THE LEVEL AND DIFFERENCES OF AEROBIC CAPACITY IN THREE DIFFERENT YOUNG SOCCER TEAMS IN THE U17 CATEGORY

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Abstract
The purpose of this study was to determine and compare parameters of aerobic capacity as an indicator of physical predispositions in three youth soccer teams of different performance levels in Yo-Yo intermittent recovery test level 1. The screened sample consisted of the national team (n=14, age: 16.5 ± 0.3 years, body weight: 68.3 ± 7.9 kg, body height: 177.2 ± 7.1 cm and body fat: 9.2 ± 1.9 %), the best league team (n=16, age: 16.4 ± 0.3 years, body weight: 70.6 ± 8.3 kg, body height: 178.8 ± 6.4 cm and body fat: 9.5 ± 2.1 %) and the worst league team (n=14, age: 16.6 ± 0.4 years, body weight: 65.6 ± 8.2 kg, body height: 176.1 ± 6.4 cm and body fat: 8.8 ± 2.4 %). To evaluate aerobic parameters, Yo-Yo intermittent recovery test (Yo-Yo IRT1) was used. Based on post-hoc analysis of means in the observed groups we found out significantly longer run distances in NT (national team) and BLT teams (best league team) when compared to WLT team (worst league team) (p<0.01). Comparison of maximum heart rate (HR max) or heart rate recorded 1 minute after load, respectively, did not indicate any significant difference. Conversely, when comparing the percentage decrease in HR max we revealed significant differences between the groups (p<0.05). The assumption of significant difference in VO2 max between players of higher performance level (NT and BLT) in comparison to players of lower performance level (WLT) was confirmed at a significance level of α ≤ 0.01. The study showed differences in levels of monitored parameters in Yo-Yo test between the team of different performance levels. A high level of monitored parameters is necessary for performing high-intensity physical activities on intermittent character throughout the match.

Key words: field test, HR max, recovery, soccer, VO2 max, Yo-Yo IRT1, youth soccer players

Introduction
To improve players’ physical preparedness, it is important to create specific training and test batteries, monitor their progress and load response on players (Impellizzeri et al., 2006; Rampinini, Coutts, Castagna, Sassi, & Impellizzeri, 2007). Diagnostics of youth players is carried out in order to monitor performance progression during the training process (Stratton, Reilly , Williams, & Richardson, 2004). Young players testing serves as feedback for coaches to assess player’s strength and weaknesses (Bangsbo, Mohr, Poulsen, Gomez, & Krustrup, 2006; Stratton, Reilly , Williams, & Richardson, 2004; Svensson & Drust, 2004), whether the training process improves players’ physical preparedness (Bangsbo, Mohr, Poulsen, Gomez, & Krustrup, 2006; Stratton, Reilly , Williams, & Richardson, 2004) or full-featured return of the player after injury (Bangsbo, Mohr, Poulsen, Gomez, & Krustrup, 2006; Newton, Cormie, & Cardinale, 2011; Stratton, Reilly , Williams, & Richardson, 2004). Other factors of diagnostics of youth players are increased motivation to greater effort in training, creating a competitive environment or optimization of training programme (Bangsbo, Mohr, Poulsen, Gomez, & Krustrup, 2006). We distinguish two main categories of testing – laboratory and field tests. Laboratory tests provide important and exact information on the current state of a player (Billat, Flechet, Petit, Muriaux, & Koralsztein, 1999; Noakes, 1988). Their disadvantage is that they often lack ecological validity (Da Silva et al., 2011), 2011 or specific movements throughout the match, for instance eccentric muscle work when changing direction (Curell & Jeukendrup, 2008). An advantage of field tests is when performing specific movements at certain load intensity (Balsom, 1994) and in a specific environment. A soccer match is characterised by an intermittent load, in which high intensity periods alter with lower intensity periods. Studies (Bangsbo, 1994; Bangsbo, Norregaard, & Thorsoe, 1991; Mohr, Krustrup, & Bangsbo, 2003), carried out within the past 20 years, found out, by means of time – spatial analysis, that adult professional players run 9 – 12 km at different paces during a match. Helgerud, Engen, Wisløff & Hoff (2001) add that the distance run by young elite players during a match is similar to that in adult players which is approximately 10.3 km. Therefore, requirements on young players are similar to the adult category (Stratton, Reilly , Williams, & Richardson, 2004). Young soccer players should not be considered as little adults and their training should be constantly directed towards future top performance. An important milestone in a player’s development is the transition into the adult category and further adaptation to training and match load (Reilly, Williams, Nevill, & Franks, 2000). In the physical training of young players, technique and tactical skills should be discovered and constantly developed.
To assess physiological parameters, several intermittent tests up to vita maxima were suggested (Carminatti, Lima-Silva, & De-Oliveira, 2004; Krustrup et al., 2003; Léger & Lambert, 1982). These tests copy, to a certain extent, the movement structures of players on the field and enable us to test more players at once (Ahmadi, Collopp, Calldau, & Préfat, 1992; Barbero-Álvarez & Barbero-Álvarez, 2003; Carminatti, Lima-Silva, & De-Oliveira, 2004; Krustrup et al., 2003).

To assess aerobic capacity, we used Yo-Yo IRT1 according to Bangsbo (1994), Bangsbo, Iaia & Krustrup (2008), Krustrup & Bangsbo (2001) and Krustrup, Mohr, Steensberg, Bencke, Kjaer & Bangsbo (2006). Players perform running activity at high intensity (a distance of 2 x 20 m with a short rest interval (10 s) and incomplete recovery for energy restoration. Yo-Yo IRT1 indicates the internal (heart rate) as well as external (total run distance) load of young soccer players (Coutts, Rampinini, Marcora, Castagna, & Impellizzeri, 2009). The ability to produce and accelerate regeneration processes after high intensity load during a soccer match is important for performance quality in terms of physical abilities (Bangsbo, 1994; Ekbloom, 1986; Fitzsimmons, Dawson, Ward, & Wilkinson, 1993). Performance of players carrying out more high intensity activities during the match requires a larger share of energy produced in an aerobic way since they use energy from 80 to 90% of aerobic energetic system. Thus the player can work at a higher intensity for a longer period of time (Bangsbo, Iaia, & Krustrup, 2008). One of the most important determiners of aerobic capacity is the value of VO2max (Hegerud, Ingjer, & Stromm, 1990; Hoff, Gran, & Helgerud, 2002). Players with a high level of VO2max have high glycogen stores which are necessary for energy release during activities performed at high load intensities or in sprints (Bangsbo & Mizuno, 1988).

Smaros (1980) adds that the value of VO2max is crucial especially towards the end of a match (the last 20 minutes), which is considered to be a crucial and decisive phase of the match. The value of VO2max also affects regeneration processes after the match or intensive training (Bangsbo & Mizuno, 1988; Ekbloom, 1986). The aim of the study was to determine and compare parameters of aerobic capacity as an indicator of physical predispositions in three youth soccer teams of different performance levels in Yo-Yo IRT1. We assume a significantly different level of aerobic capacity indicators (total distance and VO2max parameters) in teams at the higher performance level.

**Methods**

**Subjects**

The screened sample consisted of the national team (NT), best league team (BLT) and worst league team (WLT) in the highest Czech competition of the U17 category. The tested group was composed of 14 player (age: 16.5 ± 0.3 years, body weight: 68.3 ± 7.9, body height: 177.2 ± 7.1 and body fat: 9.2 ± 1.9 %), the best league team (n=16, age: 16.4 ± 0.3 years, body weight: 70.6 ± 8.3 kg, body height: 178.8 ± 6.4 cm and body fat: 9.5 ± 2.1 %) and the worst league team (n=14, age: 16.6 ± 0.4 years, body weight: 65.6 ± 8.2 kg, body height: 176.1 ± 6.4 cm and body fat: 8.8 ± 2.4 %). Prior to testing, the players got familiar with the testing protocol. The study was approved by the ethical committee of the Faculty of Physical Education and Sport, Charles University in Prague and measurements were performed according to the ethical standards of the Helsinki Declaration.

**Data collecting and processing**

Field testing was carried out outdoors on second generation artificial grass. The average temperature ranged from 20 to 24 °C and humidity was around 50 - 60 %. Prior to testing, a warm-up instructed by a coach was conducted for 15 min and was composed of running and changes of directions, stretching and six sprints up to 10 m. The interval between the warm-up and measurement was 45 min. The training unit before the test up to vita maxima focused on speed and agility exercises. Throughout the training, players’ HR was recorded by means of the Polar RS400 heart rate monitor (Polar, Kemepe, Finland). Measurements were held in the mid-competition period. The day before testing, players had a day off and did not perform any demanding physical activities. To determine parameters of aerobic capacity, Yo-Yo IRT1 according to Krustrup et al. (2003), Bangsbo et al. (2008) and Castagna, D’Ottavio & Abt (2003) was used. Field tests assessed aerobic capacity, namely the following parameters: total distance, VO2max, HRmax and recovery period one minute after the test. Each player performed the test in his own area that was 2 m wide, 20 m long and 5 m for active recovery (Figure 1). The area was marked with cones. Total testing time did not exceed more than 20 minutes.

![Figure 1 Yo-Yo IRT1 scheme](image)

5 m Recovery phase 20 m Run

After completing 2x20 m, players always have 10 seconds for active recovery which consists of 2 x 5 m walking or jogging. Yo-Yo IRT has two different levels (level 1 and 2). In the study, we used level 1, which consists of four runs (2x20 m) at velocities between 10 – 13 km.h⁻¹ (0 - 160 m), seven runs at velocities 13.5 – 14 km.h⁻¹ (160 – 440 m). Subsequent velocity is increased by 0.5 km.h⁻¹ after 8 runs (i.e. after 760, 1080, 1400, 1720 m etc.) up to vita maxima. The test is finished when the player does not reach the line on time twice or when he is exhausted. After the test, total run distance (m), HRmax and decrease of HR one minute after the test is recorded for each player. To calculate VO2max we used a prediction equation (Bangsbo et al., 2008) (1):

\[
VO_{2max} (mL.kg^{-1}.min^{-1}) = IR \times 0.0084 + 36.4
\]
Statistical analysis

The results were expressed in absolute values and percentages, and the evaluation was made with the use of basic statistical characteristics (Arithmetic Mean, Standard Deviation). To discover significant differences between the observed teams analysis of variance was used (One-Way ANOVA).

In cases of significance between groups we used Bonferroni's post hoc test. When the criterion of sphericity, as one of the conditions of ANOVA, which was assessed by the Mauchly's test ($\chi^2$), was not met, degrees of freedom were adjusted by means of Greenhouse-Geisser's (GG) sphericity correction and then the statistical significance was assessed according to particular degrees of freedom.

Rejection of the null hypothesis was assessed at the level of $p<0.05$. Effect size was assessed using the „Eta square” coefficient ($\eta^2$), which explains the proportion of variance of the monitored factor. Effect size was examined as follows: $\eta^2=0.20$ – a small effect, $\eta^2=0.50$ – medium effect and $\eta^2=0.80$ – large effect (Cohen, 1992). The statistical software IBM® SPSS® 19.0 version was used for processing the results.

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Results

Results indicated significant differences ($p<0.01$) in total run distance between the tested teams (Table 1). Based on a post-hoc analysis of means of the monitored groups we found out significantly higher total distance in the NT and BLT when compared to the WLT ($p<0.01$). The difference between NT and WLT was 451.4 m (23.3 %). A similar situation was found in comparison of BLT and WLT when the difference was 464.4 m (23.8 %). On the contrary, the difference between NT and BLT was only 12.9 m (0.7 %). When comparing maximum heart rate ($HR_{max}$) or heart rate frequency 1 minute after test load ($HR_{rec}$), respectively, neither significant difference nor effect size were detected. Conversely, when comparing percentage decrease of $HR_{max}$ we found out significant differences between the groups ($p<0.05$). Post-hoc analysis of this indicator showed significant difference between NT and BLT ($p<0.05$). $HR$ recorded 1 minute after the measurement decreased by 17.7 % in NT and by 11.2% in BLT. The assumption of significant difference in $VO_{2max}$ between players of higher performance level (NT and BLT) and players of lower performance level (NT and BLT) was confirmed at significance level of $\alpha \leq 0.01$.

Discussion and conclusion

The aim of the study was to compare parameters of aerobic capacity as an indicator of physical predispositions in three youth soccer teams of different performance levels in Yo-Yo IRT1. Players from the national and best league teams reached similar total distances which was significantly higher than in the worst league team. These results confirm the fact that Yo-Yo IRT1 and physical performance in the match significantly correlate in the amount of run intervals at high intensity (> 15km.hod⁻¹) during a soccer match ($r = 0.71, n = 18, p < 0.05$) (Krstrup et al., 2003). Mohr et al. (2003) points out that demands on high intensity performance with short rest intervals put on the players during the match are the main and crucial difference between elite and average players. We also may notice that players are selected to national team on the basis of excellent physical capacity. Studies dealing with evaluation of total distance in Yo-Yo IRT1 divide adult players according to total run distance. Players at international level (national teams, European cups) reach the greatest distance in Yo-Yo IRT1 (2420 m), elite players (the best teams in national competitions – 2190 m), average performance players in national competitions (2030 m) and semi-professional players (1810 m) (Castagna et al., 2006; Krstrup et al., 2003; Mohr, Krstrup, & Bangsbo, 2003). Youth players of the national and best league teams achieved results comparable with average and semi-professional players. Players of the least successful team are not approaching levels of any of the adult teams. In young players, demands on the pace of game and thus on the intensity of physical activity in the match are increasing along with increasing age; therefore, total run distance in Yo-Yo IRT1 increases as well (Stroyer, Hansen, & Klausen, 2004). Players of the U14 category are able to run 842 m in Yo-Yo IRT1 (n=29) (Castagna, Impellizzeri, Cecchini, Rampinini, & Barbero-Álvarez, 2009). Casamichana & Castellano (2010) found the total run distance in the U16 category to be 1816 ± 505 m (n=10).

Elite players of Australian soccer in the U16 category run 1910 m (n=20) or 1438 m at a lower level, respectively, (n=20) (Veale, Pearce, & Carlson, 2009). The comparison of total run distance (mean and variability) between ours teams and some others teams are presented in Figure 2.
Young players spend 63% of the match in the aerobic zone and 37% of the match in the anaerobic zone or, respectively (Billows, Reilly & George, 2003). These values are different in the adult category as adult players spend 66% of the match in the anaerobic zone and 34% of the match in the aerobic zone, respectively (Stratton, Reilly, Williams, & Richardson, 2004). Yo-Yo IRT1 compared to graded running test up to vita maxima is not so accurate in terms of determination of VO2max (Bangsbo, Iaia, & Krstrup, 2008; Castagna et al., 2006). Differences of performance (distance) in Yo-Yo IRT1 test in different teams.

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References


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**RAZINE I RAZLIKE AEROBNOG KAPACITETA KOD TRI RAZLIČITA TIMA MLADIH NOGOMETASA U17 KATEGORIJE**

**Sažetak**

Svih ove studije je bila utvrđivanje i sporedba parametara aerobog kapaciteta kao indicadora fizičkih predispozicija za tri mlade nogometne eike različitih razina izvedbe u Yo-Yo IRT1 (Yo–Yo intermittent recovery test level 1). Praćeni uzorak bio je sastavljen od nacionalne selekcije (n=14, uzrast: 16.5 ± 0.3 g., mase: 68.3 ± 7.9 kg, visine: 177.2 ± 7.1 cm i masnog tkiva: 9.2 ± 1.9 %), zatim najlošije ekipa lige (n=14, uzrast: 16.4 ± 0.3 g., mase: 70.6 ± 8.3 kg, visine: 178.8 ± 6.4 cm i masnog tkiva: 9.5 ± 2.1 %) te najbolja ekipa lige (n=16, uzrast: 16.4 ± 0.3 g, mase: 68.3 ± 7.9 kg, visine: 177.2 ± 6.4 cm i masnog tkiva: 8.8 ± 2.4 %). Za procjenu aerobnog kapaciteta korišten je Yo-Yo intermittent test (Yo-Yo IRT1). Temeljem post-hoc analize prosječnih vrijednosti grupa pronađene su značajno dulje distance kod NT (nacionalni tim) i BLT eike (najbolja ekipa lige) u usporedbi s WLT ekipom (najlošija ekipa lige) (p<0.01). Usporedba maksimalne frekvencije srca (HRmax) ili frekvencije snimljene jednu minute nakon rada respektivno, nisu pokazale značajne razlike. Suprotno, kad se uspoređi postotak smanjenja HRmax otkriven je značajni razlika kod NT i WLT eikpe u usporedbi s igračima niže razine izvedbe (p<0.05). Pretpostavka o značajnoj razlici u VO2max između igrača višeg razine izvedbe (NT i BLT) u usporedbi s igračima niže razine izvedbe (WLT) je potvrđena na razini značajnosti α ≤ 0.01. Studija je pokazala razlike praćenih parametara u Yo-Yo testu između ekipa različite razine izvedbe. Potrebna je viša razina praćenja parametara za provedbu visoko-osjetljivih tjelesnih aktivnosti s intervalnim aktivnostima, tj. aktivnostima s prekidima za vrijeme sportskog susreta.

**Ključne riječi:** terenski test, HRmax oporavak, nogomet, VO2max Yo–Yo IRT1, mladi nogometasi

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