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Section III – Sports Training

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Effects of Training with an Agility Ladder on Sprint, Agility, and Dribbling Performance in Youth Soccer Players

by
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The aim of this study was to examine the effects of coordination training using an agility ladder compared with a control group on physical fitness and technical performance in youth soccer players. Eighteen male youth soccer players (age: 12.2 ± 0.4 years; body height: 158.3 ± 10.8 cm; body mass: 45.0 ± 8.0 kg) were randomly assigned to an agility ladder group (n = 10) or a control group (n = 8). The intervention program was carried out three times a week over six weeks. Before and after the training period, the 10 m sprint, 20 m sprint, dribbling speed test, agility test, and slalom dribbling test performances were assessed. Within-group analysis showed significant improvements (p < 0.005) in 10 m and 20 m sprint performance from the pre- to the post-test for the agility ladder group (-2.39% and -2.10%) and the control group (-2.54% and -1.44%). No significant differences (p > 0.005) were found from the pre- to the post-test in the dribbling speed test, agility test, slalom dribbling test, and skill index. In the between-group analysis, there were no differences between the agility ladder group and the control group in any variable. In conclusion, the findings of this study suggest coordination training with an agility ladder does not seem to be effective to improve physical fitness and dribbling. Therefore, this information could be beneficial to players and coaches for programming tasks during soccer training sessions.

Key words: *team sports, physical performance, physical training.*

Introduction

Soccer players must be able to effectively perform several complex dynamic movements with (i.e., passes, kicking, dribbling, heading) and without the ball (i.e., modulating running speed and changes of direction, accelerations, decelerations, jumps) in response to unpredictable environments conditioned by the ball, teammates, and opponents (Cortis et al., 2013). Performance of such complex dynamic movements is linked to coordination abilities; suggesting players with higher coordination levels have a higher ability to acquire sport-specific skills and quicker mastering of new movements (Arazi et al., 0216; Bompa, 1999; Cordo and Gurfinkel, 2014; Kamandulis et al., 2013; Kelso, 1995). Moreover, scientific literature indicates physical and technical components in soccer players are related to biological maturation (Figueiredo et al., 2009; Mirkov et al., 2010; Philippaerts et al., 2006). In this sense, during the adolescent maturation stage, the accelerated growth in the length of limbs contributes to a transitory decline in motor coordination and physical performance in youth soccer players (Philippaerts et al., 2006).

Previous research showed that youth soccer players aged between 11-14 have higher levels of performance in lower-limb coordination tests in comparison with physically active children belonging to the same age cohort (Mirkov et al., 2010). These results suggest that chronic training in soccer allows for the development of motor coordination abilities as a result of a possible window of trainability associated with neural accelerated development (Cortis et al., 2011; Tessitore et al., 2011).

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Therefore, coaches should be aware of when soccer players are approaching the attainment of peak height velocity given that training loads should be focused on strengthening coordination movement patterns and technical skills (Lloyd et al., 2012; Oliver et al., 2012). Thus, in order to achieve high levels of performance in complex movement patterns and specific skills, it is fundamental for soccer players to develop fine multi-joint control through different training strategies (Kamandulis et al., 2013; Tessitore et al., 2011).

In this context, the agility ladder represents a relatively inexpensive and easy to implement training tool, which allows coaches and players to be imaginative, manipulating task constraints during exercises and to develop the movement coordination patterns found in team sports (Gatz et al., 2009). Despite the popularity and the theoretical benefits associated with agility ladder training, research validating this training method for improving physical and technical performance in soccer is limited. To the best of our knowledge, only one study has analysed the chronic effects of agility ladder training in soccer players (Venturelli et al., 2008). Venturelli et al. (2008) examined the effects of 6-week coordinative training using an agility ladder in 20 m sprints with and without the ball, squat jumps, and counter-movement jumps in pre-adolescent soccer players. The results indicated 6 weeks of coordination training with the agility ladder produced additional performance improvements only in 20 m sprints with the ball in comparison with repeated-sprint training groups (Venturelli et al., 2008), but no control group was included for comparison and no exercise complexity progression was taken into account.

Bearing in mind the aforementioned considerations and the fact the agility ladder is common equipment during systematic training for soccer in both youth and professional players, the aim of this research was to examine the effects of a 6-week, 18-session training program using the agility ladder as compared to a control group on speed, agility and dribbling performance in youth soccer players. We hypothesized that the use of the agility ladder would increase coordination in lower limbs and consequently players would achieve greater levels of technical abilities and speed capacity. This study was developed to support coaches and players with relevant information regarding the availability and efficiency of training methods for improving speed, agility and dribbling performance.

Methods

Design and Procedures

This study used a two-group, randomized controlled trial design to analyse the training effects of coordination training with the agility ladder compared with a control group. The assigned groups were determined by a chance process (a random number generator on a computer) and could not be predicted. This procedure was established according to the "CONSORT" statement, which can be found at http://www.consort-statement.org. An a priori power analysis (Faul et al., 2007) (G*Power, version 3.1.9.2, Universität Kiel, Düsseldorf, Germany) with an assumed Type I error of 0.05 and a Type II error rate of 0.20 (80% statistical power) was conducted according to changes in 20-m sprint performance. The total sample size computed by this method revealed that eight subjects per group would be sufficient to observe medium group × time interaction effects with a detectable effect size (ES) ≥ 0.2. To determine the effects of coordination intervention, the following tests were selected: (a) 10-m and 20-m sprints, (b) a dribbling speed test, (c) an agility test (AT), and (d) a slalom dribble test (SDT). Pre- and post-tests were performed on two consecutive days, before and after the six-week intervention program. The protocol of training took place at the beginning of the competitive period (October – November). During this period, participants trained three times a week and played one official game. To reduce the influence of uncontrolled variables, all participants were instructed to maintain their habitual lifestyle and normal dietary intake before and during the study.

Participants

Eighteen U-13 young male soccer players were recruited to participate in this study. The experience of young soccer players in systematic soccer training was of 5.05 ± 1.63 years. Players regularly practiced 3 weekly soccer sessions with their team and on an average exercised 8.4 ± 1.8 hwk^{-1} in their normal training cycle. Moreover, the team regularly competed in one official match per week. Players had never participated in

regular/systematic coordination training with the agility ladder. Players were randomly assigned into one of the two groups, a control group (CG, *n* = 8) or a coordination training group with the agility ladder (EG, *n* = 10). Table 1 shows the descriptive data of participants who were competing at the regional level. The Mann-Whitney U test revealed non-significant differences between groups on anthropometric data. The intervention program was added to the usual training routines. In all other respects, participants completed identical training activities. Only players who participated in at least 80% of all training sessions were included in the statistical analysis. Exclusion criteria were injuries resulting in the loss of one or more soccer matches/training sessions in the preceding three months prior to the initiation of the study. Written informed consent indicating their voluntary participation was obtained from players and their legal representatives after explanation of the experimental protocol and potential benefits and risks of the study. The local Investigation Review Committee of the Department of Physical Education and Sport Sciences approved the study (number 23-2506-18).

Procedures

Players performed two testing sessions before and after the 6-week training period. During testing sessions, participants were required to wear the same athletic equipment and measurements were conducted at the same time of the day to minimize the effect of diurnal variations on the selected variables during the two experimental sessions. All data collection and test sessions were performed on an indoor court where environmental temperature ranged from 18 to 21ºC. Each player was instructed and verbally encouraged to make a maximal effort during all tests. All tests were performed after 72 h of rest and at the same venue under identical conditions and supervised by the same test leaders. Before each testing session, players complied with the following pre-test guidelines: (a) no consumption of any energy/performance-enhancing drinks or supplements 48 h prior to testing; (b) no consumption of food for at least two hours prior to testing. Before testing, all participants performed 10 min of a standardized warm-up comprising two min of light active static stretching (10 repetitions for hamstrings, quadriceps, and calf muscles) and five min jogging, followed by short distance accelerations (three submaximal sprints, progressing to 90% of their maximal velocity for the shuttle distance [30 + 30 m]). This routine was supervised by the team's coach. On the first testing session, players performed the following three tests: 10 m sprint, 20 m sprint, and dribbling speed. During the second testing session, players performed the agility test and the slalom dribbling test.

10 m and 20 m sprint tests

Sprint time was measured by means of a dual infrared reflex photoelectric cell system (DSD Laser System, León, Spain). The photoelectric cells were attached to tripods, raised to a height of 0.9 m and placed in pairs 1 m apart. All players began from a standing start, with the front foot positioned 0.5 m from the first timing gate, and were instructed to perform all the sprints with a maximal effort. Players were allowed two trials, with a two min recovery period in between. The means of the two trials were used for subsequent analysis (Henry, 1967; Sands and Stone, 2006). During the two experimental sessions participants were required to wear the same shoes to avoid the effects of different athletic equipment.

Dribbling speed test

Dribbling time was measured by a photoelectric cell system (DSD Laser System, León, Spain). The dribbling speed test was administered according to the protocol described by De Gouvêa et al. (2007). Soccer players performed a maximal straight sprint with a ball over 30 m. The trial was considered valid when a) players stopped and controlled the ball in the area of four m^2 located after the finish line, and b) players performed at least four touches on the ball. All participants performed the test with the dominant leg and had a recovery time of 2 min between trials (Henry, 1967; Sands and Stone, 2006). The mean of 2 trials was recorded for the statistical analysis.

Agility test

A photoelectric cells system (DSD Laser System, León, Spain) was used to measure slalom sprint performance of young soccer players. The agility test was performed according to the procedure developed by Dardouri et al. (2014). During this test, players performed a maximal slalom sprint between 7 cones at a 15 m distance.

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When ready, players sprinted straight 1.5 m to slalom the first cone. Next, they slalomed at maximal speed over the next 6 cones that were separated by 2 m. Finally, participants sprinted straight 1.5 m to pass through the finish line. Players were allowed 2 trials, with a 2 min rest interval between maximal efforts. The mean of trials was used for subsequent analysis (Henry, 1967; Sands and Stone, 2006).

Slalom dribble test

Slalom dribble time was recorded using photoelectric cells (DSD Laser System, León, Spain). Assessment was carried out in agreement with Dardouri et al. (2013). Players executed a slalom dribble with a ball between 7 cones over a 15 m distance. When ready, players sprinted straight 1.5 m to slalom the first cone. Next, they slalomed at maximal speed over the next six cones that were separated by 2 m. Finally, participants sprinted straight 1.5 m to pass through the finish line. Each slalom dribble trial was separated by three min rest intervals. All participants were tested with their dominant leg. The average time of two trials was registered for subsequent analysis (Henry, 1967; Sands and Stone, 2006).

Skill index

This index allowed discriminating between skilful and less skilled soccer players (Mirkov et al., 2008). The skill index value was determined through a ratio between the time used to complete the agility test and the slalom dribble test.

Training intervention

After pre-testing, participants of the EG began the 6-week agility ladder training protocol presented in Table 2. The CG performed the regular team routines of training (Tuesdays at 6.30 PM, Thursdays at 6:30 PM, and Fridays at 7:00 PM). Duration of team soccer training was 90 minutes and consisted of warm-up exercises (low-intensity running, athletic drills, 5 short bursts of progressive accelerations and 3 x 30 m maximal straight line sprints), technical and tactical tasks using different formats (i.e., technical circuit, and small and large sided games), physical conditioning, and recovery strategies. The EG performed three additional weekly training sessions (Tuesdays at 5.45 PM, Thursdays at 5:45 PM, and Fridays at 6:15 PM). Variables of the agility ladder training program are presented in Table 2. Moreover, Figure 1 shows the methodological progression used in agility ladder exercises during the six micro-cycles, and the task complexity increased every two micro-cycles. In addition, a certified strength and conditioning specialist supervised all training sessions to ensure all warm-up activities and coordination exercises were completed with correct technique.

Statistical analyses

Values are reported as means and standard deviation (SD). Statistical analyses were performed using the statistical package SPSS for Macintosh (version 20.0, Chicago, IL, USA). Reliability for test–retest trials was assessed using intraclass correlation coefficients (ICCs). Data were examined via a histogram plot and the normality of distribution was tested using the Shapiro-Wilk´s test. A 2 (group: CG and EG) × 2 (time: pre, post) mixed factorial analysis of variance (ANOVA) was calculated for each variable. Partial eta squared (η_p^2) effect sizes p for the time × group interaction effects were calculated. An effect of $\eta_p^2 \geq 0.01$ indicated a small, ≥ 0.059 a medium, and ≥ 0.138 a large effect, respectively (Cohen et al., 1988). In addition to this analysis, for each variable percentage difference in the change scores between the pre- and the post-test was calculated together with 90% confidence intervals. Significance was established at the level of $p \leq 0.05$.

Results

The ICCs for test-retest trials were 0.97 (95% CI 0.91-0.99) and 0.96 (95% CI 0.89-0.98) for the 10 m and 20 m sprints, respectively. The ICC for test-retest trials was 0.80 (95% CI 0.44-0.93) for the dribbling speed test. The ICC for test-retest trials was 0.87 (95% CI 0.44-0.93) for the agility test. The ICC for test-retest trials was 0.97 (95% CI 0.91-0.99) for the slalom dribble test.

Absolute values for each variable at the pre- and the post-test, along with the ANOVA results are displayed in Table 3.

10 and 20 m Sprint Test

No significant time × group interactions were observed for the 10 m and the 20 m sprint test. The statistical analysis revealed a significant main effect of time, indicating performance improved in both the 10 m and 20 m sprint tests in the CG (2.54% and 1.44%, respectively) and the EG (2.39% and 2.10%, respectively) in the post-test. No significant main effect for group was

found for the 10 m or the 20 m sprint test.

Dribble Speed Test

For the Dribble Speed Test, our analysis revealed no significant time × group interaction and no significant main effect for time. Likewise, no significant main effect for group was detected.

Agility and Slalom Dribble Test

Regarding agility test performance, there were no statistically significant differences for time or group main effects, or time × interaction effect present. For the slalom dribble test the statistical analysis showed no significant difference between the pre- and the post-test. No significant differences were found for time × group interaction or group main effects.

Skill Index

Our statistical analyses revealed no significant main effects for time or group, and no significant time × group interactions for the skill index variable.

Table 1

Descriptive data of control and experimental training groups (mean ± SD).

Group	N	Age (years)	Body mass (kg)	Body height (cm)	Soccer experience (years)
CG	8	12.5 ± 0.5	46.9 ± 9.8	158.0 ± 13.3	4.9 ± 2.1
EG	10	12.1 ± 0.3	42.6 ± 6.1	157.1 ± 8.1	5.1 ± 1.1

Table 2

Summary of training load progression in the experimental group.

Week	Repetitions	Sets	Rest intervals between repetitions (s)	Rest intervals between sets (s)
1	6	1	30	60
2	5	2	30	60
3	5	2	30	60
4	3	4	30	60
5	3	4	30	60
6	7	2	30	60

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Table 3

Changes in the 10-m sprint, 20-m sprint, dribble speed test, agility test, slalom dribble test, and skill index after 6 weeks of agility ladder training in youth soccer players.

	CG (n = 8)			EG (n = 10)		
	Pre	Post	Δ (%)	Pre	Post	Δ (%)
10 m sprint (s)	2.05 ± 0.09	1.99 ± 0.12*	-2.54	2.02 ± 0.11	1.97 ± 0.10*	-2.39
20 m sprint (s)	3.66 ± 0.19	3.61 ± 0.22†	-1.44	3.62 ± 0.23	3.54 ± 0.17†	-2.10
Dribble Speed Test (s)	5.89 ± 0.20	5.82 ± 0.28	-1.07	5.93 ± 0.27	5.87 ± 0.22	-0.90
Agility Test(s)	8.48 ± 0.33	8.60 ± 0.42	1.54	8.64 ± 0.49	8.51 ± 0.43	-1.74
Slalom Dribble Test (s)	10.65 ± 0.68	10.71 ± 0.37	1.04	10.82 ± 1.33	10.94 ± 0.80	1.85
Skill Index	0.80 ± 0.07	0.80 ± 0.05	1.07	0.80 ± 0.06	0.78 ± 0.06	-2.68

	ANOVA p values (η_p^2)		
	Time	**Group**	**Time x Group**
10 m sprint (s)	0.002 (0.463)	0.559 (0.022)	0.935 (0.001)
20 m sprint (s)	0.036 (0.247)	0.555 (0.022)	0.655 (0.013)
Dribble Speed Test (s)	0.364 (0.055)	0.683 (0.011)	0.961 (0.001)
Agility Test(s)	0.984 (0.001)	0.854 (0.002)	0.147 (0.127)
Slalom Dribble Test (s)	0.732 (0.008)	0.552 (0.023)	0.924 (0.001)
Skill Index	0.590 (0.019)	0.679 (0.011)	0.439 (0.038)

Notes: CG = Control Group; GE = Experimental Group.
*η_p^2= Partial eta squared. *Significantly different from the pre-test ($p < 0.001$).*
†Significantly different from the pre-test ($p < 0.05$).

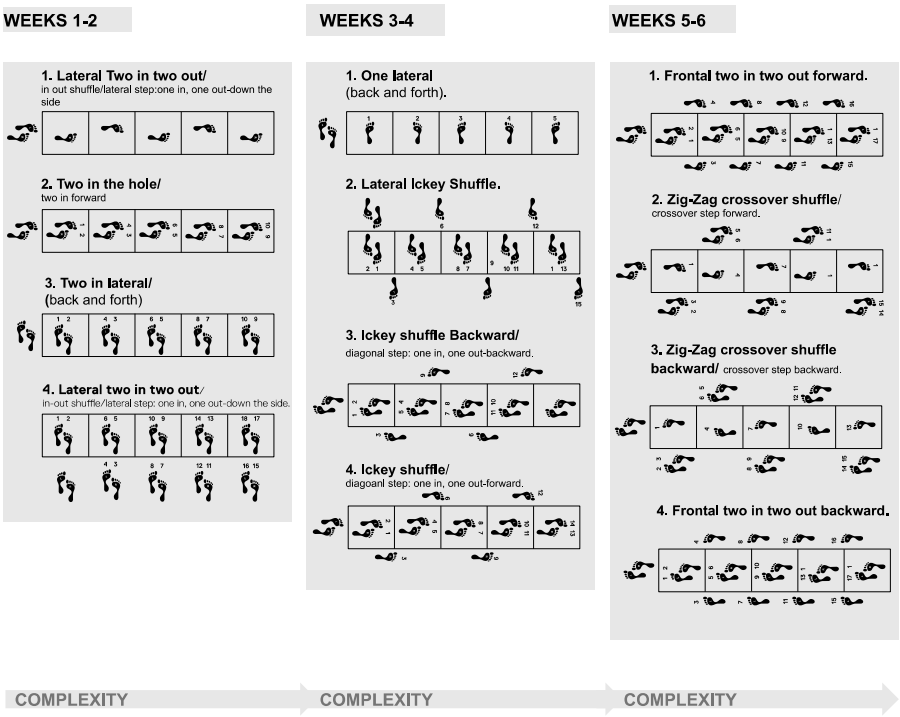

Figure 1

Schematic representation of the agility ladder exercises performed during the intervention program.

Discussion

To our knowledge, this is the first study to investigate the gradual increase of training load variables and the complexity of task constraints in coordination training with the agility ladder in adolescent soccer players. The main findings of this study indicate that an agility ladder training program in addition to normal training during the in-season period does not produce additional effects in sprint and dribbling performance in comparison with control condition. This may show that despite using agility ladder training as a coordination stimulus during three extra training sessions per micro-cycle, the adaptations obtained were similar to players undergoing chronic soccer training. In relation to these findings, Tessitore et al. (2011) reported chronic participation in soccer-specific training might be a sufficient stimulus to increase inter-limb coordination and soccer-specific skills performance.

10 m and 20 m sprint. Sprinting speed is an essential fitness component for soccer (Faude et al., 2012; Rey et al., 2017). Consequently, it appears developing this capacity during the formative categories is immensely relevant. Different studies have pointed out to the existence of critical periods for speed training between 5-9 and 12-15 years of age (Rumpf et al., 2016; Van Praagh, 1998). The results obtained in this study during the period of intervention with regard to U-12 players show an increase in performance between the pre-test and the post-test for the 10 m and 20 m sprint variables, with no evidence of differences between the experimental group and the control group. Therefore, the results did not support the experimental hypothesis that players training with the agility ladder would demonstrate significantly greater improvements in sprint performance than players in the control group. These results fall in line with those obtained by Venturelli et al. (2008), who observed a similar increase in performance between the pre-test and the post-test in the 20 m sprint without a ball for the groups following coordination training with the agility ladder and repeated sprint ability, with no differences observed between the groups. However, coordination training would seem to be the most suitable method for achieving adaptations during the first critical speed training period (Venturelli et al., 2008). In this respect, the scientific evidence suggests that during the second critical period, i.e., between 12 and 15 years of age, the most efficient training methods for increasing sprint performance are sprint training, plyometric training and a combined training method (Venturelli et al., 2008).

Furthermore, training using an agility ladder does not appear to satisfy training principles or load parameters necessary to induce chronic adaptations in youth soccer players (Haugen et al., 2014). The principle of specificity is revealed to be fundamental to speed development over the specific distances frequently covered by soccer players during a match (Venturelli et al., 2008). As such, non-specific training methods (i.e., plyometric training, resistance training, coordination training) should be used as additional methods to help strength and conditioning coaches enhance this ability (Venturelli et al., 2008). Regarding training load parameters, intensity is shown to be an essential factor (Haugen et al., 2014). Previous studies have suggested intensity must be maximum during speed training (Venturelli et al., 2008; de Villarreal et al., 2015). However, during coordination training with an agility ladder, exercises require a learning period to reproduce the proposed movement patterns with maximum speed and efficiency. Consequently, it appears the training stimulus will not always be the same. Intensity could be linked to the complexity of the task, and with the individual ability young players have to reproduce the coordinative movement patterns on the agility ladder.

Scientific literature has defined 'agility' as the ability to modify the orientation of the entire body via a change in the direction in response to a stimulus created within a context of uncertainty (Sheppard and Young, 2006). It is defined as the combination of strength, speed, balance, and coordination (Zago et al., 2016). In this study, no significant improvements in performance were shown during the agility test between the pre-test and the post-test, or between the control group and the experimental group.

Agility. According to Sheppard and Young (2006), within the leg muscle quality category, reactive strength would appear to have a decisive impact on performance during agility tasks. Recently, the kinematic variables of two agility ladder exercises

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(alternative lateral leg hopping and lateral footwork speed) have been analysed, with significant differences between both agility ladder exercises (Wong et al., 2012). Wong et al. (2012) reported lateral alternative leg hopping generated a peak rate force development of up to ~3.2 times greater than lateral footwork speed. Moreover, adaptations in agility training are found to be linked to movements made in the medial-lateral and anterior-posterior axes (Brughelli et al., 2008), with a greater peak rate of force in these two axes shown during alternative lateral leg hopping exercises (Wong et al., 2012). The kinematic variables of the exercises developed in this study may show a greater similarity with lateral footwork speed exercises. Consequently, the absence of specific adaptations in agility capability could be due to the fact that the type of exercise carried out on the agility ladder generates an insufficient peak rate of force development, as well as an insufficient peak rate of force in the medial-lateral and anterior-posterior axes (Wong et al., 2012). Future research should analyse the kinematic variables of the exercises most frequently used by coaches during training sessions with youth soccer players.

Fitness trainers and coaches would be able to create more efficient training strategies in accordance with the physical capabilities they aim to optimise with the use of the agility ladder. However, the scientific evidence has shown the effectiveness of other training methods used to increase agility and change of direction performance via small-sided games (Chaouachi et al., 2014), multidirectional sprints (Chaouachi et al., 2014), speed, agility and quickness (Jovanovic et al., 2011), and plyometric training (Asadi et al., 2018) in youth soccer players.

Dribbling. Dribbling is one of the most performed techniques during match play and is considered a decisive soccer skill because players have the possibility to advance deeper into an opponent's territory while maintaining ball possession and it could be a precursor for an action leading to a shot on goal or a pass, offering a strong tactical advantage (Ali, 2011). Hence, training programs to develop and improve this specific technical skill seem to be crucial for coaches and players. In this study, two tests were used to check dribbling skill: a dribbling speed test and a slalom dribble test, which assess dribbling ability while accelerating and dribbling ability with quick changes of direction, respectively. Contrary to expectations, which are based on the theoretical benefits associated with coordination training, no significant improvements were observed in dribbling ability following six weeks of agility ladder training. These results are in contrast with those of previous data for youth soccer players, which recorded positive effects of coordinative training in 20 m sprint time with the ball (Venturelli et al., 2008). The differences between our findings and those of previous studies may be related to a number of factors, including the competitive level or training status of the group, or more importantly, they may be related to differences between both training programs. In this respect, it is important to note that the coordination-training program in the Venturelli's (2008) study was based on multilateral coordination exercises and not only on agility ladder exercises such as in this study. In view of the current results and given the importance of technical skills in soccer, coaches should consider adding more specific training strategies than those employed in this study to improve dribbling ability.

Limitations.

The interpretation and broader implications of the present data must be undertaken within the limits of the specific data collection undertaken. Although the study had many unique aspects, there are some limitations to note. First, although the number of participants in this study was similar to other studies that have assessed coordinative training in team sports, our sample size was relatively small. A larger sample size may have provided more conclusive results. Second, the intervention period might be too short to produce improvements in technical skills and this should be explored in further research.

Conclusions.

The agility ladder is a tool often used by coaches and fitness trainers during soccer practice. This study was the first to research the effects of a training program with an agility ladder on speed, agility, straight dribbling and dribbling with change of the direction in youth soccer players. The results suggest that 6 weeks of training with an agility ladder seem not to represent a time-efficient stimulus to increase physical fitness and dribbling performance

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