed using Sigma Stat (version 3.5, Systat Software, Inc, Point Richmond, CA).

Results

Anthropometric data, body composition parameters and $VO_2\max$

Total body mass and height increased continuously during the study period. No differences were found in BMI that remained nearly constant (Table 1). After 16-weeks of recreational futsal, lean body mass (LBM) was 1.9 kg higher ($p < 0.01$) than pre-futsal program; $d = 0.45$, small effect size. Total body weight was higher ($p < 0.02$) after this period; $d = 0.21$, small effect size (Table 1). No differences were observed in body mass index; $d = 0.55$, moderate effect size (Table 1). Body fat percentage was smaller ($p < 0.01$) 6% over intervention; $d = 0.29$, small effect size. In post futsal training, maximal oxygen uptake ($VO_2\max$) was 11% higher ($p < 0.01$) after 16-weeks intervention; $d = 0.68$, moderate effect size (Table 1). No association was found between body composition and metabolic variables.

Table 1. Body composition and $VO_2\max$ before (pre) and after (post) intervention in the recreational futsal training program

Variable	Pre 0 weeks (N=16)	Post 16 weeks (N=16)	CI 95%	(Cohen's d ES)	Paired t-test P value
TBM (kg)	47.6 \pm 11.1	49.4 \pm 11.3	-3.087 to -0.488	0.21	0.010
Height (cm)	139 \pm 7.8	143 \pm 7.6	-4.403 to -3.222	0.52	0.001
BMI (kg/m ²)	24.6 \pm 0.1	24.4 \pm 0.5	-0.06 to 0.46	0.55	0.127
BF (%)	36.2 \pm 7.7	34.2 \pm 7.9	0.258 to 3.576	0.29	0.026
LBM (kg)	29.0 \pm 4.1	31.2 \pm 4.0	-2.743 to -1.594	0.45	0.001
$VO_2\max$ (mL.kg ⁻¹ .min ⁻¹)	27.6 \pm 4.6	30.6 \pm 4.2	-5.503 to -0.610	0.68	0.018

Abbreviations: TBM, total body mass; BMI, body mass index, BF, body fat percentage; LBM, lean body mass; $VO_2\max$, maxima oxygen uptake. d effect size (ES): small, 0.20-0.4; moderate, 0.5-0.8; large 0.8-1.1, very large 1.2-1.8 and extremely large ≥ 4.0 . Values are presented as mean \pm 95% CI.

Biochemical Analysis

No differences were observed in blood lipid and metabolic profiles between pre and post futsal training program (Table 2).

Table 2. Lipid and metabolic profiles before (pre) and after (post) intervention in the recreational futsal training program

Variable	Pre 0 weeks (N=16)	Post 16 weeks (N=16)	CI 95%	(Cohen's d ES)	Paired t-test P value	Reference values in blood
TC (mg/dL)	176±27	168±30	-1.190 to 17.315	0.20	0.083	< 244
HDL-c (mg/dL)	49±12	50±10	-4.337 to 3.087	0.10	0.725	35-84
LDL-c (mg/dL)	118±28	108±34	1.101 to 18.024	0.19	0.029	< 136
VLDL-c (mg/dL)	19±13	17±8	-2.280 to 5.405	0.18	0.400	< 40
TRI (mg/dL)	96±6	88±38	-11.319 to 26.694	0.09	0.402	< 137
GLU (mg/dL)	86±6	86±5	-4.497 to 4.372	0.18	0.976	60-110
In (mU/L)	10.1±5.4	11.5±6.5	-3.683 to 0.833	0.32	0.198	1.8-24.6

Abbreviations: TC, Total cholesterol; HDL-c, high-density lipoprotein; LDL-c, low-density lipoprotein; VLDL, Very-low-density lipoprotein; TRI, Triglycerides; GLU, Glucose; In, insulin. *d* effect size (ES): small, 0.20-0.4; moderate, 0.5-0.8; large 0.8-1.1, very large 1.2-1.8 and extremely large \geq 4.0. Values are presented as mean \pm 95% CI.

The intervention pilot attendance and Training intensity

The attendance rate during the intervention pilot was 80% at the end of the program and corresponded to a mean of 26 training sessions per child during the whole study period. Exercise intensity \geq 76% of HRmax was recorded during 60 min/session. Training intensity was quantified by means of heart rate monitoring several times for each child. For each individual, heart rate was recorded during an average of 20 training sessions (63% of total training time). The mean training heart rate was 153 ± 11 beats/min, corresponding to $76 \pm 6\%$ HRmax (range: 57 - 88%). Estimated energy expenditure (from gas exchange and heart rate data during treadmill exercise test) was 1.523 ± 184 kJ (364 ± 44 kcal) per training session.

Discussion

The present study highlights the positive effects of futsal training on body composition and aerobic power of the overweight

and obese children. Traditional soccer has shown several effects on health parameters¹⁷. However, no other studies assessing recreational futsal in overweight and obese children were found in the literature. Therefore, our data are compared to soccer as sport similar to futsal.

Nevertheless, the present study showed that futsal training is an effective way of obtaining improvements in performance and significant physiological adaptations¹⁸. Additionally, our findings suggest that the positive aspects of recreational futsal and the results from this research may be used in sustainable environments such as the school's physical education classes. In addition, it may be an alternative activity for other chronic diseases once soccer has already been employed with this aim. Various studies have shown the effects of traditional soccer on several performance variables in children and adults¹⁹⁻²⁰. In contrary, studies on futsal with overweight and obese children are scarce²¹.

In the present study the children showed significant changes in body composition, specifically a decrease in TBF, BF%, and increase LBM. Other studies have reported small differences with different levels of intensity in the lipid profile. Therefore, it is unclear to what extent exercise intensity influences lipemia. However, another study showed that young Italian male soccer players presented a high inter-individual variability of pubertal stage within the same class of chronological age²⁰. This can explain in part by the variability of the physical parameters (TBF, BF%, LBM) in this population²². Although exercise training could improve the lipid profile, no difference was found in present study. The possible mechanism that might explain why lipid profile was not modified after intervention is linked to hypothesis that the interaction between Lipoprotein (a) and Apo B100 and other cardiovascular risk factors suggests that high intensity mixed sports with a strong dynamic component, eccentric muscle contractions and high muscle and joint impact, such as soccer, may be associated with less favorable lipid profile, as postulated by Houmar, Tanner, Slentz, Duscha, McCartney, Kraus²³. In the report of Ostrowsky, Rohde, Asp, Schjerling, Pedersen²⁴ it is believed that intense exercise, particularly eccentric exercise accompanied by falls and collisions frequency, the soccer leads to the release of proinflammatory cytokines associated with abnormalities in metabolism. Additionally, conditions such as training volume, frequency of sessions (120min/wk) and dietary control also interfere in the response of the lipid parameters. It has been shown that the training duration of 170 min/wk induces greater effects than 117 min/wk. According to a meta-analysis study it is recommended longer duration (155-180 min) to positively affect fat reduction in overweight children²⁵. However, in the present study 120 min/wk was minimal time sufficient to decrease body fat and increase LBM, respectively. Although the ACSM and AHA time recommendations for training were not met, the effects of shorter duration in the present study were efficient to elicit beneficial effects with less time to maintain aerobic fitness²⁶.

The current findings of the present study, although in a small sample provide further evidence that playing futsal has significant health effects. Although in this study the metabolic profile was not altered, futsal interventions were effective in improving

cardiorespiratory fitness increasing VO_{2max} . In the present study the children had an improvement of 11% in VO_{2max} and this result was similar to that found by Faude et. al.²⁷ in overweight children playing traditional football. In addition, the small side games performed within the futsal sessions are as effective as performing running interval training. Intensity of futsal sessions in our study was high. Average heart rate was 153beats/min, which is equivalent to 76% of MHR (maximum heart rate). Therefore, they are positive in improving and maintaining the aerobic fitness²⁸.

Results indicated during specific drills of the 2 versus 2 and 3 versus 3, and less 4 versus 4 yielded significantly higher ball touches highlight the importance of utilizing smaller-sided games to promote greater energy expenditure by increasing ball engagement²⁹. Therefore, physiological effects of duration and variations in the numbers of children in futsal specific drills is a strategy that should be adopted²⁹. Results of our study could be a way to motivate the training, since it was conducted only for two days in a week with just 60-minutes duration with positive effect on markers of body composition and cardiorespiratory fitness. Multidimensional efforts must continue to promote the prevention and treatment of overweight and obesity. Sport is a cheap tool. In the study, the type of futsal training done was not exactly the competitive game we see on television. We emphasize that this type of match can be played by everyone, regardless of age, sex, level of futsal experience and physical fitness.

Conclusion

In conclusion, 16-week futsal training program were determinant to enhance body composition, and cardiorespiratory fitness in this group of prepubertal boys.

Study limitations

We recognize that some limitations exist for the present study: a) the small number of participants, b) the lack of control group, and c) the non-randomization of the participants. Although we have used futsal, soccer has shown that studies with smaller sample have shown positive effects when practiced regularly regardless of gender, age or health conditions. Thus, future research should compare the effects of recreational futsal with high-intensity interval training on health-related physical fitness and enjoyment in children. Given so far, few studies with futsal in children, further research should explore the effectiveness of recreational futsal training on physical fitness in longer training periods and with a larger sample size. Therefore, the findings from this study should not be generalized.

Perspectives

In times of growing obesity in the world, affecting millions of children largely due to chronic physical inactivity, futsal has

potential benefit for health and wellness promotion and can be incorporated as part of the total amount of physical activity that children can do all the days together with physical education classes or even as leisure³⁰. This project with futsal was the kickoff to aims to reinforce the role of futsal as it is already a reality his great brother soccer as a means of promoting good health. The health of the children can be improved with the right nutrition and sufficient exercise regularly³¹. To achieve this goal, an adequate exercise should be created for all age groups, and the futsal can be incorporated, including in schools. Our study was conducted with a small group of individuals. It is necessary to reproduce it in a larger group, with more time of accompaniment. Anyway, the result obtained is quite promising.

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