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Football to tackle overweight in children

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The present study aimed at analyzing the efficacy of a 6-month football training program compared with a standard exercise program on health and fitness parameters in overweight children. The study design was a 6-month, two-arm, parallel-group randomized trial. Twenty-two overweight children were randomly assigned to two groups (age = 10.8 ± 1.2 years, height = 1.56 ± 0.08 m, weight = 65.1 ± 11.4 kg). One group conducted a football training program, and the other group an established standard sports program. Both interventions took place three times per week from mid-May to mid-November. Before, after 3 months and after the training period, comprehensive testing was conducted: anthropometric characteristics, cycling ergometry, psychometric monitoring as well as several motor ability tests. Maximal performance capacity increased and submaximal heart rate during cycling ergometry decreased significantly. Several motor skills as well as self-esteem also improved considerably. Body composition and other psychometric variables remained nearly unchanged. No relevant differences were observed between both exercise programs. It can be concluded that a 6-month football training is as efficacious in improving the physical capacity, health-related fitness parameters and self-esteem of overweight children as a standard exercise program. These results provide further evidence that playing football has significant health effects.

During the last two decades, an increase in the prevalence of obesity in children and adults has been observed worldwide (Ebbeling et al., 2002; Daniels et al., 2005, 2009). This may lead to considerable problems for the public health systems in future, because overweight is associated with multiple comorbidities, for instance, several metabolic and cardiovascular diseases and psychosocial abnormalities (Ebbeling et al., 2002; Schwimmer et al., 2003; Daniels et al., 2005, 2009). Early prevention of excessive overweight and related diseases seems mandatory both from an individual as well as from a socioeconomic viewpoint.

Regular physical activity has been accepted as one means (among others) for the prevention of obesity and related comorbidities (Maziekas et al., 2003; Wareham et al., 2005; Shaw et al., 2006; Daniels et al., 2009; Lee et al., 2009). Recent evidence suggests that improvements in physical capacity and health-related fitness parameters can positively affect obesity-related health hazards (Shaw et al., 2006; Lee et al., 2009). Korsten-Reck et al. (2007) demonstrated an enhanced fitness in overweight children after an 8-month intervention (FITOC – Freiburg intervention trial for obese children, combination of organized sports, educational and nutritional advice). Similarly, blood lipids and ergometrical performance were positively affected in a non-randomized controlled study using the same intervention program (Korsten-Reck et al., 2005).

Football is associated with high energy expenditure (Ferrauti et al., 2006) and has recently been shown to induce significant beneficial effects on the health profile and physical capacity of middle-aged untrained men (Krustrup et al., 2009). Thus, football may also serve as an appropriate alternative for exercise interventions in overweight children.

Weintraub et al. (2008) evaluated the feasibility, acceptability and efficacy of an after-school football program compared with a control condition. Only the football group showed significant increases in daily physical activity. However, no detailed physiological measures or other health and fitness parameters were assessed.

Therefore, the present study aimed at analyzing the efficacy of a 6-month football training compared with a standard exercise program (modified FITOC program) on health and fitness parameters in overweight children. It was hypothesized that football is at least as efficacious as a standard exercise program in improving health and fitness in overweight children.

Methods and procedures

The study design and the procedures used are in accordance with ethical standards and the Declaration of Helsinki from 1964. The study was approved by the University of Münster (Northrhine-Westphalia, Germany) Ethics Committee. All children and their parents were fully informed about the risks associated with study participation and gave written informed consent.

Participants and general design

The study design was a 6-month, two-arm, parallel-group randomized trial of two sports programs in 8–12-year-old overweight children.

Thirty-nine children were initially recruited by means of newspaper articles as well as announcements in local schools and pediatric practices. Children underwent a stratified randomization into two groups (according to age, gender, body mass index (BMI) percentile and maximal performance in cycling ergometry). The study was designed to analyze the efficacy of exercise interventions for those children who really received the intervention (per protocol analysis). Thus, children who participated in $<50\%$ of all training sessions or who missed training for more than three consecutive weeks were excluded from statistical analyses. 17 children (44%) dropped out during the study period due to insufficient compliance ($N = 12$), private or school problems ($N = 4$) or change of residence ($N = 1$; Fig. 1). No significant differences were observed between drop-outs and children who completed the training ($P > 0.10$). 22 children (10.8 ± 1.2 years, 11 per group) were included in the statistical analyses (for anthropometric data, see Table 1). Before the study, children were not actively involved in regular sports activities and they were not exposed to any nutritional or pharmacological intervention. Before the start of the training, children were medically screened and a resting as well as an exercise ECG was conducted to exclude adverse cardiovascular conditions and chronic metabolic or orthopedic disorders.

One group conducted a football training program (FB, five girls and six boys) and the other group an established standard sports program (STD, three girls and eight boys).

Before (pre), after 3 months (mid) and after the training period (post), comprehensive testing was conducted: cycling ergometry, psychometric monitoring as well as several motor ability tests.

Sport interventions

Training was offered 3 days per week from mid-May to mid-November. One training session lasted for 1 h. The training programs were carried out in two different locations at the same time of the day on the same days of the week (Monday, Tuesday, Thursday, 16:00–17:00 hour). This was decided to blind the groups to the training program of the other group. Training was conducted by two experienced students of physical education.

Football training consisted of warm-up (10%), different (small-sided) games (50%) as well as technique (20%) and fitness courses with the ball (20%). The standard program was a modified FITOC program (Korsten-Reck et al., 2005, 2007). Nutritional and educational interventions as well as all contents without relevant energy expenditure (e.g. meditation) were excluded from the original intervention program. The modified program consisted of warm-up (10%), aerobic endurance activities (40%) as well as exercises to improve coordination/flexibility (20%), strength (15%) and speed (15%). Training intensity was assessed by means of heart rate monitoring (Polar S610, Polar Electro, Kempele, Finland) several times for each child.

Methods and data collection

Anthropometry

Height and weight were measured with children barefoot and with light sports clothing on a digital scale and stadiometer (Seca, Hamburg, Germany). Age- and gender-standardized BMI *z*-scores were calculated using the LMS method (Cole & Green, 1992). BMI percentiles were calculated with respect to a large German reference sample (Kromeyer-Hauschild et al., 2001).

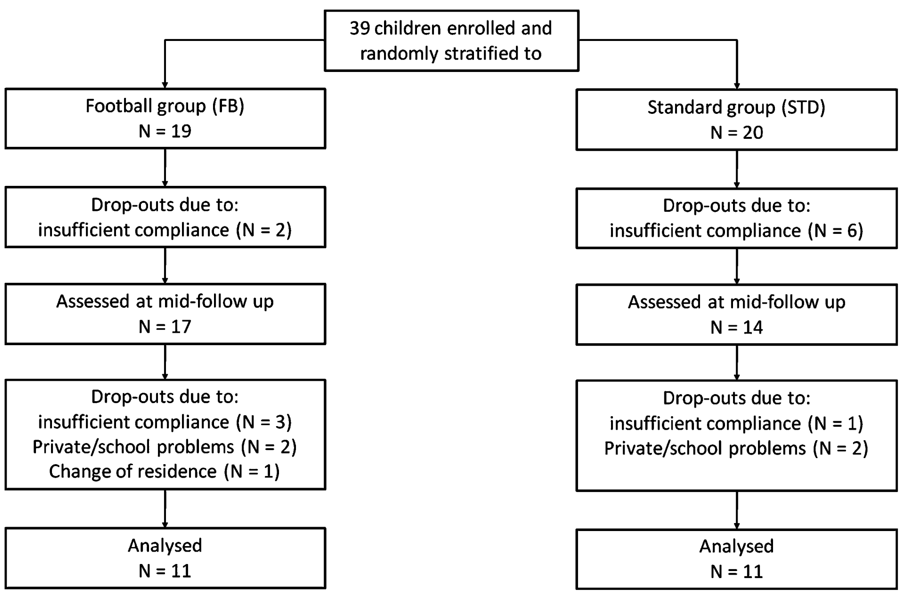

Fig. 1. Flow of participants and randomization.

Table 1. Anthropometric data during the 6-month study period

	Football ($N = 11$)			Standard ($N = 11$)			ANOVA main effects (P values)		
	Pre	Mid	Post	Pre	Mid	Post	Time	Group	Time × group
Height (cm)	155.7 (7.0)	156.9 (7.7)*	158.8 (7.5)*,†	157.1 (9.2)	158.5 (9.0)*	160.2 (9.6)*,†	**<0.001**	0.69	0.88
Weight (kg)	65.7 (11.1)	67.5 (12.1)*	69.5 (12.3)*,†	64.5 (12.6)	67.0 (13.3)*	68.6 (14.2)*,†	**<0.001**	0.88	0.76
BMI (kg/m^2)	26.9 (2.9)	27.1 (3.5)	27.4 (3.3)*	26.0 (3.5)	26.5 (3.8)	26.6 (4.1)*	**0.04**	0.63	0.84
$BMI_{percentile}$	97.7 (2.1)	97.1 (2.7)	97.3 (2.7)	95.9 (4.6)	95.8 (5.1)	94.6 (7.0)	0.23	0.32	0.36
BMI *z*-score	2.1 (0.5)	2.1 (0.5)	2.2 (0.5)	2.0 (0.6)	2.1 (0.6)	2.0 (0.7)	0.85	0.67	0.48

*Significantly different from pre-test.

†Significantly different from mid-test. Significant *P* values are in bold.

ANOVA, analysis of variance; BMI, body mass index.

Cycling ergometry

Aerobic capacity was assessed with an electromagnetically braked bicycle ergometer (Lode Excalibur, Groningen, the Netherlands) using a graded incremental exercise protocol starting at 25 or 50 W (depending on gender and body weight). Workload was increased by 25 W every 3 min until volitional exhaustion. Heart rate was measured at rest as well as at the end of each 3-min step by means of a heart rate monitor. Oxygen uptake (VO_2) was continuously measured until exhaustion using an automated open-circuit breath-by-breath metabolic system (Cosmed K4 b^2, Cosmed, Rome, Italy). The metabolic system was calibrated before each test according to the manufacturer's instructions. The highest VO_2 averaged over 30 s was taken as maximal oxygen uptake (VO_{2max}). To assess the degree of effort, a 20 μL capillary blood sample from the hyperemized earlobe was taken after cessation of exercise and analyzed for blood lactate concentration (enzymatic-amperometric method, Eppendorf, Hamburg, Germany). Cycling ergometry was conducted by a trained institutional investigator who was blinded for group randomization to avoid investigator bias (Meyer et al., 2005b).

Psychometric questionnaire

To assess health-related quality of life (QoL), the KINDL-R questionnaire was used. The KINDL-R is in the German language and comprises 24 items, which were answered by the children on a five-point Likert scale. Summing up the answer scores results in a total score as well as six sub-scores (physical well-being, emotional well-being, self-esteem, family, friends and school). All scores were transformed to values between 0 and 100, with larger scores indicating better QoL. The questionnaire is well accepted by children, shows a high reliability as well as a satisfactory convergent validity (Ravens-Sieberer et al., 2007, 2008).

Motor ability tests

Motor ability tests were conducted during regular training sessions on two different days by the trainer as well as one institutional investigator. On the first day, a countermovement jump (CMJ), a sit-and-reach test, a balance test as well as an agility test were performed. On the second day, children completed a 20-m Shuttle-Run test.

CMJ

Lower limb explosive power was assessed using a vertical CMJ (Young et al., 1995). Flight time [t in (s)] was measured using a contact mat (0.72 × 0.56 m). Jumping height was calculated according to the formula: height $= 0.125 \times 9.81\,\text{m/s}^2\,t^2$. CMJ was performed several times and the best three performances were recorded and averaged for statistical analyses.

Sit-and-reach test (S+R)

The Sit-and-reach test was used to assess the flexibility of the lower back and hamstring muscles. Children sat on the floor with the legs stretched out straight ahead. Feet (shoes off) were placed with the soles flat against a box. Both knees were fully extended. Children reached forward as far as possible with their hands along a metering rule. After three practice trials, the fourth was held for at least 2 s while the distance between fingertips and the box was recorded. A value below zero indicates that the fingertips did not reach beyond the tiptoes.

One-leg-standing (OLS)

Balance was evaluated by a OLS test. Children stood with one foot on a block-shaped bar (0.05 m high, 0.03 m broad) fixed on a board without any assistance. After several practice trials, the test was performed once with each leg. Balance times were recorded using a hand-held stopwatch to the nearest 0.1 s.

Agility run (AR)

Agility was assessed using an AR of 20 m length including six sharp turns. Run time was measured using single beam electronic timing gates (Brower Timing Systems, Draper, Utah, USA). Several trials were performed and the best two runs were averaged and used for statistical analyses.

20 m-shuttle-run test (20 mSRT)

To assess running-specific endurance capacity, children run continuously back and forth between two lines 20 m apart (Leger & Lambert, 1982). The lines should be reached at the time when a sound signal was played from a pre-recorded compact disc. The time between beeps decreased each minute. The initial running velocity was 8.0 km/h and increased by 0.5 km/h every minute until exhaustion. The test was stopped when children were not able to reach the lines early enough for two consecutive beeps. Subjects ran in groups of up to five children to simulate a competition and ensure maximal effort. Maximal heart rate at termination was taken to assess the effort spent by the children.

Statistics

All values are provided as means and standard deviation (SD).

A two-factorial analysis of variance (ANOVA: factor 1: group, factor 2: time) was calculated to analyze changes over the training period. In case of significant time effects in the main outcome variables, the mean pre–post changes and the corresponding 95% confidence intervals were calculated.

A 3-factorial ANOVA (factor 1: group, factor 2: time, factor 3: submaximal exercise level) was used to analyze changes in the submaximal heart rate response during cycle ergometry.

In the case of significant main effects, post hoc, the Scheffé test was applied.

The α-level of statistical significance was set at 0.05.

Results

Training compliance and training intensity

The average training attendance was 65 ± 12% (first 3 months: 69%; second 3 months: 60%) in FB and 72 ± 9% (first and second 3 months: 72%) in STD ($P = 0.13$). This corresponded to a mean of 54 training sessions per child during the whole study period. For each individual, heart rate was recorded during an average of 6 training sessions (11% of total training time). The mean training heart rate was 148 ± 6/min, corresponding to 78% HR_{max} (77 ± 6% in STD vs 80 ± 8% in FB, $P = 0.42$) or 67% VO_{2max} (65 ± 16% in STD vs 68 ± 13% in FB, $P = 0.44$), respectively. Estimated energy expenditure (from gas exchange and heart rate data during cycling ergometry) was 1.500 kJ (360 kcal) per training session.

Anthropometric data

Height, weight and BMI increased continuously during the study period. $BMI_{percentile}$ and BMI *z*-scores remained nearly constant. No significant group differences or time × group interactions were observed (Table 1).

Cycling ergometry

Maximal power output during cycling ergometry increased significantly during the first 3 months and remained nearly constant thereafter (Table 2). No significant changes occurred for VO_{2max} and maximal lactate concentrations. Maximal heart rate was significantly higher post-training compared with the mid follow-up. No significant group differences or time × group interactions were observed.

Submaximal heart rates were significantly decreased by an average of 7/min after 3 ($P = 0.008$) and 6 months ($P = 0.009$; Fig. 2). No significant group differences or time × group interactions were observed ($P > 0.40$).

Psychometric questionnaire

No significant group differences were observed for the total as well as all sub-scores of the KINDL-R questionnaire (Table 3). A significant main effect for time was only found for the sub-score self-esteem with an increase over time and a larger effect in FB. A significant interaction was observed for the subscale school. While a 10% increase in FB occurred, STD showed a 15% decrease.

Motor ability tests

All motor abilities improved significantly during the study period (Table 4). The OLS time mainly increased during the second 3 months and S+R as well as agility test time improved during the first 3 months only. CMJ and 20 mSRT performance improved continuously during the whole study period. Maximal heart rate after 20 mSRT was slightly enhanced (+3/min) after 3 and 6 months. There was a tendency ($P = 0.05$) for better S+R results in the STD group and for a time × group interaction with greater improvements in FB for 20 mSRT ($P = 0.07$).

Table 5 shows mean improvements and 95% confidence intervals for pre–post changes in both groups in maximal cycling performance, the KINDL-R sub-score self-esteem as well as for all motor ability tests.

Table 2. Maximal ergometric data during the 6-month study period

	Football ($N = 11$)			Standard ($N = 11$)			ANOVA main effects (P values)		
	Pre	Mid	Post	Pre	Mid	Post	Time	Group	Time × group
PO_{max} (W)	127 (18)	136 (23)*	138 (25)*	125 (21)	137 (21)*	134 (28)*	**0.003**	0.89	0.65
PO_{max} (W/kg$^{0.67}$)	7.7 (0.9)	8.1 (1.2)*	8.0 (1.6)	7.8 (1.4)	8.4 (1.3)*	8.1 (2.0)	**0.04**	0.77	0.72
VO_{2max} (mL/min)	1922 (306)	1799 (181)	1821 (377)	1971 (384)	1897 (242)	1917 (314)	0.27	0.58	0.91
VO_{2max} (mL/kg/min)	119 (11)	111 (15)	111 (26)	122 (22)	115 (16)	114 (20)	0.09	0.69	0.98
$Lactate_{max}$ (mmol/L)	5.4 (2.0)	5.7 (1.8)	5.6 (1.9)	4.7 (0.9)	5.5 (1.2)	4.6 (0.9)	0.25	0.29	0.52
HR_{max} (min^{-1})	191 (16)	188 (18)	192 (12)†	189 (9)	186 (9)	189 (11)†	**0.02**	0.47	0.26

*Significantly different from pre-test.

†Significantly different from mid-test. Significant P values are in bold.

PO_{max}, maximal power output; VO_{2max}, maximal oxygen uptake; HR_{max}, maximal heart rate; ANOVA, analysis of variance.

Discussion

The present study mainly aimed at evaluating the fitness and health effects of football training compared with an established standard exercise program in overweight children. Maximal performance capacity and submaximal cardio-circulatory strain as well as several motor skills and self-esteem improved during the 6-month study period. However, body composition remained nearly unchanged. Altogether, no relevant differences were observed between exercise programs, indicating comparable efficacy.

The increases in maximal cycling performance and, more pronounced, during 20 mSRT can be interpreted as an enhanced endurance capacity. Maximal heart rate was slightly higher at post-test. Thus, habituation with exercise protocols as well as an improved high-intensity exercise tolerance may be partly responsible for these training effects. The enhanced running endurance may augment sports ability within the peer group and thus may contribute to better compliance of overweight children with exercise programs in the future.

The lower submaximal heart rates can be interpreted as a noteworthy adaptation of the cardio-circulatory system. Similar adaptations already after 3 months of regular exercise have previously been reported in chronic heart failure patients and in recreationally active individuals (Meyer et al., 2005a, 2006). Together with the large improvements in different motor skills, this points toward an improved exercise capacity and may contribute to a considerable facilitation of everyday activities. The enhanced daily physical activity observed in overweight children playing regularly football (Weintraub et al., 2008) may at least partly be explained by an augmented physical capacity.

In contrast to the enhanced physical performance, the body composition remained nearly unchanged. Increases in height, weight and BMI are usual in this age group. Similar gains in BMI during 6 months (+0.4 to 0.8 kg/m^2) have been reported in a German reference sample (Kromeyer-Hauschild et al., 2001). Korsten-Reck et al. (2007) as well as Weintraub et al. (2008) observed significant decreases in BMI *z*-scores over similar time periods. The intervention chosen by Korsten-Reck et al. (2007) also included educational and nutritional advice and *z*-score values were initially higher than those in our study. This may partly be responsible for the different BMI trend. The reductions found by Weintraub et al. (2008) in their football group were rather small (2.15–2.06 after 6 months) and BMI *z*-scores were in the range of the pre- and post-values observed in the present study.

The estimated average energy expenditure during both training programs was about 700 kcal per week. Regular sports may be associated with greater appe-

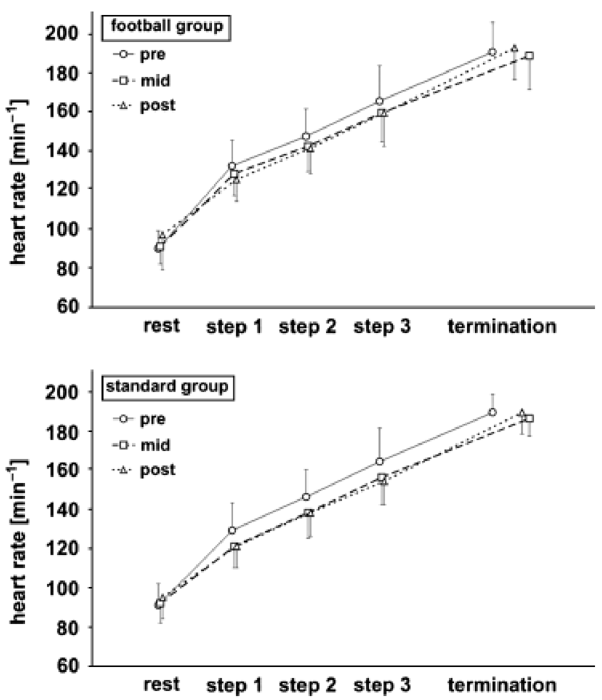

Fig. 2. Submaximal courses of heart rate during cycling ergometry. Post- and mid-test values were significantly lower compared with pre-test heart rates.

Table 3. Psychometric data during the 6-month study period

	Football (*N* = 11)			Standard (*N* = 11)			ANOVA main effects (*P* values)		
	Pre	Mid	Post	Pre	Mid	Post	Time	Group	Time × group
Total score	72.7 (8.9)	75.1 (9.6)	77.7 (8.9)	67.3 (16.4)	72.4 (14.6)	67.7 (16.5)	0.98	0.28	0.12
Physical well-being	69.4 (13.2)	73.8 (14.1)	72.5 (12.6)	72.2 (12.0)	68.8 (17.0)	65.9 (21.9)	0.83	0.60	0.37
Emotional well-being	81.3 (11.8)	80.0 (10.1)	81.3 (11.8)	70.5 (21.3)	79.0 (12.9)	77.3 (15.9)	0.43	0.33	0.30
Self-esteem	57.5 (21.4)	68.8 (16.9)*	72.5 (16.2)*	46.6 (23.3)	55.1 (26.8)*	53.4 (24.7)*	**0.01**	0.11	0.55
Family	83.1 (14.5)	75.0 (17.9)	78.6 (15.7)	77.8 (17.8)	81.8 (14.1)	79.0 (20.0)	0.73	0.93	0.13
Friends	73.1 (8.9)	77.5 (10.7)	82.5 (14.7)	63.1 (25.8)	72.1 (17.8)	67.4 (19.0)	0.14	0.12	0.41
School	71.9 (13.3)	75.6 (15.4)	78.8 (11.5)	73.9 (15.5)	77.3 (14.1)	63.1 (24.3)	0.29	0.50	**0.03**

*Significantly different from pre-test. Significant *P* values are in bold.
ANOVA, analysis of variance.

Table 4. Results of the motor ability tests during the 6-month study period

	Football ($N = 11$)			Standard ($N = 11$)			ANOVA main effects (P values)		
	Pre	Mid	Post	Pre	Mid	Post	Time	Group	Time × group
OLS right (s)	15.8 (15.7)	21.7 (26.0)*	29.9 (32.6)*,†	15.0 (9.9)	18.5 (11.9)*	25.2 (25.7)*,†	**0.001**	0.74	0.83
OLS left (s)	21.1 (22.4)	22.3 (21.0)	34.7 (28.1)*,†	16.1 (14.0)	16.1 (9.9)	23.5 (25.6)*,†	**0.003**	0.37	0.59
Sit-and-reach (cm)	– 13.0 (6.8)	– 11.0 (7.3)*	– 10.0 (7.2)*	– 6.2 (5.5)	– 5.6 (6.5)*	– 5.0 (5.9)*	< **0.001**	0.05	0.13
CMJ height (cm)	14.3 (3.5)	15.0 (3.5)*	16.5 (3.8)*,†	15.2 (2.9)	16.6 (3.3)*	17.3 (3.2)*,†	< **0.001**	0.46	0.18
Agility test (s)	11.0 (0.9)	10.6 (0.9)*	10.5 (0.9)*	10.8 (0.9)	10.5 (0.8)*	10.3 (0.9)*	< **0.001**	0.58	0.48
20 mSRT (min)	3.2 (1.5)	3.8 (1.7)*	4.8 (2.0)*,†	2.9 (1.2)	3.8 (1.5)*	4.2 (1.7)*,†	< **0.001**	0.64	0.07
$HR_{20\,mSRT}$ (min^{-1})	194 (9)	196 (7)*	197 (6)*	192 (10)	195 (8)*	196 (8)*	< **0.001**	0.68	0.65

*Significantly different from pre-test.

†Significantly different from mid-test. Significant P values are in bold.

OLS, one-leg-standing; CMJ, countermovement jump; 20 mSRT, 20 m-Shuttle-Run; $HR_{20\,mSRT}$, maximal heart rate during the 20 m-Shuttle-Run; ANOVA, analysis of variance.

Table 5. Mean training changes and 95% confidence intervals for maximal power output during cycling ergometry (PO_{max}), the motor ability tests as well as for the KINDL-R sub-score self-esteem

	Football ($N = 11$)	Standard ($N = 11$)
PO_{max} ($W/kg^{0.67}$)	+0.4 [– 0.4; 1.2]	+0.3 [– 0.4; 1.1]
OLS right (s)	+14.1 [2.0; 26.1]	+10.2 [– 2.2; 22.6]
OLS left (s)	+13.6 [4.7; 22.6]	+7.3 [– 7.4; 22.1]
Sit-and-reach (cm)	+2.9 [1.0; 4.8]	+1.2 [0.4; 2.0]
CMJ height (cm)	+2.3 [1.4; 3.1]	+2.0 [1.4; 2.7]
Agility test (s)	– 0.55 [– 0.33; – 0.77]	– 0.48 [– 0.21; – 0.77]
20 mSRT (min)	+1.7 [1.1; 2.3]	+1.3 [0.9; 1.8]
Self-esteem	+13.6 [1.1; 26.2]	+6.8 [– 3.7; 17.3]

OLS, one-leg-standing; CMJ, countermovement jump; 20 mSRT, 20 m-Shuttle-Run.

tite and, thus, energy balance and, as a consequence, the body composition may remain constant. However, nutrition was not controlled for during the long duration of our intervention period and, therefore, a conclusive statement cannot be drawn.

A recent meta-analysis (Atlantis et al., 2006) recommended 155–180 min per week of aerobic exercise to reduce body fat in overweight children. Thus, the constant body composition in the present study might be at least partly explained by an insufficient training volume (~ 120 min/wk). However, two hours of moderate to vigorous exercise or an energy expenditure of about 700 kcal per week is in line with current recommendations of the American College of Sports Medicine and the American Heart Association to maintain cardiovascular health in adults (Haskell et al., 2007). Furthermore, Sui et al. (2007) recommended in older adults an energy expenditure of about 8 kcal/kg body weight and week to reduce all-cause mortality. Being active and fit, thereby, can counteract the health hazards of obesity (Lee et al., 2009). Although the question remains as to whether these recommendations are valid for overweight children, it seems obvious from the present results that fitness considerably improved. In addition, recent meta-analytical findings (Shaw et al., 2006) suggest that exercise improves health even if no weight is lost. Improved health and fitness may increase daily physical activity and compliance with exercise programs. As a consequence, long-term weight reductions may be achieved.

Schwimmer et al. (2003) observed lower QoL scores in severely obese children compared with healthy children but similar values compared with children suffering from cancer. Similarly, Ravens-Sieberer et al. (2001) found lower QoL scores in obese children compared with children suffering from asthma or atopic dermatitis. In the latter study, reduced QoL was associated with stress, coping as well as a lack of emotional support. In particular, emotional support may be enhanced when sports is conducted together with peers, an effect likely to be more pronounced in team sports. In the present study, only the sub-scale self-esteem considerably improved through training, with a larger effect found in the football group. This may be explained by the social but also competitive nature of the game leading regularly to a feeling of success and coherence in the team, whereas this component is partly missing in routine exercise programs. When comparing our results with age- and gender-specific normative data from Germany (Ravens-Sieberer et al., 2008), it is noteworthy that FB – although not statistically significant in most cases – increased their scores up to corresponding reference values for total as well as for several sub-scores (self-esteem, friends, school) after the training period, whereas STD did not.

A major limitation of this study is the limited number of investigated subjects as well as the relatively short intervention period and, in this regard, the likely sub-optimal statistical power. In addition, the study was designed as a per protocol analysis and, thus only the efficacy under optimal conditions can be assessed. To allow definite conclusions toward the long-term effectiveness of such exercise programs in increasing the health and fitness of overweight children and its effectiveness in inducing significant weight reductions, implementation of exercise programs as a routine intervention specially designed for overweight children seems necessary. Such an implementation should at best be adopted with the support of schools or public health organizations (Daniels et al., 2009).

A further limitation is that activity in daily life (incl. school) was not controlled for. It seems possible that the usual behavior during daily life has changed as a consequence of training during the study period. In addition, seasonal influences on the investigated parameters might have occurred. However, such influences are not likely to lead to different effects between groups but instead to increased variability.

Furthermore, hormonal changes due to the beginning of puberty cannot be ruled out. At the start of the examination, Tanner state was assessed and all children were Tanner grade 2 or lower. Thus, some children were at the beginning of puberty and rapid hormonal changes may have occurred. However, different effects between genders or children of different stages of puberty have not been observed.

The present study includes no control condition and, thus, the possibility that some effect might have occurred without either intervention cannot be completely ruled out. From an ethical point of view, it seems problematic to give one group no treatment whereas the other group receives a probably efficacious intervention. FITOC has been shown to be advantageous compared with a control condition (Korsten-Reck et al., 2005) and, therefore, the present conclusions seem justified.

Perspectives

It is concluded from the present results that football training is at least as efficacious in improving the physical capacity, health-related fitness parameters and self-esteem of overweight children as a standard exercise program. In accordance with two recent studies (Krustrup et al., 2009; Weintraub et al., 2008), the present results provide further evidence that playing football has significant health effects. Long-term follow-up studies using such exercise programs as a routine client-specific intervention are warranted in future research to arrive at evidence-based recommendations for the early treatment of obesity and related comorbidities in childhood (Daniels et al., 2009).

Key words: obesity, performance, motor skills, exercise, soccer, team sports, cardiorespiratory fitness.

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