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Original Article

Effects of plyometric–agility and agility training on agility and running acceleration of 10-year-old soccer players

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Abstract
The purpose of this study was to determine the effects of 6-week agility training and plyometric–agility training on level changes of agility and running acceleration of 10-year-old soccer players and compare both training programs. For our study, we were usinga 3-group, 2-factortime-parallel experiment. Thirty young soccer players attended a 10-minute warm-up. Eleven of them completed agility training, and 10 of them completed plyometric–agility training duringthe same duration of 20-25 min withclassic improvement of gaming activities and preparatory games of 40–50 min. Nine soccer players were included in the control group, which was only involved in 60–75min of preparatory exercises. For evaluation of the parameters of running speed and strength–speed abilities in input and output measures, we used a vertical jump test with countermovement with no arms, running for 5 m from athree-point start, running for 20 m from athree-point start, and a pro-agility test. After implementing agility training, we noted improvements in CMJ tests of 2.8 (24.50 ± 4.61 to 27.30 ± 3.81 cm; ~ Δ11.4 %; $p \leq 0.01$) and in the pro-agility test of 0.18 (6.17 ± 0.30 to 5.99 ± 0.23 s; ~ Δ 2.3%; $p \leq 0.01$). After implementation of plyometric–agility training, improvement in CMJ 2 (23.40 ± 4.17 to 25.40 ± 4.33 cm; ~ Δ 8.6%; $p \leq 0.01$) running at 5 m from the mid-start was 0.04 (1.24 ± 0.08 to 1.20 ± 0.07 s; ~ Δ 3.2%; $p \leq 0.01$) and in the pro-agility test - 0.11(6.19 ± 0.35 to 6.09 ± 0.30 s; ~ Δ 1.8%; $p \leq 0.05$). Although we were not able to confirmthat one of the training programs is more effective,thefindings highlight the importance of establishing agility and plyometric–agility training at an early age as they contribute to developing agility and running acceleration of athletes.
Keywords: **change of direction speed, counter movement jump, high-intensity activity, sports performance**

Introduction

Football is the most popular collective game in the world, as evidenced by its long history (Hurych& Scholz 2020). Soccer places high demands on the physical condition of players becauseit requires frequent changes in the intensity of their performance (Stolen et al. 2005). Physiological loading during a soccer match is directly proportional to its intensity, which onaverage makes up for 70% of the player's VO2 max (Bangsbo et al. 2006). Energy is predominantly gained in aerobic conditions, which represent up to 90% of the total energy consumed during the course of amatch (Bangsbo 1994). Therefore, a high aerobic capacity throughout a 90-minute match is an important attribute of soccer players. The ability to reach high-intensity activity by developing maximum efforts, such as sprints, quick changes of direction, or jumps is very important (Stolen et al. 2005; Mathisen& Pettersen 2015).

During a match, higher intensity periods alternate with lower intensity ones, during which the body regenerates (Bujnovsky et al. 2015).Another factor that influences the speed reached while changing direction is the player's running speed. However, it is importantto keep in mind that a largernumber of significant deflections reduce the relationship between rectilinear running speed and speed with changes indirection. Therefore, improved direct running speed does not necessarily mean improved speed with changes of direction. The technique for achieving these skills (i.e. running speed and agility) claims that unlike straight-line speed, to improve speed when changing direction, it is better to lower the center of mass and to shorten the running step before changing direction. This increases stability and ensures better conditions to slow down the movement (Sayers 2000). Technique plays an essential role in effectively and rapidly changing direction, and its character varies depending on a number of factors, such as the magnitude of the deflection (by 90° or 180°) and the frequency of these deflections (Hewit et al. 2012). A player who can achieve higher speed while changing direction has better conditions to get rid of their opponents and, therefore, can reduce time and space pressure to their advantage (Hammami et al. 2017). Rapid changes in direction constitute dynamic movements that

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requirehigh levels of muscle force and most likely are closely connected with recoil and agility (Ioan-Sabin&Pomohaci 2016). Soccer players aged 10 to 12 years of age playing at the national level achieve significantly better results compared to players of the regional level when compared in lower limb explosive strength tests: triple jump ($p < 0.01$) and in speed tests: 10m, 20m, and 30 m ($p <0.01$) (Jezdimirovic et al. 2014). The speed and rebound abilities of children are most effectively developed by implementing plyometric training in sports preparation for pre-pubescent athletes (Rumpf et al. 2012; Negra et al. 2017). It is recommended to implement this trainingtwice a week (48-hour rest period between training for 6 to 12 weeks). Training with plyometric content has to be 10 to 25 minafter awarm up. For the best time effectivity, it is recommended to include itduring an8-week plan low-volume training forprepubertal players. Progress in the field of rebound and speed capability can also be achieved at a frequency of 1 training per week, under which conditions the duration of the entire mesocycle is extended to 14 weeks (Michailidis et al. 2013; Rodríquez-Rosell et al. 2016; Chaabene& Negra 2017; Makhlouf et al. 2018).

Short-term 6-week workouts in the first soccer group that used the isolated changes of direction protocol twice a week contributed to improvements in thelong jumps (ES = 0.26) and 10-m sprints (ES = 20.22). However, for the second group, which followed plyometric training, it had a greater effect onlong jumps (ES = 0.32) and 10-m sprints (ES = 20.51). These short-term protocols are important because they provide meaningful improvements in strength and speed parameters for 17-year-old soccer players (Beato et al. 2017). For example, 13-year-old players can improve their sports performance by jumping from 20- and 40-cm high boxes after 7 weeks ($p <0.05$), except for a linear sprint (Ramirez-Campillo et al. 2019). The positive effect of an 8-week plyometric program consisting of bounce exercises twice a week caused a statistically significant time reduction ($p <0.01$) in the speed test with changes in direction of the 13-year-old soccer players (Meylan& Malatesta 2009). Additionally, 10-week plyometric training can improve running performance ofthe 30-m sprint and standing long jump performance ($p <0.01$) for 11-year-olds (Michailidis 2015). Running technique twice a week in a 12-week training mesocycle for 9- to 13-year-old athletes improved their performance of sprints and ball holding agility in tests: linear sprint with ball possession (ES = 0.85) and sprint with change of direction and ball possession (ES = 0.33) (Corrado et al. 2019). Thus, the importance of introducing agility and plyometric–agility training at an early age is important for acquiring the skills needed to carry out physical activities in football.

Materials and Methods

Participants

This study was approved by the Ethics Committee of the Faculty of Physical Education andSports, Comenius University, Bratislava, Slovakia, and it was performed according to the Declaration of Helsinki. Thirty male soccer players took part in this study.An informed consent form was read and signed by guardians of the subjects prior to the investigation. Full details of the study procedures, including possible risks, were explained to the subjects and their guardians, who signed an informed consent form.The participants were divided into three groups. The first experimental group consisted of 11soccer players (mean ± SD [age: 10.0 ± 0.1 years; height: 144 ± 6 cm; weight: 33.7. ± 6.6 kg; sporting age 3.0 ± 0.6])who had included agility training in their sports preparation. The second experimental group consisted of 10 soccer players(mean ± SD [age: 10.0 ± 0.2 years; height: 146 ± 6 cm; weight: 37.2. ± 7.4 kg; sporting age: 3.3 ± 0.4]) who had included combined agility and plyometric training in their sports preparation. Nine soccer players (mean ± SD [age: 10.7 ± 0.1 years; height: 149 ± 6 cm; weight: 42.0. ± 5.6 kg; sporting age: 3.9 ± 0.5]) were included in the control group, who developed their physical abilities by gaming activities and preparatory games.

Measurements

Prior to implementation of the training processes, the participantsunderwent initial measurements to determine the level of their speed and speed–force abilities (countermovement jump, 5-m sprint, 20-m sprint, and pro-agility test). To diagnose performance in the tests, we used: OptoGait (Microgate, Bolzano, Italy) and dual-beam photocells. OptoGaitworks with the data of the flight and contact phase time and uses the obtained data to calculate the jump height.

Countermovement jump [cm]

For the countermovement jump [cm], after stepping on the tester plate,the participantputs his hands on his hips, performs a squat, which immediately followed by a vertical jump with maximum effort, and landson straightened legs. During the test, the participantperformed three jumps, where the first wasan exercise attempt. The rest time interval between jumps was20 s. The jump parameters were measured with an OptoGait device that includes OptoJump, which is highly reliable with ICCs = 0.98(Kajetan et al. 2017).

5-meter sprint [s]

In the 5-metersprint [s], we marked the start and finish line and then placed a pair of photocells perpendicular to the lines. Then, 50 cm before the starting line was an additive line, from which the participantstarted on his own initiative with maximum effort. In our test, we placed a pair of cones after the finish line (1.5 m) toward which the participantswere runningto prevent premature deceleration. There were two attempts with a 1-min rest interval.

20-meter sprint [s]

For the 20-meter sprint [s], the test organization and execution instructions were the same as for the 5-meter run. The subject had two attempts with a 2-minrest period.

Pro-agility test [s]

For the pro-agility test [s], the track was marked and defined by cones for the start and finish lines. The first pair of photocells wasset up at the start line. The location of the second pair of photocells wasperpendicular to the finish line. Participantstarted from the half-start position and hada stepping foot 50-cm back from the start line. The task wasto run as quickly as possible along a 20-m long track, which includedtwo changes of direction (of180°) around the cones before finishing. The participant hadtwo attempts between which he hada minimum 2-minrest period.

Procedures

The training started with a 10-minwarm-up. The experiment was carried out during a 20–25 minperiod. After the end of the experimental factor, both groups practiced and improved their gaming activities and preparatory games for 40–50 min. The duration of the entiretraining was 75 to 90 min.

The input and output testing was preceded by a warm-up that consisted of these exercises: warm-up (3 min) that included a jog of moderate intensity forward with simultaneous rotation of both arms (parallel and alternate) forward and backward, a trot with left and right flank forward, jogging backward with alternating disapproving straining and engaging upper limbs, and dynamic stretching;then, six exercises mostly focused on lower limbs (number of repetition during exercises: 6), elements of running drills and rebound exercises on a7-msection with running sections with maximum effort, and competitive form in pairs or triples (2 × 5 m, 2 × 8 m, 1 × 10 m, rest interval: 30 s). Prior to the CMJ test, they had five ankle rebounds and five vertical jumps from squat with maximum effort (rest interval between exercises: 1 min).

Example of the main part of training in TG1. Four forward jumps over obstacles (25 cm height) followed by a 6-m run (with one 90° change indirection), number of series = 5. Rebounds forward using a frequency ladder "into each window once", number of repetitions = 10, and number of series = 4, and "in and next to each window", the number of repetitions = 12, and the number of series = 3. Then, 15-m run with direction changes (4 direction changes at 60°), number of repetitions = 5. Then, four ankle rebounds and five forward jumps over obstacles (25 cm height), number of series = 4. Then, 9-m run (2 direction changes, 180° and 90°) withfive repetitions. Example of the main part of training in TG2: 12-m run (2 changes of direction), 15-m slalom (4 changes of direction), 15-m run (1 change of direction), rest interval: 60 sand number of repetitions during exercises = 5. Then, 12-m run (2 × 6 m "relay" run around the ground and join the team), rest interval: 50 s,and number of repetition during exercises = 5.

The training protocol at TG1 consisted of 1440 m ofspeed training with direction changes, 360 m oftraining with one direction change, 1104 repetitions of containing ankle rebounds, and 480 obstacle jumps (25 cm) training. At TG2, we only applied 2340 m ofspeed training with direction changes and 900 m oftraining with one direction change. We applied the experimental factor two times a week for 6 weeks. Three training sessions were conducted each week, of which two included an experimental factor and one did not, where they practiced and perfected gaming activities. Our training load is based on the recommendations of Miller et al. (2006), which utilized 730 repetitions of foot contacts over 6 weeks in a plyometric training protocol and Beato et al. (2017), which demonstrated that a training frequency of two times a week for 6 weeks is important and can provide a meaningful improvement in the strength and speed parameters of the soccer population.

CG during the week underwent three trainings, where the content in the preparatory part consisted of exercises aimed at training and improving the gaming activity of the individual (shooting, passing, ball guidance, and circumvention of the opponent) and in the main part of the preparatory game. The training lasted 75 to 90 min.

During the exercise, the correct technique forperforming the rebound exercise was reminded by verbal and visual demonstration by the coach.We put emphasis on upright posture of the spine, impact on the feet in order of toes to heel, and correct positioning of the knees. We used instructions, such as "jump as fast and as high as possible".For speed exercises with direction changes to maintain maximum intensity, players competed in pairs or teams. The intensity was continually checked and measured using a manual stopwatch. To assess the entry and exit levels, we used the tests carried out in the following order: countermovement jump (CMJ) [cm], 5-m sprint [s], 20-m sprint [s], and pro-agility test [s].

Statistical analyses

Traditional methods were used to determine the mean values and standard deviations. Normality was assessed by the Kolmogorov–Smirnov test, and Levene's test was used to assess the homogeneity of variance.Main effects for time, group, and time×group were assessed by analysis of covariance ANCOVA with repeated measures using baseline values as covariates.

Bonferonni post hoc tests were used to determine within-group changes overtime. Differences between groups in relative changes (Δ%) over time were assessed by independent T-test. Calculation of effect size was performed by using Cohen´s d where 0.2 is a small effect, 0.2–0.8 is a moderate effect, and >0.08 is a large effect. Alpha was set at 0.05, and all statistics were performed by IBM SPSS statistics 24 software (IBM, Armonk, New York, USA).

Results

After a 6-week mesocycle, the countermovement jumps of TG1 ($p < 0.01$; ES = 0.60) and TG2 ($p < 0.01$; ES = 0.61) significantly improved. When comparing the average TG1 and CG increments, this difference was statistically significant ($p < 0.05$) for TG2 and CG ($p < 0.01$) as well.

In the 5 -m sprint, TG1 showed statistically significant increases ($p < 0.05$; ES = 0.59). Comparison of TG1 and CG showed statistically significant increases($p < 0.05$). The pro-agility test showed statistically significant increases forTG1 ($p < 0.05$; ES = 0.44) and TG2 ($p < 0.01$; ES = 0.54). In TG2 and CG, there was a statistically significantly higher change in the increments ($p < 0.05$). For the20-m sprint, there were no statistical significant results forTG1, TG2, and CG.

The statistical characteristics of the performances in individual tests for TG1, TG2,and CG are presented in Table 1, and theaverage player performances are in Table 2.

Table 1. Summary baseline data before and after 6 weeks of COD and plyometric training (TG1, n = 10), COD training (TG2 = 11), and basic soccer training (CG = 9)

Group	CMJ [cm] before	CMJ [cm] after	Sprint 5 m before	Sprint 5 m after	Sprint 20 m before	Sprint 20 m after	Pro-agility [s] before	Pro-agility [s] after
TG1	23.4 ± 4.17	25.4 ± 4.33**	1.24 ± 0.08	1.2 ± 0.07**	3.83 ± 0.2	3.85 ± 0.2	6.19 ± 0.35	6.09 ± 0.3*
TG2	24.5 ±4.61	27.3 ± 3.81**	1.23 ± 0.07	1.19 ± 0.04	3.84 ± 0.17	3.84 ± 0.02	6.17 ± 0.3	5.99 ± 0.23**
CG	25.41 ± 1.63	24.69 ± 4.38	1.23 ± 0.05	1.23 ± 0.08	3.77 ± 0.11	3.8 ± 0.22	6.12 ± 0.15	6.17 ± 0.38

*Note. *p < 0.05; **p < 0.01; COD = changes of direction; TG = training group; CG = control group; CMJ = countermovement jump*
†Data are presented asmeans ± SD

Table 2. Average player performance after 6 weeks ofindividual tests between TG1 (COD and plyometric training, n = 10), TG2 (COD training, n = 11), and CG (basic soccer training, n = 9)

Groups	CMJ [cm]	Sprint 5 m [s]	Sprint 20 m [s]	Pro-agility [s]
TG1 – TG2	0.9	0.00	0.02	0.07
TG1 - CG	2.5*	0.04*	0.04	0.16
TG2 - CG	3.6**	0.04	0.04	0.23*

*Note. *p < 0.05; **p < 0.01; COD = changes of direction; CMJ = countermovement jump;*
TG = training group; CG = control group

The comparison of differences in the CMJ test between groups was statistically significant ($p <0.05$; ES = 0.38), especially between TG1 and CG ($p \leq 0.05$) and TG2 and CG ($p \leq 0.01$). In the 5-m sprint, the differences between the groups were not significant ($p = 0.28$; ES = 0.09); however, a statistical significance was confirmed between TG1 and CG ($p \leq 0.05$). In the 20-m sprint, the differences between groups were not significant ($p = 0.78$). Comparing the differences in the pro-agility test was also not significant ($p = 0.11$); however, a statistical significance was confirmed between TG2 and CG ($p \leq 0.05$).

The comparison of mean value differences between TG1, TG2, and CG is shown in Figure 1.

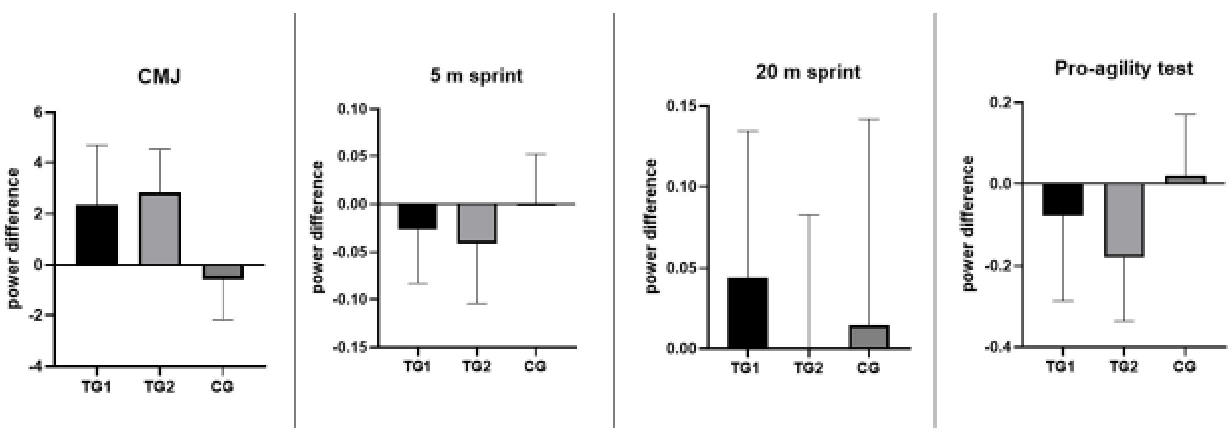

Fig. 1 Comparison of mean value differences between the groups after 6 weeks of training
Note. TG = training group; CG = control group; CMJ = countermovement jump

Discussion

In this study,we examined the effectiveness of two experimental factors. Experimental group TG1 performed plyometric exercises along with speed with direction changes in a 6-week mesocycle. Statistically significantly improvements were observedin height of the vertical jump with countermovement without arm work (CMJ, $p < 0.01$), running at 5 meters with a half-start ($p < 0.05$) and in the pro-agility test ($p < 0.05$). Experimental group TG2 performed speed tests with changes in direction, and after application of the mesocycle, we observed statistically significant improvements in the vertical jump with a countermovement without arm work ($p < 0.01$), and in the pro-agility test ($p < 0.01$).

The influence of plyometric exercises on speed–strength and speed abilities in 10–14 year-old soccer players has been studied by several authors (Ramiréz-Campillo et al. 2014; Meylan&Malatesa 2009; Diallo et al. 2001; Michailidis et al. 2013). The efficacy of the plyometric method was applied two times in a weekly microcycle for 7 weeks with different resttime lengths. In one training, they performed60 jumps up after jump off with a total of 840 in the mesocycle. Soccer players achieved statistically significant increments in the CMJ test (+8.1 to +9.1%) and in speed with changes of direction. Overall, in CMJ, they achieved a small to medium effect (ES: 0.49, 0.58 and 0.55) and in the speed test with direction changes, a mean effect (ES = −1.03, −0.87, −1.04). In the 20-m sprint, their results decreased slightly (3-4%) and were not statistically significant (Ramirez-Campillo et al. 2014). Similar increases in CMJ were observed in our participants, and they achieved with a higher volume of rebounds inone training (in our country, 120 vs. 60) but with a significantly lower intensity of exercise. We did not use jumps up after jump off from 20, 40 to 60 cm in height, which were used by otherauthors. We also noticed a significant improvement in speed with direction changes and a slight deterioration in the 20-msprint (0.5 and 0.08%), as hasbeen noted by previous authors. A favorable outcome of the 8-week plyometric program in addition to jump-off abilities, agility test performance, and the acceleration rate that was similar to our experiment was achievedby players twice a week in microcycles lasting 20 to 25 min. The plyometric training was followed by football training. For young players, the height of the vertical jump with a counter-motion ($p = 0.04$) was significantly increased compared to the baseline measurement ($p = 0.04$), the run time was significantly reduced in the 10-m sprint ($p = 0.04$) and in the agility test ($p < 0.01$) (Meylan& Malatesta 2009). The effect of plyometric training on speed and speed–force abilities for 10 to 12 weeks significantly increased running to 10, 20, and 30 m ($p < 0.05$) and vertical jump height in CMJ and SJ (Diallo et al. 2001;Michailidis et al. 2013). However, it didnot show significantly lower times over the first 10 mcompared to the control group (Kotzamanidis 2006). Soccer players (TG1) have performed rebound exercises, but they have not yet achieved similar improvements in the 20-msprint, according to publications by the above-mentioned authors. The reason for this can be the duration of the mesocycles. In our experiment, we applied a shorter mesocycle. When comparing the TG1 group performance of the CMJ test with that of the TG2 group players (performing speed only with direction changes), TG1 players did not achieve significantly higher increments. The reason may be as follows. A vertical jump with countermovement (CMJ) involvesa slow stretch and short cycle (SSC). In the exercises we used in the experimental factor (plyometric exercises), fast SSC wasused; therefore, the stimulation of performance in the CMJ was not significant enough to manifest into a rate thatwas significantly higher compared to the group where the plyometric exercises were absent (TG2). Leaps using slow SSC (e.g., CMJ) are relatively independent of the ability to use fast SSC (Salaj& Markovic 2011).

The impact of a plyometric jump (exercises expected from 20 to 40 cm with height boxes taking into account different physical properties) haseffects that are inducible by regular football training of visible expression in the physical performance of soccer players (Ramirez-Campillo et al. 2019).

Another study suggested that speed with change of direction training in young soccer players may have a positive effect on skills of speed with changes of direction, sprinting, and jumping (Rodríguez-Osorio et al. 2019). Experimental groups TG1 and TG2 were implemented during intervention speed with changes of direction. A similar sample of young soccer players was divided into two groups, one experimental (EG), and control (CG) in a 6-week experiment. The EG implemented an experimental factor in one of the three trainings, which included speed with changes of direction and agility exercises. Exercises included approximately 30 repetitions of a length of 10-15 m for a period of 5 s(with changes of direction of180° and 90°). At the end of the experiment, ES significantly improved in the agility test and running at 10 and 20 m. In CG, similar to in our work, the participantsexperienced a slight deterioration in the 20-m sprint and agility test, but none of the tests were statistically significant (Pettersen &Mathisen 2012).

When comparingpriorresults with the results here, we observedsimilar improvementsin a test that represents acceleration speed (10 m running) and speed with changes of direction(agility test). Nevertheless, we did not record forour partictipantssignificant changes in the 20-m run test (in neither experimental group). We believe that in our experiment, there was no improvement in running to 20 mdue to the more frequent changes of direction, and the individual sections between changes of direction were on average shorter in our training protocol. Therefore, our players did not have enough space to produce a high running speed to stimulate an increase in running speed over a longer distance, as in this case of 20 m. One important aspect of our study was the methodological limitations that may have influenced the results. The soccer players had feedback on the quality of technology, but it was not rated qualitatively. We also recommend measuring and controlling the external intensitybecause if it was not sufficient (90% of their one-off maximum), then it is difficult to achieve improvements and the efforts of the football players alone willnot be enough. We also realize that the outcome of the test could be influenced by the determined order of the input and output measurements: countermovement jump (CMJ) [cm], 5-m sprint [s], 20-m sprint [s], and pro-agility test [s]. In conclusion, the inclusion of plyometric exercises, speed exercises with changes of direction, and their combination in the training process of young soccer players can positively affect the level of speed and speed–strength abilities, which wasconfirmed by our results and by the above-mentioned authors.

Conclusion

Based on the obtained results, in our experiment, due to the experimental tests, there were statistically significantly higher increments in the pro-agility test, CMJ, and acceleration speed to 5 m compared to that of the control group, which performedonly specific training (with the ball). In terms of performance development in CMJ, the use of rebound exercises in parallel with speed changes in the training of 10-year-old soccer players appears more effective thanengaging speed with directional changes alone (with great effect). In terms of speed development with directional changes in the pro-agility test, a higher training effect was demonstrated in the group that only engaged in speed-directional exercises (large effect vs. medium effect). Therefore, for more effective speed development with directional changes for10-year-old soccer players, we recommend using directional exercises only, rather than a combination. We should also pay attention on the position of the foot during steps, which reduces the negative effect of forces against the underlay. However, for effective development of acceleration speed to5 m, as an important component of power in football, it is recommended to include rebound exercises where it is necessary to set a minimum threshold, which potentially provide better effects;thus, we recommend individual adjustment and positioning cones at 90% of their one-off maximum.

In our study, unlike the experimental groups, we did not observeany significant improvement in performance in the control group that had priority training with the ball in any of the speed orspeed–strength tests. For this reason, we also recommend the use of non-specific training means (without the ball) with alternatives to speed with direction changes and rebound exercises. As a final recommendations, we mention the necessity to apply the mesocycle over a longer period of time of at least 8 weeks withtwo trainings in a weekly microcycle.When choosing a particular means of rebound exercise, it is recommended to evaluate the possibilities of the athlete and thus avoid using too high intensity of exercise that a young player is not able to realize while maintaining the correct technique. To include speed with directional changes, we recommend using a varied "palette" of exercises for10-year-old soccer players. The focus should be on loweringthe center of gravity, overtaking the center of gravity with the lower limbs, and shortening and subsequently extending the stride.This knowledge can help improve athletic performance.

Conflicts of interest – The authors declare that there areno conflicts of interest.

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References

Bangsbo, J., Mohr, M.,&Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *J Sport Sci*,*24(7),* 665-674. ISSN 0264-0414.

Bangsbo, J.(1994). *The physiology of soccer: with special reference to intense intermittent exercise*. Acta PhysiolScand Suppl, 619, 1–155. ISSN 0302-2994.

Beato, M., Bianchi, M., Coratella, G., Merlini M.,&Drust, B. (2017). Effects of Plyometric and Directional Training on Speed and Jump Performance in Elite Youth Soccer Players. *The Journal of Strength & Conditioning Research*,*32(2),* 289-296. ISSN1064-8011.

Bujnovsky, D., Maly, T., Zahalka, F.,& Mala, L. (2015). Analysis of physical load among professional soccer players during matches with respect to field position.*Journal of Physical Education and Sport*,*15(3),*569-575. ISSN 2247-806X.

Chaabene, H.,& Negra, Y. (2017).The Effect of Plyometric Training Volume in Prepubertal Male Soccer Players´ Athletic Performance. *International journal of sports physiology and performance*,*12(9),* 1205-1211. ISSN 1555-0265.

Corrado, L., Ungureanu, A., Varalda, M.,&Brustio, P. R. (2019). Running technique is more effective than soccer-specific training for improving the sprint and agility performances with ball possession of prepubescent soccer players. *Biology of Sport*,*36(3),* 249-255. ISSN 0860-021X.

Diallo, O., Dore, E., Duche, P.,&Praagh, E. V.(2001). Effects of plyometric training followed by a reduced training programme on physical performance in prepubescent soccer players. *Journal of Sports Medicine and Physical Fitness*,*41(3),* 342-348. ISSN 0022-4707.

Hammami, R., Granacher, U., Pizzolato, F., Chaouachi, M., Chtara, M., David, G. B.,&Chaouachi, A. (2017). Associations between change of direction, balance, speed, and muscle power in prepubescent soccer players*. J AthlEnhanc*,6:6. ISSN 2324-9080.

Hewit, J. K., Cronin, J. B.,& Hume, P. A. (2012). Understanding change of direction performance: a technical analysis of a 180°aerial catch and turn task. *International Journal of Sports Science and Coaching*,*7(3)*, 503-514. ISSN2048-397X.

Hurych, E. & Scholz, P. (2020). Czech football fans and some aspects of their declared and applied approaches. *Journal of Physical Education and Sport, 20(6),* 3377-3383. ISSN 2247-806X.

Jezdimirovic, M., Joksimovic, A., Kocic, M., Nikolic, D.,&Dosic, A. (2014). The differences between jump performance and speed of young football players with different levels of competition. *Research in Physical Education, Sport and Health*,*3(2),* 35-39. ISSN1857-8160.

Kajetan, S., Sobota, G., Skowronek, T.,&Rzepko, M. (2017). Evaulation of reliability and concurrent validity of two optoelectric systems used for recording maximum vertical jumping performance versus the gold standard. *Acta of Bioengineering and Biomechanics*,*19(2),* 141-147. ISSN 1509-409X.

Kotzamanidis, C. (2006). Effect of plyometric training on running performance andvertical jumping in prepubertal boys. *Journal of Strength &ConditioningResearch,20(2),* 441-445. ISSN1064-8011.

Makhlouf, I., Chaouachi, A., Chaouachi, M., Othman, A. B., Granacher, U.,&Behm, D. G. (2018). Combination of Agility and Plyometric Training Provides Similar Training Benefits as Combined Balance and Plyometric Training in Young Soccer Players. *Frontiers in Physiology*, 9,1611. ISSN 1664-042X.

Mathisen, G. E., & Pettersen, S. A. (2015). The effect of speed training on sprint and agility performance in female youth soccer players. *Journal of Physical Education and Sport, 15(3),* 395-399.

Meylan, C.,& Malatesta, D.(2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *Journal of Strength &Conditioning Research*,*23(9),* 2605-2613. ISSN1064-8011.

Michailidis, Y., Fatouros, I. G., Primpa, E.,Michailidis, C. H., Avloniti, A., Chatzinikolaou, A., Barbero-Álvarez, J. C., Tsoukas, D., Douroudos, I. I., Draganidis, D., Leontsini, D., Margonis, K., Berberidou, F.,&Kambas, A.(2013). Plyometrics' Trainability in Preadolescent Soccer Athletes. *Journal of Strength & Conditioning Research*,*27(1),* 38-49. ISSN1064-8011.

Michailidis, Y. (2015).Effect of plyometric training on athletic performance in preadolescent soccer players. *Journal of Human Sport and Exercise*,*10(1),*15-23. ISSN 1988-5202.

Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C.,& Michael, T. J. (2006).The Effects of a 6-Week Plyometric Training Program on Agility. *Journal of sports science & medicine*, *5(3),* 459-465. ISSN 1303-2968.

Negra, Y., Chaabene, H., Sammoud, S., Bouguezzi, R., Mkaouer, B., Hachana, Y., &Granacher, U. (2017). Effects of Plyometric Training on Components of Physical Fitness in Prepuberal Male Soccer Athletes: The Role of Surface Instability. *J Strength Cond Res, 32(12),* 3295-3304. ISSN 1533-4287.

Pettersen, S. A.,&Mathisen, G. E. (2012). Effect of short burst activities on sprint and agility performance in 11-to 12-year-old boys. *The Journal of Strength & Conditioning Research*,*26(4),* 1033-1038. ISSN1064-8011.

Ramírez-Campillo, R., Meylan, C., Alvarez, C., Henríquez-Olguín, C., Martínez, C., Cañas-Jamett, R.,Andrade, D. C., &Izquierdo, M. (2014). Effects of in-season low-volume high-intensity plyometrictraining on explosive actions and endurance of young soccer players. *Journal ofStrength & Conditioning Research*,*28(5),*1335-1342. ISSN1064-8011.

Ramirez-Campillo, R., Alvarez, C., García-Pinillos, F., Gentil, P., Moran, J., Pereira L. A.,&Loturco, I.(2019). Effects of Plyometric Training on Physical Performance of Young Male Soccer Players: Potential Effects of Different Drop Jump Heights. *PediatrExerc Sci,31(3),* 306-313. ISSN 0899-8493.

Rodríguez-Osorio, D., Gonzalo-Skok, O.,&Pareja-Blanco, F.(2019). Effects of Resisted Sprints With Changes of Direction Through Several Relative Loads on Physical Performance in Soccer Players. *International Journal of Sports Physiology and Performance*,*14(8),* 1022-1028. ISSN 1555-0265.

Rodríquez-Rosell, D., Franco-Márquez, F., Pareja-Blanco, F., Mora-Custodio, R., Yáñez-García, J. M., González-Suárez, J. M.,& González-Badillo, J. J. (2016).Effects of 6 Weeks Resistance Training Combined With Plyometric and Speed Exercises on Physical Performance of Pre-Peak-Height-Velocity Soccer Players. *International Journal of Sports Physiology and Performance,11(2),* 240-246.

Rumpf, M. C., Cronin, J. B., Pinder, S. D., Oliver, J.,& Hughes, M.(2012). Effect of different training methods on running sprint times in male youth. *PediatrExerc Sci, 24(2),* 170-186. ISSN 0899-8493.

Salaj, S.,& Markovic, G. (2011).Specificity of jumping, sprinting, and quick change-of-direction motor abilities. *Journal of Strength & Conditioning Research*,*25(5),* 1249-1255. ISSN1064-8011.

Sayers, M. (2000). Running techniques for field sport players. *Sports Coach*, 23,26-27.

Ioan-Sabin, S.&Pomohaci, M. (2016).Study regarding the development of agility skills of students aged between 10 and 12 years old. *Timisoara Physical Education and Rehabilitation Journal*,*9(17),* 7-16. ISSN2199-6040.

Stolen, T., Chamari, K., Castagna, C.,&Wisloff, U. (2005). Physiology of soccer: An update. *Sports Med*,*35(6),* 501–536. ISSN 0112-1642.