



## Original article

## Effects of soccer training on health-related physical fitness measures in male adolescents

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Received 20 September 2017; revised 10 October 2017; accepted 31 October 2017

Available online

**Abstract**

**Purpose:** The aims of this study were to (1) investigate the health-related physical fitness profile of untrained adolescent boys in comparison to adolescent soccer players, (2) determine the intensity and enjoyment of 6v6 and 4v4 small-sided games, and (3) evaluate the health-related effects of a short-period of soccer training in the untrained group.

**Methods:** Forty-one adolescent boys (untrained,  $n = 24$ ; age =  $15.9 \pm 0.6$  years; trained,  $n = 17$ ; age =  $15.7 \pm 0.7$  years) were recruited. For Purpose 1, the players ( $n = 17$ ) and the untrained ( $n = 24$ ) boys were tested for speed, jumping power, balance, flexibility, and aerobic capacity. After baseline testing, Purposes 2 and 3 were addressed by randomly assigning the untrained boys to either a soccer-training group (small-sided games, 2 sessions per week for 8 weeks) or to a control group, followed by identical retesting.

**Results:** At baseline, physical fitness was higher ( $p < 0.001$ ) in trained players than in untrained for aerobic fitness, sprinting, jumping power, and balance. Small-sided games using 6v6 or 4v4 elicited similar heart rate (HR) (mean:  $\sim 85\%$  peak heart rate,  $HR_{peak}$ ), rate of perceived exertion, and enjoyment responses. Over 8 weeks, the between-group analysis revealed that soccer training had a large beneficial effect on balance (45%) when compared with control group with unclear effects on other fitness parameters.

**Conclusion:** Adolescent soccer players had markedly higher physical fitness compared with untrained adolescents. Small-sided soccer games practiced by untrained adolescents elicited high exercise intensity. While 8 weeks of twice-weekly soccer training sessions induced significant improvement in balance, the short duration of the study was not sufficient to result in between-group differences in sprint and jump performance or aerobic fitness.

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**Keywords:** Enjoyment; Football; Heart rate; Small-sided games; Training

**1. Introduction**

A low level of physical fitness and life-style-related diseases during childhood and adolescence are associated with an increased risk of cardiovascular disease during adulthood.<sup>1</sup> Recent estimates suggest that many adolescents and children do not achieve the recommended level of physical activity<sup>2</sup> that is required to cause a reduction in the risk for cardiovascular

disease and physiological disorders during childhood and adolescence.<sup>3</sup>

Studies investigating the health-related physical fitness benefits of regular physical activity participation have focused primarily on aerobic exercise, including treadmill or outdoor running and cycle ergometry.<sup>4,5</sup> However, adherence to these modes of physical activity (e.g., continuous running) in the general population, and especially in adolescents, is relatively low, perhaps because such activities are perceived as isolating and boring.<sup>6</sup> There is, therefore, a need to find more enjoyable modes of training that elicit great adherence by optimizing intrinsic motivation while offering health benefits that match

Peer review under responsibility of Shanghai University of Sport.

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<https://doi.org/10.1016/j.jshs.2017.10.009>

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those accomplished by treadmill and cycle ergometry programs.<sup>7</sup> In this context, recreational soccer may be a popular alternative for those seeking to improve their cardiovascular, metabolic, and musculoskeletal fitness.<sup>8,9</sup>

A growing body of research has highlighted the health benefits of recreational soccer training in sedentary but otherwise healthy adults<sup>10,11</sup> and obese<sup>12</sup> or various patient populations.<sup>13,14</sup> Recent reviews<sup>15,16</sup> suggest that regular participation in recreational soccer can enhance both physical fitness and health status in untrained individuals. It has been shown for example, that a period of 12-24 weeks of soccer training caused a 7%-15% increase in the maximum amount of oxygen utilized ( $VO_{2max}$ ) in previously untrained participants.<sup>15</sup> Moreover, 12 weeks of soccer training in young and middle-aged men led to a significant decrease (15%) in low-density lipoprotein cholesterol.<sup>17</sup>

Only few studies have investigated the health effects of soccer-based training in adolescence.<sup>12,18</sup> In these studies, it was reported that obese adolescent boys improved a range of health markers, such as a reduction in body fat and blood pressure, an increase in high-density lipoprotein cholesterol, and  $VO_{2max}$  after 12 weeks of organized recreational soccer training. To the best of our knowledge, no data exist on the effects of recreational soccer in untrained normal-weight adolescents. Moreover, no data exist on the acute effects of different forms of small-sided games on perceived enjoyment for adolescent boys.

The aims of the present study were therefore to (1) investigate the health-related physical fitness profiles of untrained adolescents compared with adolescent soccer players, (2) determine the intensity and enjoyment responses to different forms of small-sided games for adolescent boys, and (3) investigate the effects on health-related fitness measures of a short-term (8 weeks) recreational soccer intervention performed with untrained boys.

## 2. Materials and methods

### 2.1. Participants

Twenty-four untrained post-pubertal adolescents (age:  $15.9 \pm 0.6$  years, years to and from peak height velocity [Y-PHV], see Section 2.2.4:  $0.2 \pm 0.9$ ) and 17 adolescent soccer players (age:  $15.7 \pm 0.7$  years, Y-PHV:  $0.8 \pm 0.8$ ) took part in the study. The baseline characteristics of the participants are presented in Table 1. To be included, participants had to be healthy, not suffering from any acute or chronic disease, and not receiving medical treatment. The trained boys had to have a minimum of 2 years of soccer training and competitions without any loss of time due to injury within 3 months preceding the study. The untrained boys had not been involved in regular physical activity for at least 2 years, but they participated in school physical education program (gymnastics, athletic sessions) for maximally 2 sessions of 1 h per week. All participants were fully informed of the risks and discomforts associated with the experimental procedures, and the children and their parents signed informed consent for their children to participate in the study. After baseline testing of all participants, the untrained boys were randomly (using simple randomization:

Table 1

Baseline characteristics of subjects for the intervention and control group.

	Untrained adolescents		Soccer players ( <i>n</i> = 17)
	Control group ( <i>n</i> = 10)	Intervention group ( <i>n</i> = 10)	
Age (year)	$15.8 \pm 0.7$	$15.9 \pm 0.4$	$15.7 \pm 0.7$
Y-PHV (years)	$0.5 \pm 0.7$	$0.3 \pm 0.7$	$0.8 \pm 0.8$
Body mass (kg)	$56.0 \pm 5.9$	$54.4 \pm 5.2$	$62.4 \pm 5.6$
Height (m)	$1.60 \pm 0.10$	$1.60 \pm 0.10$	$1.70 \pm 0.10$
BMI ( $kg/m^2$ )	$20.3 \pm 1.0$	$20.0 \pm 2.0$	$20.7 \pm 1.7$
BF (%)	$14.9 \pm 1.8$	$14.8 \pm 1.5$	$15.3 \pm 1.1$
LBM (kg)	$47.8 \pm 4.6$	$46.2 \pm 4.3$	$52.5 \pm 4.5$

Abbreviations: BF = body fat; BMI = body mass index; LBM = lean body mass; Y-PHV = years to and from peak height velocity.

based on a single sequence of random assignments) allocated to either a soccer intervention group (ING) or a non-training control group (CON) and were retested after 8 weeks. The procedure and the study design are presented in Fig. 1. The protocol of the study conformed to the Declaration of Helsinki for human research, and the study was approved by the Ethical Committee of the Laboratory of Physiology, Faculty of Medicine of Sousse, Sousse, Tunisia.

### 2.2. Procedures

#### 2.2.1. Training intervention

The intervention group participated in 2 sessions of outdoor regular small-sided soccer per week over 8 weeks. Training usually took place on Wednesday and Friday afternoons. Each session was comprised of a short dynamic warm-up followed by 30-45 min of ordinary small-sided soccer drills (4v4 to 6v6). The small-sided games were played with varying rules and with goal keepers on an outdoor field with pitch size adjusted according to the number of players ( $30 \times 20$  m to  $50 \times 30$  m).<sup>19</sup>

#### 2.2.2. Measurements and testing

Perception of effort was evaluated using rate of perceived exertion (RPE) scores (10-point scale)<sup>20</sup> collected during the training period in all training sessions. Heart rates (HRs) (Polar S-810; Polar-Electro, Kempele, Finland) were collected during the last 2 weeks of training. Furthermore, we compared the physiological and perceptual responses and enjoyment between training sessions involving the 4v4 (with goalkeeper on a  $30 \times 20$  m pitch) or 6v6 (with goalkeeper on a  $50 \times 30$  m pitch) forms. A modified and validated Physical Activity Enjoyment Scale (PACES)<sup>21</sup> was completed after the 2 game formats. The PACES consisted of a 16-item questionnaire relating to different aspects of enjoyment and rated on a 5-point Likert-type scale.

#### 2.2.3. Anthropometric measures

Body composition, body mass, and height were measured under standard conditions. Body mass index (BMI) was assessed as weight in kilograms divided by height in meters squared. The 4 skinfolds (biceps, triceps, suprailiac, subscapular) were obtained by the same investigator using a Harpenden skinfold caliper (Lange, Cambridge, MA, USA). Skinfold thickness was then used to calculate body fat percentage using

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