*Journal of Physical Education and Sport* ® (JPES), 16(2), Art 82, pp. 522 - 526, 2016
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

**Original Article**

# Level and differences of sprint acceleration among soccer players in three different age categories

MICHAL DRAGIJSKY[1], TOMAS MALY[2], DAVID BUJNOVSKY[3], FRANTISEK ZAHALKA[4], MIKULAS HANK[5], LUCIA MALA[6]
[1,2,3,4,5,6,] Faculty of Physical Education and Sport, Charles University in Prague, CZECH REPUBLIC

*Published online: June 25, 2016*
*(Accepted for publication May 29, 2016)*
**DOI:10.7752/jpes.2016.02082**

**Abstract**:
The purpose of this study was to identify and compare acceleration speed in running tests at 5 and 10 meters among young soccer players in three different age categories (U16: n=26, U17: n=14 and U19: n=19). The screened sample consisted of Czech elite youth soccer players who compete in the highest domestic league. Acceleration speed was measured using photocells (Brower Timing system, Utah, USA). The results of the study showed the effect of ontogenetic development on the level of acceleration speed in youth soccer players. Furthermore, the results serve as an indicative base for comparing with the results of their counterparts in other research groups. The results may be beneficial for sport practice especially for clinical staff, fitness coaches, soccer coaches and sports rehabilitation.
**Key words:** *youth athletes, field tests, performance, sprint ability*

## Introduction

Currently, soccer is characterised by dynamic developments, and we can observe increasing demands on movement for achieving maximum running speed (Haugen, Tønnessen & Seiler, 2013). Absolute and relative intensity of actions during matches is influenced by the age and field position of players (Al Haddad, Simpson, Buchheit, Di Salvo & Mendez-Villanueva, 2015). During the game, high intensity actions of players occur approximately every 90 seconds and on average last for 2-4 seconds. Sprinting constitutes 1-11% of the total distance covered during the game, and players sprint 30 to 40 times for various distances (Mohr, Krustrup & Bangsbo, 2003). Actions requiring maximal efforts can be divided into three categories based on their impact on soccer performance: acceleration, agility and maximum speed. These three categories are mutually independent (Little & Williams, 2005; Maly, Zahalka, Mala & Teplan, 2014). It is believed that specific types of tests and exercises should be used for diagnostics and development. Though speed is very important in most game situations, acceleration (initial three steps) is significantly more important and is especially decisive for short sprinting bouts (up to 20 meters), which occur during games (Deutsch, Kearney & Rehrer, 2013). Additionally, it is necessary to realize that players rarely achieve maximum running speed during games. Therefore, acceleration and its testing is more important for soccer performance (Jovanovic, Sporis, Omrcen & Fiorentini, 2011). Gambetta (1996) explains acceleration as a rapid change of speed, which allows players to reach maximum velocity in a minimum amount of time. Acceleration (especially 5 m and 10 m sprints) is an inseparable part of a soccer game (Bangsbo, Nørregaard & Thorsoe, 1991; Deutsch et al., 2013; Douge, 1987), and it is also an important aspect of standard game situations (Spinks, Murphy, Spinks & Lockie, 2007). According to several authors (Cometti, Maffiuletti, Pousson, Chatard, & Maffulli, 2001; Duthie, Pyne, Ross, Livingstone & Hooper, 2006; Rienzi, Drust, Reilly, Carter & Martin, 2000), the level of acceleration speed is a parameter that potentially determines the outcome of a match. From the physiological point of view, this parameter is determined by the level of knee and hip extensor strength (Kraemer, Ratamess, Volek, Mazzetti & Gomez, 2000). On average, players perform 91 accelerations per match, and this number is dependent on their field position. Thus, players in lateral positions accelerate more often compared with players in central positions (Ingebrigtsen, Dalen, Hjelde, Drust & Wisløff, 2015). The movement analysis of players in a top Italian league (Serie A) indicated that approximately 75.8% of high-intensity runs (>19 $km \cdot h^{-1}$) were performed within 9 m (Vigne, Gaudino, Rogowski, Alloatti & Hautier, 2010), and the straight line sprinting performance was the most important component of the offensive phase for scoring (Faude, Koch & Meyer, 2012). The aim of the study was to determine the level and differences of sprinting acceleration among elite soccer players in three youth age categories.

## Materials and Methods

*Subjects*

The research group consisted of U19, U17 and U16 category soccer players competing in the highest Czech leagues in respective age categories. Each monitored team participated in 5 training sessions and one


Corresponding Author MICHAL DRAGIJSKY, E-mail: dragijsky@gmail.com

match during a one-week microcycle. The U19 tested team was comprised of 19 players (age: 18.7±0.3, body height: 179.4±6.9 cm, body weight: 77.9±5.6 kg), the U17 team consisted of 14 players (age: 16.4±0.2, body height: 178.5±5.8 cm, body weight: 75.9±3.9 kg) and the U16 team consisted of 26 players (age: 15.3±0.4, body height: 176.5±6.4 cm, body weight: 73.7±3.6 kg). All participants were healthy and were not recovering from injury at the time of testing.

*Data collecting and processing*

Field testing was conducted outdoors on the fourth generation artificial grass field. The average temperature ranged between 17 and 19˚C, and humidity was between 62-70%. Prior to the measurement, a warm-up took place, which was controlled by the coach. It lasted for 25 minutes and consisted of the following parts: jogging (5 min), static stretching (3 minutes), dynamic stretching (6 minutes), basic athletic running exercises (5 minutes) and 4 runs (40 m with varying speeds). The measurement took place at the end of autumn season. The day before the measurement, players completed a light training session.

Acceleration speed parameters were measured using the acceleration speed test at 5 and 10 meters from a stationary start position (Cometti et al., 2001; Little & Williams, 2005; Wilson, Newton, Murphy & Humphries, 1993). Running time was recorded using three pairs of photocells (Brower Timing system, Utah), which were arranged in series (Figure 1). The players initiated the run at their own discretion from the line at the first pair of photocells, which recorded the start. The players were required to run 10 meters at maximum velocity. Acceleration speed was measured at 5 and 10 meters.

The participants had 2 trials, and the best performance was used for analysis.

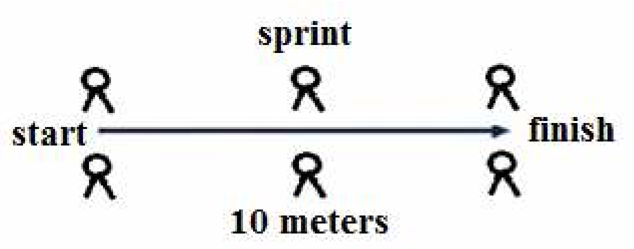


Figure 1 Scheme of the 5 m and 10 m running test

*Statistical analysis*

The analysis of variances (ANOVA) was used for evaluating dependent variables such as acceleration speed between the three teams (independent variable). To evaluate equality of error variances, Levene's test was used. Multiple comparisons of the mean of the monitored groups were conducted using Bonferroni's posthoc test. The probability of type I error (alpha) was set at 0.05 in all statistical analyses. Statistical analysis was performed using IBM® SPSS® v21 (Statistical Package for Social Science, Inc., Chicago, IL, 2012).

**Results**

The results revealed a significant difference in acceleration speed for the 5 m test ($F_{2,59} = 6.45$, $p < 0.01$, $\eta = 0.187$). U16 and U17 players achieved comparable performances (U16 = 1.145 ± 0.012 s, U17 = 1.150 ± 0.017 s), and the difference between the monitored groups was not significant. On the contrary, the older players (U19) achieved better performance (1.084 ± 0.014 s) in comparison with the U17 category ($\Delta v = 0.066$ s, 5.74%). This difference was significant ($p < 0.05$). We also observed a significantly better performance ($p < 0.01$) between U19 vs. U16 categories ($\Delta v = 0.066$ s, 5.74%).

For the doubled distance (10 m), we detected a significant difference in acceleration speed in the monitored groups ($F_{2,59} = 9.516$, $p < 0.01$, $\eta = 0.254$).

U16 and U17 players achieved similar performances (U16 = 1.913 ± 0.013 s, U17 = 1.931 ± 0.018 s), and the difference between these groups was not significant ($p>0.05$). Just as for the 5 m test, the older players (U19) achieved better performance (1.838 ± 0.016 s) compared with their younger counterparts from the U17 category ($\Delta v = 0.093$ s, 4.82 %). This difference was significant ($p < 0.01$). In addition, a significant difference ($p< 0.01$) was observed between U19 vs. U16 categories ($\Delta v = 0.075$ s, 3.92 %).

Table 1 Description of profiles and statistical differences between the teams

| Parameters | U16 | | U17 | | U19 | | F | p | Eta |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | | | |
| Acceleration 5 m (s) | 1.145 | 0.012 | 1.15 | 0.017 | 1.084 | 0.014 | 6.45 | < 0.01 | 0.187 |
| Acceleration 10 m (s) | 1.913 | 0.013 | 1.931 | 0.018 | 1.838 | 0.016 | 9.516 | < 0.01 | 0.254 |

Legend: S.D. – standard deviation

**Discussion**

The aim of the study was to compare parameters of acceleration speed, which was an indicator of fitness predisposition, using 5 and 10 m sprinting tests from a stationary starting position among soccer players in three age categories.

The level of acceleration speed in the U16 category was investigated by several authors. Malý et al. (2014) found the average value of 1.09±0.06 s using the 5 m test in U16 elite Czech soccer players. This value was better than the value measured in our study. Furthermore, these subjects, on average, needed shorter time for 10 meter sprints, and their average time was 1.85±0.08 s. In Scotland, the U15 youth age category group, which was monitored by McKenna (2010), achieved an average time of 1.81±0.02 s. Mendez-Villanueva, Buchheit, Kuitunen, Douglas, Peltola and Bourdon (2011) tested 14 young Spanish players (U14) whose time in acceleration speed test was 1.93±0.11 s, which is comparable to our results. However, players from the identical age category U16 achieved better results than our players (1.80±0.06 s). U16 players in our study achieved an average time of 1.145±0.012 s in the 5 m test and 1.913±0.013 s in the 10 m test.

U17 players, which were evaluated in our study, achieved an average time of 1.150±0.017 s in the 5 m test. Better results were recorded in identical age categories of the Chinese national youth team (1.150±0.017 s) and in youth Portugal players (average age of 17.4±0.6), when the average time of players was 1.07±0.05 and 1.09±0.07 s, respectively. Reilly, Williams, Nevill and Franks (2000b) compared elite and sub-elite players in this age category. They found that young elite players achieved better results (1.04±0.03 s) in acceleration speed tests than sub-elite players (1.07±0.06 s). This partially explains the difference between our elite soccer players and elite players from countries with more advanced soccer training. In 10 m sprinting, the results of young players of Celtic Glasgow Academy (McMillan, Helgerud, Macdonald & Hoff, 2005) (n=16, average age of 16.9±0.4, average time was 1.96±0.06 s) were comparable to ours. Young Tunisian and Senegalese players (average age of 17.5) achieved an average time of 1.87±0.1 s (Chamari et al. 2004). Slightly better results were found in young Asian plyers whose average time in this test was 1.81±0.05 s (Wong & Wong, 2009). The total average time of U17 players from our study for the 10 m test was 1.931±0.018 s.

Probably most studies dealing with acceleration speed are devoted to the adult category. Because the U19 category is the last junior category, these players should achieve results that are comparable with adult players due to their forthcoming transfer to the adult category. The oldest players (U19) achieved a value of 1.084±0.014 s in 5 m sprinting. The analysis of acceleration speed among Portuguese league players showed an average time of 1.02±0.05 s in this test (Silva, Magalhães, Ascensão, Seabra & Rebelo, 2013). Kollath and Quade (1993) determined that the average time of professional players was 1.03±0.08 s, while amateur players achieved worse results in this test with a value of 1.07±0.07 s. The difference between elite and sub-elite players was confirmed in France where a significantly higher level of 10 m sprinting was found in French elite players than in their counterparts from two lower performance levels. Professional 1$^{st}$ league players run the 10 m distance with the best average time of 1.804±0.063 s, the 2$^{nd}$ league players value is 1.818±0.058 s, and the values of amateur players is 1.859±0.075 s (Cometti et al. 2001). Our players (U19) achieved an average time of 1.838 s during 10 m sprinting. This result is worse compared with soccer players from countries with a more developed soccer training such as Italy or Spain. This difference in performance becomes apparent when we compare our results with the results presented by Bravo, Impellizzeri, Rampinini, Castagna, Bishop and Wisloff (2008), who measured the average total time of 1.77±0.06 s in U18 Italian players. Similar results when the players achieved the value of 1.73±0.06 in this test were also reported in young Spanish players (Mendez-Villanueva et al., 2011). However, in their study, goalkeepers were excluded from the overall assessment, and this fact can emphasize the difference between our and Spanish players. A comparable to our results average time was achieved by Norwegian elite junior soccer players whose average final time was 1.88±0.06 s.

Compared with another study (Kollath & Quade 1993), our results are closest to the values achieved by amateur players whose average time was 1.88±0.10 s. Professional players in the (Kollath & Quade 1993) study were better, and their final average time was 1.79±0.09 s.

Based on these results, it is possible to observe differences between Czech elite youth players and foreign players at different performance levels. Compared with youth players from other studies (thus, from other countries and teams), it is necessary to realize that the differences in performances may be attributed to various factors such as different training methods, length of participation in the training process and categorisation into higher age categories. Villanueva et al. (2011) states that compared with anthropometric characteristics, the biological maturity level of players is a very important determinant, which significantly impacts the test results. Therefore, we believe that it is an important factor to consider when evaluating and comparing results of individual age categories. Sporis Jukic, Ostojic and Milanovic (2009) emphasize the importance of considering field positions of players that were examined in individual studies. Furthermore, the performance levels of players are important because several studies (Cometti et al., 2001; Comfort, Bullock & Pearson 2012; Kollath & Quade 1993) identified differences between elite players and players at lower performance levels.

In our study, we confirmed a statistically significant effect of age on acceleration speed between soccer players in the oldest age category and two younger categories. These differences were probably caused by ontogenesis and were related to longer training, level of biological maturity or participation of some players in training sessions and preparatory matches in adult category where there were greater demands on physical fitness and regular strength training.

On the contrary, an insignificant difference between two younger categories can be attributed to the interplay of age category affinity, biological age, maturation rate and beginning of functional strength training in younger age categories.

**Conclusion**

Our research dealt with the level and differences of acceleration speed of youth soccer players in three age categories. The results showed significant differences in both acceleration speed tests (5 and 10 m) between the U19 category and two younger categories (U17, U16). On the other hand, the differences between performances of U16 and U17 players were not significant.

The detected acceleration speed differences, which favoured older players, could have been caused by the level of biological maturity, length of sport practice, regular strength training in this age category and subsequent hormonal response.

The results of our study confirmed the effect of ontogenetic development on acceleration speed in youth soccer players. Our study can serve as an indicative base for comparison with the results of counterparts in other research groups. The results may be beneficial for sport practice, especially for clinical staff, fitness coaches, soccer coaches and sports rehabilitation coaches.

**Acknowledgements:**
This project was supported by GACR 16-21791S, PRVOUK P38, SVV 2016-260346

**References**

Al Haddad, H., Simpson, B. M., Buchheit, M., Di Salvo, V., & Mendez-Villanueva, A. (2015). Peak Match Speed and Maximal Sprinting Speed in Young Soccer Players: Effect of Age and Playing Position. *International Journal of Sports Physiology & Performance, 10*(7).

Bangsbo, J., Nørregaard, L., & Thorsoe, F. (1991). Activity profile of competition soccer. *Canadian journal of sport sciences= Journal canadien des sciences du sport, 16*(2), 110-116.

Bravo, D. F., Impellizzeri, F., Rampinini, E., Castagna, C., Bishop, D., & Wisloff, U. (2008). Sprint vs. interval training in football. *International Journal of Sports Medicine, 29*(8), 668-674.

Chamari, K., Hachana, Y., Ahmed, Y. B., Galy, O., Sghaier, F., Chatard, J. C., . . . Wisloff, U. (2004). Field and laboratory testing in young elite soccer players. *British Journal of Sports Medicine, 38*(2), 191-196.

Cometti, G., Maffiuletti, N., Pousson, M., Chatard, J., & Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer players. *International Journal of Sports Medicine, 22*(1), 45-51.

Comfort, P., Bullock, N., & Pearson, S. J. (2012). A comparison of maximal squat strength and 5-, 10-, and 20-meter sprint times, in athletes and recreationally trained men. *The Journal of Strength & Conditioning Research, 26*(4), 937-940.

Deutsch, M., Kearney, G., & Rehrer, N. (2013). 25 A comparison of competition work rates in elite club and'super 12'rugby. *Science and football IV*, 160.

Douge, B. (1987). Football: the common threads between the games. *Science and Foot*.

Duthie, G. M., Pyne, D. B., Ross, A. A., Livingstone, S. G., & Hooper, S. L. (2006). The reliability of ten-meter sprint time using different starting techniques. *The Journal of Strength & Conditioning Research, 20*(2), 251.

Faude, O., Koch, T., & Meyer, T. (2012). Straight sprinting is the most frequent action in goal situations in professional football. *Journal of Sports Sciences, 30*(7), 625-631.

Gambetta, V. (1996). In a blur: How to develop sport-specific speed. *Sports Coach, 19*, 22-24.

Haugen, T. A., Tønnessen, E., & Seiler, S. (2013). Anaerobic performance testing of professional soccer players 1995-2010.

Ingebrigtsen, J., Dalen, T., Hjelde, G. H., Drust, B., & Wisløff, U. (2015). Acceleration and sprint profiles of a professional elite football team in match play. *European journal of sport science, 15*(2), 101-110.

Jovanovic, M., Sporis, G., Omrcen, D., & Fiorentini, F. (2011). Effects of speed, agility, quickness training method on power performance in elite soccer players. *The Journal of Strength & Conditioning Research, 25*(5), 1285-1292.

Kollath, E., & Quade, K. (1993). Measurement of sprinting speed of professional and amateur soccer players. *Science and football II*, 31-36.

Kraemer, W. J., Ratamess, N. A., Volek, J. S., Mazzetti, S. A., & Gomez, A. L. (2000). The Effect of the Meridian Shoe on Vertical Jump and Sprint Performances Following Short-Term Combined Plyometric/Sprint and Resistance Training. *The Journal of Strength & Conditioning Research, 14*(2), 228-238.

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *The Journal of Strength & Conditioning Research, 19*(1), 76-78.

Maly, T., Zahalka, F., & Teplan, J. (2014). Profile, correlation and structure of speed in youth elite soccer players. *Journal of human kinetics, 40*(1), 149-159.

McKenna, M. (2010). *Methods of identifying high velocity growth in youth soccer players.* University of Glasgow.

McMillan, K., Helgerud, J., Macdonald, R., & Hoff, J. (2005). Physiological adaptations to soccer specific endurance training in professional youth soccer players. *British Journal of Sports Medicine, 39*(5), 273-277.

Mendez-Villanueva, A., Buchheit, M., Kuitunen, S., Douglas, A., Peltola, E., & Bourdon, P. (2011). Age-related differences in acceleration, maximum running speed, and repeated-sprint performance in young soccer players. *Journal of Sports Sciences, 29*(5), 477-484.

Mohr, M., Krustrup, P., & Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *Journal of Sports Sciences, 21*(7), 519-528.

Reilly, T., Williams, A. M., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. *Journal of Sports Sciences, 18*(9), 695-702.

Rienzi, E., Drust, B., Reilly, T., Carter, J. E. L., & Martin, A. (2000). Investigation of anthropometric and work-rate profiles of elite South American international soccer players. *Journal of Sports Medicine and Physical Fitness, 40*(2), 162.

Silva, J. R., Magalhães, J., Ascensão, A., Seabra, A. F., & Rebelo, A. N. (2013). Training status and match activity of professional soccer players throughout a season. *The Journal of Strength & Conditioning Research, 27*(1), 20-30.

Spinks, C. D., Murphy, A. J., Spinks, W. L., & Lockie, R. G. (2007). The effects of resisted sprint training on acceleration performance and kinematics in soccer, rugby union, and Australian football players. *The Journal of Strength & Conditioning Research, 21*(1), 77-85.

Sporis, G., Jukic, I., Ostojic, S. M., & Milanovic, D. (2009). Fitness profiling in soccer: physical and physiologic characteristics of elite players. *The Journal of Strength & Conditioning Research, 23*(7), 1947-1953.

Vigne, G., Gaudino, C., Rogowski, I., Alloatti, G., & Hautier, C. (2010). Activity Profile in Elite Italian Soccer Team. *International Journal of Sports Medicine, 31*(5), 304-310.

Wilson, G. J., Newton, R. U., Murphy, A. J., & Humphries, B. J. (1993). The optimal training load for the development of dynamic athletic performance. *Medicine and Science in Sports and Exercise, 25*(11), 1279-1286.

Wong, D. P., & Wong, S. H. (2009). Physiological profile of Asian elite youth soccer players. *The Journal of Strength & Conditioning Research, 23*(5), 1383-1390.