

Investigation of the repeated sprint performance and fatigue index of pubescent girl athletes of different age groups

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Abstract:

The purpose of this study is to investigate the age-related differences in the repeated sprint ability and fatigue index in Turkish girl athletes in puberty. 36 youth girls (11 age group n=13, 12 age group n=16, 13 age group n=7) participated in this study voluntarily. Repeated sprint ability of girls was determined by 7 × 30 m running repeated sprint test with 25 sec active recovery durations. Body composition was measured in terms of height, weight and body mass index. The height values were found to be slightly lower in 11 age group compared to 12 and 13 age groups ($p<0.05$), but there was no difference between 12 and 13 age groups in height values ($p>0.05$). There were significant differences among the three groups in weight values ($p<0.05$). Best sprint time, total sprint time and the repeated sprint decrement/fatigue index were determined for each player. One way analysis of variance indicated significant differences in the best sprint time ($F(2,34) = 35.78, p<0.05$) and total sprint time ($F(2,34) = 21.73, p<0.05$) among 11, 12 and 13 age groups. According to the Tukey analysis results, these differences arose from 11 age group for both the best sprint time and total sprint time. No significant difference was observed in fatigue index among the three groups ($p>0.05$). Our results indicated that the repeated sprint ability, and fatigue index are independent from age and other variables such as height, weight and body mass index, while the best sprint time and total sprint time improve with age.

Keywords: Fatigue index, Repeated sprint ability, Girls in puberty

Introduction

Many team sports require using both aerobic and anaerobic energy system (Özdemir et al., 2014). There are a lot of acceleration and deceleration activities in these kinds of games. One of the most important things for a player is to perform most of acceleration and deceleration movements which are maximal or near-maximal with very short recovery time during the game. This ability is defined as a repeated sprint ability (RSA) (Fitzsimons et al., 1993). The RSA is quite important for players because the activities of acceleration or deceleration should be performed permanently and at the same high intensity with a very short recovery duration during match (Mujika et al., 2009). The study performed with match analysis system suggested that the rate of approximately 1-10 % of the total distances was maintained by sprint or high intensity activities in males (Spencer et al., 2004). For this reason, the physiological and physical requirements of RSA have to be fully understood and should be improved with appropriate training strategies, especially in team games (Bishop et al., 2011). The RSA is evaluated with fatigue index and the best repeated sprint performance is defined with high level sprint performance (Bishop et al., 2011). The fatigue index that occurs during RSA is defined as a decrement maximal force output or decrement sprint performance. The RSA is related with a lot of physiological parameters (VO_{2max} , muscle glycogen stores, buffering capacity of H^+ ion) that affect the improvement of both aerobic and anaerobic performance and therefore, the improvement of sports performance (Aziz, 2004; Bishop & Edge, 2006; Bishop et al., 2004; Ratel et al., 2004).

Muscular fatigue (peripheral fatigue) can be well understood with high intensity repeated activity that is defined as a decline maximal force or speed capacity (Gandevia, 2001). During high intensity repeated exercises, the muscle's recovery capacity and fatigue resistance contribute to neuromuscular function (Dipla et al., 2009). Besides, fatigue resistance and muscle's recovery capacity are related with biological maturation (Ratel et al., 2002) and sex (Hicks et al., 2001). Children have a better fatigue resistance than adults (Falk & Dotan, 2006). Fatigue resistance is much better in children because of their muscle morphological structure and metabolic differences may have important roles in these diversities (Falk & Dotan, 2006). Dipla et al. (2009) suggested that there was no fatigue resistance difference between children, postpuberty and adult men and women. On the other hand, Falk and Dotan (2006) found that children have faster recovery capacity than adults (Falk & Dotan, 2006).

Although the repeated sprint activity is used intensively in team sports, the studies that investigate the relationship between children's RSA and age development in team sports are not quite much in the literature.

The participant group is constituted with men or boy athletes. Children have different development phases and they have different physical, physiological and biological growth rates in these developmental phases that effect the performance directly (Açıkada, 2004). Muscle mass, body size, muscle fiber type and contractil properties, glycogen stores, glycolytic enzyme activities increase with age (Rowland, 2005). However, girls have a less anaerobic performance than boys at the same age (Eisenmann & Malina, 2003; Kosar & Demirel, 2004; Morin et al., 2011; Saavedra et al., 1991). The boys' sprint performance improves with age, but girls have less physical and performance improvement than boys (Kosar & Demirel, 2004). To our knowledge, the studies that investigate age related differences in RSA and fatigue index generally included only boys and this relation is not clear in the girl population. For this reason the purpose of this study is to investigate the relation of RSA and fatigue index with the age development in girl athletes.

Material and Methods

Participants

Thirty-six healthy girl football (n=18) and basketball (n=18) players between 11-13 years old volunteered to participate in this study. All subjects were members of the same team who were trained for 2 hours per day, five days a week. None of the participants had medical history, injury, cardiovascular and pulmonary diseases. At the beginning of the study all participants were informed about possible risks and benefits of the study and written consents were obtained from the players and their parents or legal guardians. The study was conducted in accordance with the Declaration of Helsinki for experiments involving humans.

Experimental protocol- The players were grouped on the basis of chronological age categories: 11 age group, 12 age group and 13 age group. Participants' height and weight were measured before the repeated sprint test. Participants performed, in a randomized order, 7 repeated maximal 30 m sprints with 25 sec active recovery duration. Prior to the study, all subjects were familiarized with the repeated-sprint protocol. All tests were performed on an indoor synthetic track.

Anthropometr y- Participants' heights were measured with a stadiometer (Seca, 767) to the nearest 0.1 cm and their weights were measured with an electronic scale (Seca, 767) to the nearest 0.1kg. Body mass index (BMI) (kg/m^2) was calculated using the following formula:

$$\text{BMI} = \text{Body weight (kg)} / \text{Height (m)}^2$$

Repeated sprint test - All players performed the test after warm-up which included 5-7 min jogging and 3-5 min stretching. The participants performed 30 m twice to become familiarized. Repeated sprint tests began two minutes after the familiarization session. The best maximal single sprint time was used as the players' reference performance (the best sprint performance). The players were instructed to sprint maximally for every repetition within the lane formed by Smart Speed (Fusion Sport, Qld, Australia) electronic timing gates, which was approximately 2-m wide. The repeated-sprint performance consisted of seven repeated straight-line 30-m sprints separated by 25 sec of active recovery (i.e. jogging back to the starting line within 20 sec to allow 4-5 sec of passive recovery before the start of the next sprint repetition). Three seconds prior to the commencement of each sprint, subjects were asked to assume the ready position and await the start signal. During recovery, audio feedback (i. e., time countdown) was given to the subjects so that they maintained the required running speed. Participants were instructed to complete all sprints as fast as possible, and strong verbal encouragement was provided to each subject during all sprints. Three scores were calculated for the RSA tests: the best sprint time (BST (m/s)), the total sprint time (TST (m/s)) and the percent sprint decrement (as a fatigue index) (SD%) were calculated as follows: $((\text{Total Sprint Time}_{\text{mean}} / \text{Best Sprint Time}) * 100) - 100$ (Rampini et al., 2002)

Statistical Analysis - All values are presented as mean \pm standard deviation. Before parametric analyses were done, the normality of distribution of the data was assessed with Kolmogorov-Smirnov test. Homogeneity of variance was verified with a Levene test. The one way ANOVA was used for measuring differences among 11, 12 and 13 age groups. The correlation between age, repeated sprint performance (BST, TST, SD%) and anthropometric variables (height, weight and BMI) were evaluated using the Pearson Product Moment Correlation analysis. All analyses were executed using the SPSS for windows version 22.0 and statistical significance was set at $p < 0.05$.

Results

Participants' height, weight and BMI values are presented in Table 1. The weight values of the participants were different among three groups ($p < 0.05$). Height and BMI values in the 11 age group were significantly different from 12 and 13 age groups' values ($p < 0.05$).

Table 1: Participants' physical variables

	11 age group	12 age group	13 age group
Weight (kg)	32.94 \pm 5.70*	42.97 \pm 8.37*	52.96 \pm 9.65*
Height (cm)	142.59 \pm 6.76 [#]	153.41 \pm 7.4	159.02 \pm 6.89
BMI (kg/m^2)	16 \pm 2.02 [#]	18.10 \pm 2.32	20.79 \pm 4.48

Note: *Significant differences between groups. #11 age group was different from 12 and 13 age groups $p < 0.05$.

The BST, TST and SD% values are presented in Table 2. The BST values were not significantly different between 12 and 13 age groups ($p > 0.05$), but 11 age group was significantly different from both 12 and 13 age groups ($p < 0.05$). Similarly, the TST values of 11 age group were significantly different from 12 and 13 age groups ($p < 0.05$), but there were no significant differences between 12 and 13 age groups ($p > 0.05$). Besides, SD% values are similar for all groups ($p > 0.05$).

Table 2: BST, TST and SD% values of the participants

	11 age group	12 age group	13 age group
BST (m/s)	6.46±0.46 #	5.45 ± 0.23	5.59 ± 0.24
TST (m/s)	47.78 ± 4.71#	40.14 ± 2.25	40.69 ± 1.64
SD% (%)	5.57 ± 4.47	5.73 ±0.32	3.97 ± 1.42

Note: BST: Best sprint time; TST: Total sprint time; SD% : Repeated sprint decrement/Fatigue index; # 11 age group was different from 12 and 13 age groups $p < 0.05$.

The relationship between RSA scores (BST, TST and SD%) and physical features are presented in Table 3. The BST and TST values were negatively correlated with height and weight (Table 3), but SD% were independent from all variables ($p > 0.05$).

Table 3: Pearson moment correlation coefficient between physical parameters, age, BST, TST and SD%

	BST(m/s)	TST (m/s)	SD% (%)
Age (years)	-0.670**	-0.632**	-0.153
Height (cm)	-0.57**	-0.46**	0.06
Weight (kg)	-0.48**	-0.43**	-0.41
BMI (kg/m²)	-0.36*	-0.35*	0.08

** $p < 0.01$, * $p < 0.05$

Discussions

The main aim of the present study is to investigate the relationship between age and RSA variables in girl athletes. According to our knowledge, this study is the first to report relationship between age and RSA in the girl athletes in puberty. The main findings of the current study demonstrate that the best sprint time and total sprint time for 7 × 30 m repeated sprint test improve from 11 to 13 years old.

The studies investigated the age-related differences in RSA mostly evaluated the boys or male participants. The number of the study that investigate relationship between age, maturation and RSA in girls at different age stage was limited. Mujika et al. (2009) investigated the differences between RSA and age development from U11 to U18 and reported that the RSA getting better until U15 age group, but there was no performance differences between U15 and U18 age group (Mujika et al., 2009). In the another study Mendez-Villanueva et al. (2011) indicated that U18 age group have the best sprint time, whereas the worst sprint time belonged to U14 age group and they suggested that sprint performance increased with age (Mendez-Villanueva et al., 2011). Similarly, Özdemir et al. (2014) showed that RSA increased with age in U14, U15 and U16 (Özdemir et al., 2014). The aforementioned studies were conducted with male or boy subjects and the results are compatible with our findings. The correlation coefficient is middle and inverse between BST, TST, age, height, weight and BMI.

The anaerobic power is less in children than puberty or adults (Boisseau & Delamarche, 2000; Inbar & Bar-OR, 1986). The anaerobic power increase with age (Boisseau & Delamarche, 2000; Inbar & Bar-OR, 1986; Saavedra et al., 1991) because the children's anaerobic capacity is less than adults (Kosar & Demirel, 2004). The most clear improvement in anaerobic power is between 9 and 15 years age for both sexes (Saavedra et al., 1991). Especially for the girls, the speed ability improvement depends on stopping of growth after 15 years old (Açıkada, 2004). In addition, the activities that required speed and power achieve plateau in the girls after 13 and 14 years old (Kosar & Demireş, 2004). It has been reported that the speed improvement was the same in 13, 14 and 15 years old girls (Virus et al., 1999). Similarly, Papaïakovou et al. (2009) observed that 30 m sprint performance was positively related to age and reported that 18 years old group had a better performance than 15 years old group (Papaïakovou et al., 2009). In the present study, younger girls completed the running distance in longer sprint time than older girls ($p < 0.05$). Additionally, the findings of the current study showed that the values of the best sprint time and total sprint time were higher in 12 age group, but these differences were not significant.

The repeated sprint decrement/fatigue index is expressed as a percentage and represent the amount of fatigue occurring during the RSA test and give an information about player's fatigue resistance. The results of the present study demonstrated that the SD% was independent of age in girls ($p > 0.05$). Furthermore, our findings are compatible with results obtained from boys and male participants. Mujika et al. (2009) emphasized that there was no fatigue index differences between young and puberty boys (Mujika et al., 2009). Similarly, another study showed that there was no fatigue index differences between U14, U15 and U16 boy football

players (Özdemir et al., 2014). Children have different muscle morphology and metabolic characteristics. So they may have a better fatigue resistance than adults (Falk & Dotan, 2006). Although they didn't evaluate sprint or anaerobic performance, Armstrong et al. (1999) didn't find significant differences in VO_{peak} and physical parameters values between 11-13 years old girls (Armstrong et al., 1999). The study's sample size was small and this is one of the limitation of the present study. The teams that we work with included only 36 pre-puberty girls on their roster. Additionally, the other limitation of the present study is that players were grouped by chronological age and the biological maturation was not take into account. Furthermore the players' muscle mass were not determined. Therefore the future study may focus on the metabolic (lactate, sex hormones levels etc.) physiological parameters (VO_{2max} , HR etc.) and biological differences that effect on the sprint ability with emphasis on not only the chronological age but also the biological age.

Conclusions

RSA is considered by many researchers and coaches to be determined by a combination of specific physiological, biological, biomechanical and morphological factors and require different training techniques. The main findings of the present study show that age has positive effects on RSA performance. So that the coaches who especially work with pre-puberty and/or puberty girls may consider this detail and use different training strategies for each age groups. Also, the correlation appears negative and medium among height, weight, BMI, BST, TST and age. The BST and TST are independent of height and weight, therefore the maturation level should be taken into account for a more certain relation between physical parameters and age development. SD% is not related with age or other variables.

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