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Original Article

# Aerobic Fitness of 17-Year-Old Soccer Players Throughout the Annual Training Cycle According to Their Playing Position

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**Abstract**

The purpose of the study was to assess the level of aerobic fitness in U17 Slovak elite soccer players throughout the annual training cycle according to their playing position. The participants were 14 soccer players who played for the 1st league U17 soccer team. To assess their levels of aerobic fitness, players performed the Yo-Yo intermittent recovery test Level 1 (Yo-Yo IRTL1) during four different phases of the annual training cycle. The results showed that the greatest distance covered by a player was 2,476 m during the final testing session after the regular season. Therefore, we may conclude that according to the total distance covered in Yo-Yo IRTL1 players showed test results at the level of international players.

## 1. Introduction

Soccer is a sport consisting of high- to maximum-intensity exercise interspersed with low-intensity exercise bouts (Orendurff et al., 2010; Psotta, Bunc, Netscher, & Mahrová, 2006). Performance enhancement in soccer is determined primarily by aerobic endurance. Therefore, soccer training should include training stimuli for the development of players' aerobic fitness (Chaouachi et al., 2010; Hoff & Helgerud, 2004; Stølen et al., 2005). From the viewpoint of training load and current levels of players' performance levels, fitness testing plays an important role in the assessment of the current levels of players' motor abilities (Pivovarniček et al., 2011). Therefore, the testing conditions should mimic the game conditions as much as possible. Therefore, players must show optimal levels of special

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endurance to be able to perform as many all-out sprints as possible (Hipp, 2007; Psotta et al., 2006).

The purpose of the study was to determine and analyze aerobic fitness levels in U17 soccer players throughout the annual training cycle according to their playing position.

According to the aim of the study, we formulated the following research questions:

What playing position shows highest aerobic fitness levels according to the total distance run?

What are the fitness levels according to the playing position throughout the season?

When, during the yearly macrocycle, do the players achieve the highest aerobic fitness levels?

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## 2. Material and methods

The sample included fourteen under-17 soccer players who played for the team of 1. FC Tatran Prešov. The players born in 1999 and aged 16 to 17 years played for the 1st division U17 soccer team and trained between 3:30 p.m. to 5:00 p.m. five times per week. During the weekends, players played a league or training match under the supervision of their coaches. The team consisted of 25 players, with 16 players who trained on a regular basis since 7 years of age. The players were selected using nonrandom sampling.

Only test scores of players who participated in all four testing sessions were included in the study. Players performed aerobic fitness tests on the natural grass playing surface on the premises of the soccer academy of 1. FC Tatran Prešov. To determine the levels of aerobic endurance, players performed the intermittent Yo-Yo intermittent recovery test Level 1 (Yo-Yo IRTL1). The testing was conducted during four different phases of the season. Baseline testing was conducted at the beginning of the regular season, that is, at the end of the 1st preseason and at the beginning of the 1st half of the regular season (Phase I). Players participated in the second testing session at the end of 1st transition period, that is, before the 2nd preseason in January 2016 (Phase II). Third testing session took place after the 2nd half of preseason, that is, before the beginning of the second half of the regular season in March 2016 (Phase III).

The final testing session was conducted after the regular season, that is, at the end of the second half of the season (Phase IV). Fourteen players who received information about the course and purpose of testing participated in all testing sessions. After a 10-minute warm-up players were divided into two groups of seven players each. The testing sessions took place under the supervision of the teaching staff of the Faculty of Sports, University of Prešov and the soccer coaches.

## 3. Results and Discussions

Data on the total distance covered and maximal oxygen uptake ($VO_2max$) according to playing position are presented in Tables 1, 2, and 3. The results showed that forwards achieved highest scores during phase IV, that is, at the end of the 2nd half of the regular season. When assessing $VO_2max$, we did not take into consideration the running economy from the viewpoint of muscle recruitment, efficiency of oxygen utilization, or stride length, which, to a certain extent, may affect the final value of $VO_2max$. We compared only the test scores achieved by players in the sample by using a formula for calculating $VO_2max$. Therefore, the scores for $VO_2max$ may be considered slightly inaccurate. When comparing the distances covered with findings reported by Psotta et al. (2006), players showed average values of distance covered. According to Bunc (2008), elite level and competitive soccer players show $VO_2max.kg^{-1}.min^{-1}$ values higher than 62 $ml.kg^{-1}.min^{-1}$ and 55 $ml.kg^{-1}.min^{-1}$, respectively. Compared with the $VO_2max.kg^{-1}.min^{-1}$ values ranging from 49.6 to 52.8 $ml.kg^{-1}.min^{-1}$ for elite Czech soccer players aged 16 to 17 years (Teplan et al., 2012), the players showed a higher mean $VO_2max$ value than the mean value reported.

**Table 1.** *Maximal oxygen uptake according to playing position*

| Player | $VO_2max.kg^{-1}.min^{-1}$ | | | | Distance covered (m) | | | | PP |
|---|---|---|---|---|---|---|---|---|---|
| | I. | II. | III. | IV. | I. | II. | III. | IV. | |
| H1 | 51.5 | 50.8 | 50 | 53 | 1,800 | 1,720 | 1,640 | 2,000 | G |
| H2 | 51 | 51.5 | 50 | 53 | 1,760 | 1,800 | 1,640 | 2,000 | G |
| H3 | 53 | 56 | 56.5 | 59 | 2,000 | 2,360 | 2,400 | 2,680 | F |
| H4 | 53.8 | 55 | 56 | 55.5 | 2,080 | 2,240 | 2,360 | 2,280 | F |
| H5 | 64 | 58 | 63 | 64 | 3,280 | 2,600 | 3,200 | 3,280 | OF |
| H6 | 50.5 | 54.8 | 57 | 55.5 | 1,680 | 2,200 | 2,480 | 2,280 | D |
| H7 | 62.6 | 53.5 | 59 | 59 | 3,120 | 2,040 | 2,720 | 2,680 | D |
| H8 | 53 | 55 | 55.8 | 56 | 2,000 | 2,240 | 2,320 | 2,360 | D |
| H9 | 49 | 50.8 | 52.5 | 55 | 1,520 | 1,720 | 1,920 | 2,240 | D |
| H10 | 58 | 52.5 | 56.5 | 58.5 | 2,560 | 1,920 | 2,400 | 2,640 | MP |
| H11 | 56.5 | 53.5 | 57 | 55.8 | 2,400 | 2,040 | 2,480 | 2,280 | MP |
| H12 | 60 | 53.5 | 46 | 60.5 | 2,800 | 2,400 | 1,120 | 2,880 | MP |
| H13 | 60.5 | 59 | 60 | 60 | 2,880 | 2,720 | 2,800 | 2,840 | MP |
| H14 | 55 | 53.5 | 55.5 | 57 | 2,200 | 2,040 | 2,280 | 2,480 | MP |

***Note.*** PP - playing position; G - goalkeeper; F - forward; OF - outside forward; D - defender; MP - midfield player; Phase I - July 2015; Phase II - January 2016; Phase III - March 2016; Phase IV - June 2016

The results showed that players demonstrated highest $VO_2max$ levels during phase IV at the end of the regular season. According to the playing position, forward players showed the highest $VO_2max$ values of all positions, followed by midfield players, defenders, and goalkeepers. When compared with $VO_2max$ values reported by Bunc (2008), we may conclude that players did not show $VO_2max$ of

elite players. A surprising finding was that $VO_2$max values of goalkeepers did not approach the values reported for competitive players. Compared with the $VO_2$max values ranging from 49.6 to 52.8 $ml.kg^{-1}.min^{-1}$ for elite Czech soccer players aged 16 to 17 years (Teplan et al., 2012), we may conclude that players showed a higher mean $VO_2$max value than the mean value reported by Teplan et al. (2012).

**Table 2.** *Mean values of maximal oxygen uptake according to playing position*

| $VO_2$max $\bar{x}$ | Goalkeepers | Forwards | Midfield players | Defenders |
|---|---|---|---|---|
| Phase I | 51.3 | 57 | 58 | 53.8 |
| Phase II | 51.2 | 56 | 54.4 | 53.5 |
| Phase III | 50 | 59 | 55 | 56.1 |
| Phase IV | 53 | 60 | 58.4 | 56.4 |

***Note.*** $VO_2$max $\bar{x}$– mean value of maximal oxygen uptake; Phase I - July 2015; Phase II - January 2016; Phase III - March 2016; Phase IV - June 2016

**Table 3.** *Mean distance covered according to playing position*

| Distance $\bar{x}$ | Goalkeepers | Forwards | Midfield players | Defenders |
|---|---|---|---|---|
| Phase I | 1,780 | 2,453 | 2,568 | 2,080 |
| Phase II | 1,760 | 2,400 | 2,224 | 2,050 |
| Phase III | 1,640 | 2,653 | 2,216 | 2,360 |
| Phase IV | 2,000 | 2,747 | 2,624 | 2,390 |

***Note.*** distance $\bar{x}$– mean distance covered; Phase I - July 2015; Phase II - January 2016; Phase III - March 2016; Phase IV - June 2016

According to Psotta et al. (2006), players aged 16 to 17 years should show the following scores for the Yo-Yo IRTL1: above-average: over 2,200 m, average: 1,600 - 2,200 m, below-average: under 1,600 m. When comparing distances covered according to the playing position (Table 3), we may conclude that forwards, defenders, and goalkeepers showed the highest mean values of distance covered. According to Verheijen (1998), midfielders carry out the highest number of different types of sprints at various intensities, followed by defenders and forwards. This means that higher amount of running work carried out by midfielders reduces the recovery time during the game. Midfield players stand or walk less than defenders and forwards and therefore recover while running at low intensity. As reported by Verheijen (1998), due to their playing position midfielders show higher levels of aerobic fitness, with higher $VO_2$max values than defenders or forwards. From the viewpoint of total distance covered and ball work, midfielders have to meet stricter requirements compared with defenders or forwards. According to Verheijen (1998), this applies to youth and senior players at all performance levels. While midfield players are characterized by higher amount

of running work carried out at medium to high speed, the attacking playing position emphasizes sprinting. During the game, forwards perform 40-45% more sprinting than midfield players and 15-60% more than defenders. Hipp (2007), who tested the members of the senior Slovak soccer national team, found that performances of defenders and midfield players were at the same level, with lower amounts of distance covered. According to the analysis of test scores achieved by the players from our study, we partly agree with findings reported by Psotta (2003), Verheijen (1998) and Hipp (2007) because midfield players covered the greatest distance of 2,568 m during phase I only. During phases II, III, and IV, forwards covered the greatest distance of all playing positions, which is contradictory to findings reported in other studies. The distance covered during these phases were 2,400 m, 2,653 m, and 2,747, respectively. As compared with Psotta et al. (2006), the players showed either average or above-average distances. The goalkeepers covered distances from 1,600 to 2,200 m, which falls within the average category. During the phases I and II defenders showed average distances covered. However, during phases III and IV the distances covered fell within the above-average category. Midfield players showed similar values to defenders. Even though midfielders showed values within the above-average range, during phase II and III the distance covered fell within the average and above-average ranges. When compared with the criteria reported by Psotta et al. (2006), forwards showed above-average values of distance covered during all four phases of the season. The results showed that the greatest distance covered by a player was 2,476 m during the final testing session after the regular season. Therefore, we may conclude that according to the total distance covered in Yo-Yo IRTL1, players showed the level of international players. Compared with findings reported by Psotta et al. (2006), mean Yo-Yo IRTL1 distance fell within the above-average range.

Football is a sport that requires high levels of aerobic fitness and the Yo-Yo tests have been considered as useful tools in football training, since its procedures are quite similar to the intermittent characteristics of game activities (Brito, Fernandes, Seabra, & Rebelo, 2010). The ability to perform high-intensity intermittent exercise with relatively short recovery times has been shown to be relevant fitness variables in soccer (Chaouachi et al., 2010). The Yo-Yo intermittent test Level 1 evaluates an individual's ability to repeatedly perform intense exercise leading to a maximal activation of the aerobic system. Evaluations of elite athletes in various sports involving intermittent exercise showed that the higher the level of competition the better an athlete performs in the Yo-Yo IR tests. The Yo-Yo IR tests have shown to be a more sensitive measure of changes in performance than maximum oxygen uptake. The Yo-Yo IR tests provide a simple and valid way to obtain important information of an individual's capacity to perform repeated intense exercise and to examine changes in performance. Heart rate measurements during a submaximal version of the Yo-Yo IR1 test provide useful information about the fitness level of an individual (Bangsbo, Iaia, & Krustrup, 2008).

Studies that evaluated total distance covered in the Yo-Yo IRTL1 classify players into groups according to the distance covered. Teplan et al. (2012), who evaluated aerobic capacity in three different U17 soccer teams, found that the national team players and best league team players covered the mean distances of 1,940 and 1,952 m, respectively. The results of the study by Markovic and Mikulic (2011) showed that U17 players who were members of a successful club competing in Croatia's first soccer league covered a mean distance of 1,581 m in the Yo-Yo IR1 test. Similarly, Rampinini Impellizzeri, Castagna, and Wisloff (2008) found that the total distance covered by 16 junior players from a professional soccer team during the YYIRT was 2,150 $\pm$ 327 m (range, 1,440–2,720 m). Also, Casamichana and Castellano (2010) found that youth soccer players who competed at regional level, with a mean of 7.5 years of experience in federation soccer, averaged 1,816 m in Yo IRTL1. Deprez et al. (2014) reported that the grand mean Yo-Yo IRTL1 distance for U17 soccer players was 1,556 m. According to the mean distance covered, the players showed a comparable level of aerobic witness when compared with the mean distance covered in Yo-Yo IRTL1 by national league players.

Teplan et al. (2012) determined and compared aerobic capacity levels in three U17 soccer teams of different performance levels. The scores in the Yo-Yo IRTL1 were used to determine maximal oxygen uptake, which ranged from 48.89 $ml.kg^{-1}.min^{-1}$ for the worst league team players to 52.69 $ml.kg^{-1}.min^{-1}$ for the national team players. In comparison with these scores, players showed similar $VO_2max$ values to those reported for their age-matched peers on the Czech national team. Reilly, Williams, Nevill, & Franks (2000) assessed $VO_2max$ in young elite and sub-elite soccer players who showed values from 55 $ml.kg^{-1}.min^{-1}$ to 59 $ml.kg^{-1}.min^{-1}$. When comparing $VO_2max$ of players from our study with that reported by Reilly et al. (2000), it is evident that players showed lower levels of aerobic fitness than their elite counterparts. Similar findings were reported by Castagna, Impellizzeri, Chamari, Carlomagno, and Rampanini (2006) who tested amateur players from the same team. The players showed a $VO_2max$ level of 56.28 $ml.kg^{-1}.min^{-1}$. Krustrup et al. (2003) found that high-intensity running covered by the players during games was correlated to Yo-Yo test performance but not to $VO_2max$. As reported by Castagna Impellizzeri, Cecchini, Rampinini, and Barbero Alvarez (2009), specific endurance, as determined by Yo-Yo IR1 performance, positively affects physical match performance in male young soccer players. Consequently, the Yo-Yo IR1 test may be regarded as a valid test to assess game readiness and guide training prescription in male youth soccer players. Krustrup et al. (2003) studied seasonal changes in physical performance of soccer players. The Yo-Yo test performance of 10 elite soccer players was 1,760 m before the seasonal preparation period and was 25% better at the start of the season. At the end of the season, the mean distance covered in the Yo-Yo test was not significantly altered, but large inter-individual performance changes were observed during the season. Impellizzeri, Rampanini and Marcora (2005) have suggested that the Yo-Yo test could provide information on both general aerobic fitness and soccer-specific endurance.

## 4. Conclusions

Approaching the competitive season, and during it, coaches and fitness trainers can take advantage of YYIRTL1 to test soccer-specific endurance of players, with information about both aerobic and anaerobic capacities (Castagna et al., 2006). The results of the Yo-Yo IRTL1 test based on intermittent running exercise with changes of direction may be useful for coaches from the perspective of feedback about soccer players' aerobic fitness levels. The results of this study may serve for continuous development of fitness levels of soccer players during long-term monitoring. The advantage of this test is that we can test players during the season and simultaneously not miss a training unit at the expense of testing. Testing players during training units may be considered a full-value form of training (Teplan et al., 2012). Determining differences in motor preconditions according to playing position is the result of both the selection of an individual for a particular playing position based on the fitness levels and player's long-term physiological adaptation to specific demands related to the playing position. According to Psotta (2003), differences in motor and physical fitness of players at different playing positions appear as early as pubertal age.

The results showed that players demonstrated highest $VO_2$max levels during phase IV at the end of the regular season. According to the playing position, forward players showed the highest $VO_2$max values of all positions, followed by midfield players, defenders, and goalkeepers. When comparing distances covered according to the playing position (Table 3), we may conclude that forwards, defenders, and goalkeepers showed the highest mean values of distance covered.

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