ORIGINAL RESEARCH PAPER

EFFECT OF HIGH-SPEED AND PLYOMETRIC TRAINING FOR 13-YEAR-OLD MALE SOCCER PLAYERS ON ACCELERATION AND AGILITY PERFORMANCE

Gunnar Elling Mathisen

Department of Sport Sciences
UiT, the Norwegian Artic University
Address: 9037 Tromsø, Norway
Phone: + 47 77660472, fax: + 47 77688118
E-mail: gunnar.mathisen@uit.no

Abstract

Acceleration, sprint and agility performance are crucial in sports like soccer. There are few studies regarding the effect of training on youth soccer players in agility performance and in sprint distances shorter than 30 meter. Therefore, the aim of the recent study was to examine the effect of a high-intensity sprint and plyometric training program on 13-year-old male soccer players. A training group of 14 adolescent male soccer players, mean age (±SD) 13.5 years (±0.24) followed an eight week intervention program for one hour per week, and a group of 12 adolescent male soccer players of corresponding age, mean age 13.5 years (±0.23) served as control a group. Pre- and post-tests assessed 10-m linear sprint, 20-m linear sprint and agility performance. Results showed a significant improvement in agility performance, pre 8.23 s (±0.34) to post 7.69 s (± 0.34) ($p<0.01$), and a significant improvement in 0-20m linear sprint, pre 3.54s (±0.17) to post 3.42s (±0.18) ($p<0.05$). In 0-10m sprint the participants also showed an improvement, pre 2.02s (±0.11) to post 1.96s (± 0.11), however this was not significant. The correlation between 10-m sprint and agility was $r = 0.53$ ($p<0.01$), and between 20-m linear sprint and agility performance, $r = 0.67$ ($p<0.01$). The major finding in the study is the significant improvement in agility performance and in 0-20 m linear sprint in the intervention group. These findings suggest that organizing the training sessions with short-burst high-intensity sprint and plyometric exercises interspersed with adequate recovery time, may result in improvements in both agility and in linear sprint performance in adolescent male soccer players. Another finding is the correlation between linear sprint and agility performance, indicating a difference when compared to adults.

Key words: *speed training, agility, adolescent male soccer players*

Introduction

Physical factors are important in youth soccer development, among them running at straight-line speed and change-of-direction speed, often referred to as agility (Stroyer, Hansen & Klausen, 2004). Agility performance is a physiological prerequisite in soccer because players are often involved in sudden direction change in order to be effective during the game (Little & Williams, 2005). Match analyses have shown that sprint time is often only a few seconds (Castanga, D'Ottavio & Abt, 2003), and most sprints are shorter than 20 meter (Haugen et al., 2013).

Physiological consideration and concern regarding trainability are essential in youth athlete development because physiological adaption to training is different from that of adults (Malina, Bouchard & Bar-Or, 2004, Malina et al. 2004b). Growth spurt is associated with physical performance development (Rowland, 2005; Malina, Bouchard & Bar-Or, 2004), and 13.8 (± 0.8) years is the estimated age for peak height velocity for male soccer players, and 14.2 years for samples of European boys (Malina, Bouchard & Bar-Or, 2004). The present literature states that the age between 12 to 15 years is a critical period of speed development or as "windows of trainability" regarding sprint performance (Rumpf, Cronin & Pinder, 2012). Speed training is supposed to have a positive effect, stimulating the nervous system and muscular coordination during this stage of natural maturation (Aagaard, 2001; Mero, 1998), with an increase in testosterone, and in muscle mass (Rowland, 2005; Malina, Bouchard & Bar-Or, 2004). Therefore, training regimens that simulate speed performance are critical for optimal training results at this age (Venturelli, Bishop & Pettene, 2008; Diallo et al., 2001).

Training programs using short sprints have shown an improvement in the performance of adolescents in 10- and 30-meter straight-line sprint (Papiakovou, Giannakos & Michailidis, 2009; Venturelli, Bishop & Pettene, 2008). Pettersen & Mathisen (2012) found improvement in speed and agility in 11- to 12 -year-old soccer players with a program consisting of short-burst high-intensity activities. However, Buchheit et al. (2010) found no effect with repeated shuttle sprint and explosive strength training in adolescent soccer players in 30 meter sprint. In a review article Hughes, Lloyd & Meyers (2012) shows to a significant improvement in sprint performance in boys aged 12 and 15 years, but not in boys aged 11, 13, or 14 years, and concluded that more research is needed to discover the effectiveness of training at these stages of development.

Plyometric drills are recommended in soccer training because of the fast force production and explosive actions with change-of-directions, and their needs for the ability to start and stop quickly (Thomas, French & Hayes, 2009; Little & Williams, 2005). Plyometric training has been shown to improve performance in 10-30 meter straight-line speed in young male athletes (Thomas, French & Hayes, 2009; Meylan & Malatesta, 2009; Kotzaminidis, 2006; Diallo et al., 2001), and also in agility performance (Vaczi et al., 2013; Thomas, French & Hayes, 2009; Miller et al., 2006). However other studies have shown a limited effect in straight-line sprint performance (Haugen et al., 2013); thus, there is still a discrepancy regarding the effect. Plyometric training has been avoided in exercises for children and adolescents because there has been an understanding that it may lead to injuries (Michalidis et al., 2013; Hughes et al., 2012). The current view among researchers is that it is safe, if the program is considered with appropriate training volume and intensity, and that it may reduce the instance of injuries (Meylan & Malatesta, 2009).

Few studies have been conducted with adolescents; most have been executed as a mixture of short sprint with strength training (Hughes, Lloyd & Meyers, 2012)**.** To the authors' knowledge, there is no study involving both short-burst high-speed exercises including plyometric drills in adolescent soccer players. Therefore, in the present study, one of the ordinary soccer training sessions was replaced with those aforementioned exercises for 13-year-old male soccer players. Furthermore, there is uncertainty as to whether ordinary soccer training sessions alone will offer enough stimuli to develop short-speed and agility performance (Jullien et al., 2008, Meylan & Malatesta, 2009); thus, it would be interesting for coaches and practitioners to recognize whether the program would have any effect on speed and agility performance.

Materials and Methods

Experimental approach. To compare the effects of one hour of speed and plyometric training per week versus traditional soccer training, we tested 10-meter and 20-meter linear sprint and agility performance before and after an eight-weeks training program. The intervention took place in the preseason period, and the training group (TG) replaced one of the ordinary soccer training sessions with the intervention program. The training program for this period consisted of short-burst running straight-line sprints, or change-of-direction sprints with maximal effort for 2-6 seconds, and resisted acceleration with a partner, this was interspersed with recovery periods lasting 60 seconds (Pettersen & Mathisen, 2012; Ferrigno

& Brown, 2005). The program also included plyometric drills, which included skipping, multiple hurdle jumps, horizontal and lateral bounding executed as multiple jumps with a variation of single and double leg jumps. Each session started with 10 minutes' warm-up, followed by 15 minutes plyometric drills and 35 minutes of sprint training. The sessions consisted of a total of 30 short-burst sprints; 15 with straight-line and 15 with changes-of-directions, followed by 30 horizontal and vertical jumps (measured as ground contacts) in the first four weeks, and 40 jumps in the final four weeks. The control group (CG) followed an ordinary soccer training program of the same session duration as the TG. Pre- and post-tests assessed 10-m linear sprint, 20-m linear sprint and agility performance.

Participants. Fourteen male soccer players from a local club, with a mean age of 13.5 years (± 0.8), participated in the study. Twelve male soccer players with a mean age of 13.5 years (± 0.7) from another local club at a similar level served as control group (CG). In addition to the intervention program, the participants in the TG undertook two one-hour organized traditional soccer training sessions, and the CG undertook three organized sessions with traditional soccer training. Written informed consent to participate in the study was obtained from both the participants and their parents in both groups. The study was given institutional ethical approval, met the ethical standards in sports and exercise science research (Harris & Atkinson, 2011), and was undertaken in compliance with The Helsinki Declaration.

Test Procedures. The straight-line sprint-test consisted of a 20-meter track with 10-meter split-time recording. The photocells were placed at a height of 20 cm in the starting position, and at 100-cm height at 10-m and 20-m in the straight-line test. All tests were completed from a standing start, with the front foot placed 30 cm behind the photocells' start line. The agility test course was a 20-m standardized course used in previous studies, starting with a 5-m straight sprint followed by a 90° turn, a 2.5-m sprint followed by a 180° turn, a 5-m slightly curved sprint followed by a 180° turn, a 2.5-m straight sprint followed by a 90° turn, and a 5-m straight sprint (Pettersen & Mathisen, 2012). Three 120-cm high coaching sticks, which were not allowed to be touched, were used to ensure correct passage in the turns. The test was executed with the same starting procedure as the straight-line test and with photocells placed at a height of 100-cm at the finish line. Each participant performed two trials with a minimum of three minutes' recovery between; times were recorded to the nearest 0.01 second, and the faster of the two times was recorded. A familiarizing test on the sprint and agility track was conducted during both the pre- and post-tests with two sub-maximal trials prior to the start of the test. Electronic photocells timing gates were used to record split and completion times (Brower Timing System, USA). The exercises and the tests were executed in a gym with a parquet floor, and with a temperature of 20 ° C. Prior to testing, the participants followed the same warm-up procedure with jogging and sprint drills.

By calculating the intraclass correlation coefficient (ICC), it has been demonstrated that both tests show good reliability (Table 3). Differences between groups were tested with a one-way analysis of variance, and the Pearson product moment correlation *r* was used to evaluate the relationship between linear sprint and agility performance test measures (SPSS 19.0).

Statistical Analyses. Data were checked for normality by a histogram plot and by using the Shapiro-Wilk's normality distribution test. Descriptive statistics were then calculated and reported as mean ± standard deviations (SD) of the mean for each group of players on each variable. Students *t*-test showed no difference in baseline between groups. A one-way between-group analysis of variance (ANOVA) was conducted to find the mean difference between training group and control-group before and after the intervention. The relationship between performances in linear sprints and agility tests was determined by using Pearson's correlation (*r*). The same procedure was used to detect any correlation among linear sprint, agility, and anthropometrical variables. The reliability of tests was assessed using the ICC. The test-retest reliability of parameters describing the players' running and agility performance is shown in Table 3. The ICC values showed good reliability in the tests. All calculations were carried out using SPSS v 19.0 (Inc., Chicago, Il., USA).

Results

Table 1 presents the anthropometric characteristics of the two groups before and after the intervention. There was no significant difference between the groups.

Table1

Anthropometric characteristic of the two groups (mean±SD)

	Training Group		Control Group	
	Pre	Post	Pre	Post
Age (years)	13.5 (0.2)	13.7 (0.2)*	13.5 (0.2)	13.7 (0.2)*
Height (cm)	162.5 (8.1)	163.5 (8.1)*	160.5 (5.7)	161.2 (5.7)*
Weight (kg)	48.8 (10.1)	49.6 (10.1)*	49.3 (5.6)	49.9 (5.5)*

*$p<0.05$ for pre- post-tests within group differences.
No significant differences between groups

The results of pre- and post-tests for both groups are presented in Table 2.

Table 2

Pre- and post-test results for sprint and agility performance (mean±SD) for training group (TG) and control group (CG)

	Training Group		Control Group	
Test	Pre	Post	Pre	Post
10 m sprint (sec)	2.02 (0.11)	1,96 (0.11)*	2.00 (0.11)	2.02 (0.12)
20 m sprint (sec)	3.54 (0.17)	3.42 (0.18)*#	3.55 (0.19)	3.58 (0.20)
Agility (sec)	8.23 (0.34)	7.69 (0.34)*#	8.25 (0.25)	8.18 (0.21)

*p<0.05 for pre- and post-tests within-group change in performance.
#p<0.05 for pre- and post-tests between-group change in performance.

Results showed a significant improvement in agility performance, pre 8.23s (±0.34) to post 7.69s (±0.34) (p<0.01), and a significant improvement in the 0-20 m straight-line sprint, pre 3.54s (±0.17) to post 3.42s (±0.18) (p<0.05). In the 0-10-m straight-line sprint; the participants showed an improvement, pre 2.02s (± 0.11) to post 1.96s (± 0.11), however this was not significant.

Table 3 the intraclass correlation (ICC) and SEM values between test and retest of each dependent variable in the CG, showing good reliability between test and retest.

Table 3

Test-retest reliability coefficients (ICC) and standard error of mean (SEM) values in sprint and agility tests in control group (n=12)

Test	ICC	SEM	p-value
10 m sprint	0.87	0.02	<0.001
20 m sprint	0.95	0.02	<0.001
Agility	0.79	0.07	<0.05

Table 4 shows the correlation between 10-m sprint and agility was r=0.53 (p<0.01), and between 20-m linear sprint and agility performance r=0.67 (p<0.01).

Table 4

The relationship between the performances in straight line sprint and agility performance and height in the two groups (n=26)

Relationship assessed	Pearson's r	p value
10 sprint vs agility	0.53	p<0.01
20 m sprint vs agility	0.67	p<0.01
height vs 10 m sprint	0.33	not sign.
height vs 20 m sprint	0.34	not sign.
height vs agility	0.11	not sign.

Discussion

In the present study we tested the effect of an eight-week program consisting of short-burst high-speed exercises including some plyometric drills on 13-year-old male soccer players. The main result in the study was a significant improvement (6.6%) in agility performance (Tab. 2), a significant improvement (3.4%) in 20-m straight-line sprint, and an improvement in 10-m straight-line sprint (3.0%), not significant between groups (Tab. 2). Sprint training is appropriate at the age of 12-15 years for the male population, because the improvements in strength, power and neural adaption are due to the rise of testosterone level at this stage of development (Rowland, 2005; Malina, Bouchard & Bar-Or, 2004). Growth spurt with an increase in testosterone and following an increase in muscle mass may partly explain the improvement in performance (Rowland, 2005; Viru et al., 1999); however, the duration of the intervention period was only eight weeks, and no significant changes in sprint and agility performance were found in the CG (Tab. 2). To the author's knowledge, this is the first study of adolescents soccer players involving both a speed and a plyometric program. The result from the present study is in accordance with that of previous research consisting of short-burst speed-training programs in 11-12-year-old soccer players (Pettersen & Mathisen, 2012), and speed combined with strength training (Rumpf et al., 2012; Kotzaminidis, 2006; Castanga, D'Ottavio & Abt, 2003). Plyometric training program has been shown to be effective in developing agility performance among youth soccer players (Meylan & Malatesta, 2009, however a study by Thomas, French & Hayes (2009) found no effect in straight-line sprint.

There is a suggestion that the positive effects in the present study are related to the choice of exercises in the intervention program, consisting of sprinting with change of directions, acceleration and deceleration, and plyometric drills with jumping, bounding and hopping exercises (Miller et al., 2006). Strength, balance and neuromuscular coordination are influenced by explosive actions throughout the training program, and plyometric and sprint training have been shown to improve these requirements (Meylan & Malatesta, 2009; Thomas, French & Hayes, 2009; Sheppard & Young, 2006; Ferrigno & Brown, 2005; Aagaard, 2003). The improvement is supposed to be due to the fact that neuromuscular adaptions including recruitment, activation of motor units, and coordination of muscles, are likely to have occurred (Thomas, French & Hayes, 2009; Rowland, 2005). Hughes, Lloyd & Meyers (2012) concluded that performance adaptions gained from sprint and plyometric training programs are linked to neural plasticity, especially at the onset of puberty.

Body height is a factor that indirectly affects speed through stride length in children and adolescents, and it has been shown that taller and heavier players are more often selected in teams younger than 18 years (Gravina et al., 2008; Gil et al., 2007). Almuziani (2000) found a correlation between the 50-meter sprint and relative height in 12-year-old boys, and Rowland (2005) shows an improvement in sprint velocity connected to height and stride length in children and youths up to 15 years. Maturational level is related to height at that age, and the adolescent spurt with enhancement in muscle mass occurs shortly after peak high velocity (Malina, Bouchard & Bar-Or, 2004). Findings from the present study showed a weak correlation between height and speed in 10-m (r=0.33) and in 20-m sprints (r=0.35), and in agility (r=0.11) (Tab. 4), and these results may be somewhat surprising. However, it is suggested that speed performances is more related to biological maturation than to anthropometric characteristics such as height alone (Mendez-Villnueva et al., 2011), and that other factors, such as stride frequency, attributed to neural factors are linked to speed ability, and also coordination and technique are linked to speed performance (Papiakovou, Giannakos & Michailidis, 2009).

This study also showed a significant relationship between 10-m linear sprint and agility performance, r=0.53 (p<0.01), and between 20-m linear sprint and agility, r=0.67 (p<0.01) (Tab. 4). Straight-line sprint and change-of-direction speed have been found to be independent abilities that are specific and produce limited transfer to each other in adult athletes (Little & Williams, 2005; Young, McDowell & Scarlett, 2001). However, Jones et al., (2009) suggest that a positive effect in straight-speed may lead to an improvement in change-of-direction speed. There are few studies on the topic; however, two studies with soccer players and basketball players aged between 11 and 14 years found a stronger correlation in linear sprint and agility performance than in adults (Jakovljevic et al., 2012; Pettersen & Mathisen, 2012). Common physiological and biomechanical determination may imply transfer to each other (Jakovljevic et al., 2012, Pettersen & Mathisen, 2012) and raise the issue of whether there is a stronger relationship between straight-line speed and agility performance in the youth population than among adults.

Moreover, there is a question about the effect of enhanced speed and agility performance on soccer match play. The capacity to produce high-speed actions is known to have an impact on soccer match performance (Little & Williams, 2005), and both initial acceleration and agility performance are found to be powerful discriminators between elite and regional junior players (Reilly, Bangsbo & Franks, 2000; Reilly et al., 2000b). Therefore, the program demonstrated in the present study consisting of speed and plyometric training may have a positive effect on this type of physical demand. The current study indicates that a training program including straight-line sprints, sprints with changes-of-directions, and plyometric training, is effective in the development of sprint and agility performance in adolescent soccer players beyond the gain of traditional soccer training alone in adolescents.

Conclusions

From the results obtained in the present study, speed and plyometric training in one training session per week over eight weeks is sufficient to enhance sprint and agility performance in youth players in the preseason period. Taking into account the background from previous reports and with the demands for speed and agility performance in soccer, these physical factors have been shown to contribute to performance in match play. Therefore, since these qualities are important, and seem vary in the performance of young soccer players, speed and plyometric exercises ought to be part of a training program in adolescent soccer players in the pre-season period.

Acknowledgement

The author thanks the young soccer players and their coaches in both groups for their cooperation in the training intervention study. No external financial support was required for the project.

References

1. Aagaard P. (2003). Training-induced changes in neural function. *Exerc Sport Sci Rev* 31, 61-67.
2. Almuzaini KS. (2000). Optimal peak and mean power on the Wingate test: Relationship with sprint ability, verticall jump, and standing long jump in boys. *Pediatr Exerc Sci* 12, 349-359.
3. Buchheit M, Mendez-Villanueva A, Delhomel G, Brughelli M, Ahmaidi S. (2010). Improving Repeated Sprint Ability in Young Elite Soccer Players: Repeated Shuttle Sprints vs. Explosive Strength Training. *J Strength Cond Res* 24, 2715-2722.
4. Castanga JB, D'Ottavio S, Abt G. (2003). Activity profile of young soccer players during actual match play. *J Strength Cond Res* 17, 775-780.
5. Diallo O, Dore' E, Duche P, Van Praagh E. (2001). Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. *J Sports Med Phys Fitness* 42, 342-348.

6. Ferrigno V, Brown LE. (2005). Training for speed, agility, and quickness. Champaign, Ill.: Human Kinetics.
7. Gil SM, Irazusta A, Ruiz F, Gil J, Irazusta J. (2007). Selection of young soccer players in terms of anthropometric and physiological factors. *J Sports Med Phys Fitness* 47, 25-32.
8. Gravina L, Gil SM, Ruiz F, Zubero J, Gil J, Irazuta J. (2008). Anthropometric and physiological differences between first team and reserve soccerplayers ages 10-14 years at the beginning and end of the season. *J Strength Cond Res* 22, 1308-1314.
9. Harris DJ, Atkinson G. (2011). Update - ethical standards in sport and exercise science. *Int J Sports Med* 32, 819-821.
10. Haugen T, Tønnesen E, Hisdal J, Seiler S. (2013). The Role and Development of Sprinting Speed in Soccer *International Journal of Sport Physiology and Performance*. Human Kinetics, Inc. (accepted aug. 2013)
11. Hughes MG, Lloyd R, Meyers R. (2012). Sprinting and Plyometric Ability in Youths: The Effect of Natural Development and Training. New York: Nova Science Publishers, Inc.
12. Jakovljevic ST, Karalejic MS, Pajic ZB, Macura MM, Erculj FF. (2012). Speed and agility of 12- and 14-year-old elite male basketball players. *J Strength Cond Res* 26, 2453-2459.
13. Jones P, Bampouras TM, Marrin K. (2009). An investigation into physical determinants of change of direction speed *J Sports Med Phys Fitness* 49, 97-104
14. Johnson BA, Salzberg CL, Stevenson DA. (2011). A systematic review: Plyometric training programs for young children. *J Strength Cond Res* 25, 2623-2633.
15. Jullien H, Bisch C, Largouet N, Manovrier C, Carling CJ, et al. (2008). Does a short period of lower limb strength training improve performance in field-based tests of running and agility in young professional soccer players? *J Strength Cond Res* 22, 404-411.
16. Kotzamanidis C. (2006). Effect of plyometric training on running performance and vertical jumping in prepubertal boys. *J Strength Cond Res* 20, 441-445.
17. Little T and Williams AG. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *J Strength Cond Res* 19, 76-78.
18. Malina RM, Bouchard C, Bar-Or O. (2004). Growth, maturation and physical activity. Human Kinetics.
19. Malina RM, Eisenmann JC, Cumming SP, Ribeiro B, Aroso J. (2004b). Maturity-associated variation in the growth and functional capacites of youth football (soccer) players 13-15 years. *Eur J Appl Physiol* 91, 555-562.

20. Mendez-Villanueva A, Buchheit M, Simpson B, Bourdon PC. (2013). Match Play Intensity Distribution in Youth Soccer. *Int J Sports Med* 34: 101-110
21. Mero A. Power and speed trainingduring childhood. (1998). In: Van Prsagh, (ed). Pediatric Anaerobic Performance. Champaign, IL: Human Kinetics, pp. 241-267.
22. Meylan C, Malatesta D. (2009). Effects of in-Season Plyometric Training within Soccer Practice on Explosive Actions of Young Players. *J Strength Cond Res* 23, 2605-2613.
23. Michailidis Y, Fatouros I, Primpa E, Michalididis C, Avloniti A, et al. (2013). Plyometrics' trainability in preadolescent soccer athletes. *J Strength Cond Res* 27:1, 38-49
24. Miller MG, Herniman JJ, Richard MD, Cheatam CC, Michael TJ. (2006). The effect of a 6-week plyometric training program on agility. *J Sports Sci Med* 5, 459-465.
25. Papiakovou G, Giannakos A, Michailidis C. (2009). The effect of chronological age and gender on the development of sprint performance during childhood and puberty. *J Strength Cond Res* 23, 2568-2573.
26. Pettersen SA, Mathisen GE. (2012). Effect of Short Burst Activities on Sprint and Agility Performance in 11-to 12-Year-Old Boys. *J Strength Cond Res* 26, 1033-1038.
27. Reilly T, Bangsbo J, Franks A. (2000). Anthropometric and physiological predispotions for elite soccer. *J Sports Sci* 18, 669-683.
28. Reilly T, Williams AM, Newill A, Franks A. (2000b). A multidisciplinary approach to talent identification in soccer. *J Sports Sci* 18, 695-702.
29. Rumpf MC, Cronin JB, Pinder SD, Oliver J, Hughes M. (2012). Effect of different training methods on running sprint times in male youth. *Pediatr Exerc Sci* 24, 170-186.
30. Rowland TW. (2005). Children's exercise physiology. Champaign, Ill.: Human Kinetics.
31. Sheppard JM, Young WB. (2006). Agility literature review: Classifications, training and testing. *J Sports Sci* 24, 919-932.
32. Stroyer J, Hansen L, Klausen K. (2004). Physiological profile and activity patterns of young soccer players during match play. *Med Sci Sport Exerc* 36, 168-174.
33. Thomas K, French D, Hayes PR. (2009). The effect of two plyometric training techniques on muscular power and agility training in youth soccer players. *J Strength Cond Res* 23, 332-335.
34. Venturelli M, Bishop D, Pettene L. (2008). Sprint Training in Preadolescent Soccer Players. *Int J Sport Physiol* 3, 558-562.
35. Vaczi M, Tollar J, Meszler B, Juhasz I, Karsai I. (2013). Short-Term High Intensity Plyometric Training program Improves Strength, Power and Agilty in Male Soccer Players. *J Hum Kinetics* 36, 17-26

36. Viru A, Loko J, Harro M, Volver A, Viru M. (1999). Critical periods in the development of performance capacity during childhood and adolescence. *Eur J Phys Educ* 4, 75-119.
37. Young WB, McDowell MH, and Scarlett BJ. (2001). Specificity of sprint and agility training methods. *J Strength Cond Res* 15, 315-319.

Submitted: September 16, 2014
Accepted: December 9, 2014