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Research article

Effects of a 12 Week SAQ Training Programme on Agility with and without the Ball among Young Soccer Players

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Abstract
The purpose of this study was to determine the effects of a 12 week conditioning programme involving speed, agility and quickness (SAQ) training and its effect on agility performance in young soccer players. Soccer players were randomly assigned to two groups: experimental group (EG; n = 66, body mass: 71.3 ± 5.9 kg; body height: 1.77 ± 0.07 m) and control group (CG; n = 66, body mass: 70.6 ± 4.9 kg; body height: 1.76 ± 0.06 m). Agility performance was assessed using field tests: Slalom; Slalom with ball; Sprint with 90° turns; Sprint with 90° turns with ball; Sprint with 180° turns; Sprint with backward and forward running; Sprint 4 x 5 m. Statistically significant improvements ($p < 0.05$) between pre and post training were evident for almost all measures of agility, with and without the ball, with the exception being the Sprint with backward and forward running. This suggests that SAQ training is an effective way of improving agility, with and without the ball, for young soccer players and can be included in physical conditioning programmes.

Key words: speed, specific agility, change of direction, SAQ.

Introduction

Soccer requires players to perform numerous actions that require strength, power, speed, agility, balance, stability, flexibility and endurance (Bloomfield et al., 2007; Gorostiaga et al., 2004; Helgerud et al., 2001) suggesting that the physical conditioning of players is a complex process. During a soccer match, players cover about 10 km in total, which includes a sprint every 90 seconds (11% of overall activity) with each action lasting on average of 2 to 4 seconds and covering a distance of 15 m (Stolen et al., 2005). Although speed represents a very important component of fitness for a soccer player, quickness (acceleration speed during the first steps) is probably more important. This is because sprints in soccer are mainly performed over short distances undertaken at maximal intensity although the longest distances tend to be about 40 m and usually involves several changes in direction (Jovanovic et al., 2011; Rienzi et al., 2000).

High-speed actions in soccer have been categorized as requiring acceleration, maximal speed or agility skills (Gambetta, 1996) whilst Chapman et al. (2008) described speed in soccer as consisting of running speed, reaction speed and acceleration speed during the first steps (referred to as quickness). Both of these categorizations imply that the SAQ (speed, agility and quickness) training method should be a useful component of fitness training in soccer (Pearson, 2001). A typical SAQ session involves explosive movements with the goal of progression from fundamental movement patterns to highly positional specific movements (Yap and Brown, 2000). Hence this form of training is thought to encourage the adaptation of movement mechanics, length and frequency of steps, and increased hip height in the pursuit of increased speed, agility and quickness (Pearson, 2001).

Little and Williams (2006) observed a significant correlation between acceleration, maximal speed and agility but concluded that there were enough unique characteristics in each component to consider them as unrelated to each other. This is an important distinction for coaches who work on improving speed and agility as the research suggests that different activities are needed for each. Indeed, SAQ training seeks to improve speed, agility and quickness through a range of soccer specific exercises designed to address both the common and unique characteristics of each of these components.

Agility has also been shown to be an important component of soccer play (Jovanovic et al., 2011). Jullien et al. (2008) demonstrated that a short-term agility training programme (3 weeks duration) improved agility test results among young professional soccer players. However Jovanovic et al. (2011) did not find that a SAQ training programme improved the agility performance in young soccer players during the in-season period when training with and without a ball although this was found to be an effective way of improving some aspects of power performance. Whilst these results were somewhat surprising they do not invalidate the link between SAQ training and improvements in agility, both for players with and without the ball, since the training programme may have been insufficient, in terms of duration or volume of training, to promote significant improvements. Logically, given the nature of SAQ training, this type of training should improve soccer players' agility with and without ball, although this would depend on the specific nature of the training and its duration. In one such study, Rösch et al. (2000) concluded that elite players, but not amateurs, were able to adapt their body positions as a result of SAQ training such that they could perform soccer movements with better balance, strength and control without any loss of speed.

Despite the aforementioned research, at this point in time there is little scientific evidence to support the effectiveness of SAQ training for conditioning soccer

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players such that football specific improvements are produced (Jovanovic et al., 2011; Sporiš et al., 2010b; 2011). Therefore, the purpose of this study was to determine the effects of a SAQ training method on agility with and without ball in young soccer players.

Methods

Participants

All participants were male members of teams playing in the First Croatian Junior U-19 League during the 2010/2011 competitive season. Only six out of twelve clubs in this league fulfilled the requested conditions regarding equipment and facilities and these were randomly divided into two groups: experimental (EG) including 66 players from three clubs (20, 22 and 24 players) (mean ± SD: body mass: 71.3 ± 5.9; body height: 1.77 ± 0.07) and control (CG) including 66 players from three (21, 21, 24 players) clubs (mean ± SD: body mass: 70.6 ± 4.9; body height: 1.76 ± 0.06). All participants were at the investigators disposal and were familiar with SAQ training. None of the participants had been injured 6 months before the initial testing or during the training programme. Nutritional supplements were not included in their diets and participants were not taking exogenous anabolic-androgenic steroids or other drugs that might have affected their physical performance or hormonal balance during the study. The study was financed by the Croatian Football Federation and was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb according to the Helsinki Declaration. Participants were fully informed and signed a consent form and were aware that they could withdraw from the study at any time. Training programs for the experimental and control group were given in Table 1.

Goalkeepers were not involved in this study due to potential differences in their morphological characteristics and motor ability (Taskin, 2008). Physical conditioning for all clubs started within one week of each other. Participants were only eligible for the study if they had played at least 10 matches and been involved in 70% of training sessions in the past season and had at least eight years of soccer experience. They were also required to undertake at least 75% of the training sessions during the experimental programme. The experimental group undertook four SAQ training sessions a week (information on the intensity and volume of the training programme is presented in Table 2; distribution of SAQ components presented in Table 3). The control group was involved in regular soccer training that did not include elements of the SAQ training methods.

Procedure

Basic anthropometric parameters (stature and body mass) were registered in the study protocol. The initial testing took place before the beginning of the pre-season period while the final testing was performed after 12 weeks of intervention with the SAQ training method. To prevent unnecessary fatigue accumulation, players and coaches were instructed to avoid intense exercise for a 24-hour period before each testing session. Immediately prior to testing participants performed a standard 25-minute warm-up consisting of 10 min of light running, 10 min of dynamic stretching and 5 x 30m of running exercises. During testing, the air temperature ranged from 22°C to 27°C. Testing always commenced at 10 a.m. and was completed by 1 p.m. The physical load at given intensities was monitored by heart rate monitors (Polar S610, Finland). All agility tests were performed on a grass sports field and the players wore soccer boots in order to replicate competitive playing conditions. Each test was performed from a standing start and measured using infrared photocells (RS Sport, Zagreb, Croatia).

Slalom test

Each participant started the test with his feet behind the start line. Six cones were set up 2 m apart, the first cone 1 m away from the starting line. Each player stood still facing the starting line, with his feet apart and the cone between his legs. He then started running after the sound signal and ran from point to point. The player at the second point had to be passed on his right-hand side. The player continued to run as fast as possible constantly changing direction from right to left, until he reached the player standing at the last point. After the last point, the player made a 180° turn and continued the slalom to the starting line. The intraclass correlation coefficient for test-retest reliability for the Slalom test was 0.90.

Slalom Test with ball: This test was structurally the same as the SL test, but differed in that it was performed with the ball. The intraclass correlation coefficient for test-retest reliability for the Slalom Test with the ball was 0.88.

Table 1. Training programs for the experimental and control group.

Mesocycle	1 Multilateral	2 Basic	3 Specific	4 Situational	5 Competition	Total
Conditioning vs. Technical-tactical training (%)	55 : 45	65 : 35	70 : 30	30 : 70	30 : 70	
Duration (days)	14	14	7	7	42	84
Days of training and matches	12	12	6	6	36	72
Number of training sessions	20	20	10	9	42	101
Number of matches	2	4	2	2	6	16
Hours of practice and matches	38	47	21	20	84	210
Number of the days of rest	2	2	1	1	6	12
Number of conditioning hours+ technical-tactical hours	21+17	31+16	15+6	6+14	32+62	105+105
Extensity of training	3.16	3.91	3.50	3.33	2.33	3.24
Intensity (% Hrmax)	80 %	85 %	85 %	95 %	90-100 %	90 %
Dates of testing	Initial				Final	

Table 2. Specific speed and agility training program (SAQ).

		SAQ Continuum							Total
		Flexibility	Mechanics	Innervation	Accumulation of potential	Explosion	Expression of potential	Cool down	
Week 1	**Intensity (%)**	50%	60%	100%				30%	70%
	Volume (min)	30	40	40		0	0	10	120
	Top Cont %	25.00%	33.33%	33.33%	0.00%	0.00%	0.00%	8.33%	
Week 2	**Intensity (%)**	50%	70%	100%	70%			30%	64%
	Volume (min)	30	30	40	10	0	0	10	120
	Top Cont %	25.00%	25.00%	33.33%	8.33%	0.00%	0.00%	8.33%	
Week 3	**Intensity (%)**	50%	75%	100%	80%	100%		30%	73%
	Volume (min)	30	30	30	20	10	0	10	130
	Top Cont %	23.08%	23.08%	23.08%	15.38%	10.01%	0.00%	7.69%	
Week 4	**Intensity (%)**	50%	80%	100%	80%	100%		30%	73%
	Volume (min)	25	25	30	25	15	0	10	130
	Top Cont %	19.23%	19.23%	23.08%	19.23%	11.54%	0.00%	7.69%	
Week 5	**Intensity (%)**	50%	85%	100%	90%	100%	70%	30%	83%
	Volume (min)	25	25	25	25	20	10	10	140
	Top Cont %	20.83%	20.83%	20.83%	20.83%	16.67%	8.33%	8.33%	
Week 6	**Intensity (%)**	50%	85%	100%	90%	100%	80%	30%	84%
	Volume (min)	25	20	25	30	20	10	10	140
	Top Cont %	20.83%	16.67%	20.83%	25.00%	16.67%	8.33%	8.33%	
Week 7	**Intensity (%)**	50%	90%	100%	100%	100%	90%	30%	88%
	Volume (min)	20	20	25	30	25	15	15	150
	Top Cont %	16.67%	16.67%	20.83%	25.00%	20.83%	12.50%	12.50%	
Week 8	**Intensity (%)**	50%	90%	100%	100%	100%	100%	30%	90%
	Volume (min)	20	20	20	35	25	15	15	150
	Top Cont %	16.67%	16.67%	16.67%	29.17%	20.83%	12.50%	12.50%	
Week 9	**Intensity (%)**	50%	95%	100%	100%	100%	100%	30%	91%
	Volume (min)	20	20	20	35	30	20	15	160
	Top Cont %	16.67%	16.67%	16.67%	29.17%	25.00%	16.67%	12.50%	
Week 10	**Intensity (%)**	50%	95%	100%	100%	100%	100%	30%	91%
	Volume (min)	20	20	25	30	30	20	15	160
	Top Cont %	16.67%	16.67%	20.83%	25.00%	25.00%	16.67%	12.50%	
Week 11	**Intensity (%)**	50%	100%	100%	100%	100%	100%	30%	92%
	Volume (min)	20	20	20	30	30	30	20	170
	Top Cont %	16.67%	16.67%	16.67%	25.00%	25.00%	25.00%	16.67%	
Week 12	**Intensity (%)**	50%	100%	100%	100%	100%	100%	30%	92%
	Volume (min)	20	20	20	25	35	30	20	170
	Top Cont %	16.67%	16.67%	16.67%	20.83%	29.17%	25.00%	16.67%	

Top Cont %: Topic contribution in %.

Sprint with 90° turns

Each of the participants commenced the test with their feet behind the start line. They started from the first point after the sound signal, ran as fast as possible to the second point and performed a 90° turn to the right. On reaching the second point, they continued to run to the third point where they performed a 90° turn to the left. At the fourth point, they performed another 90° turn to the left and ran on to point five, where they performed a 90° to the right. Point six had the same direction and turning angle (90° turn to the right). At point seven, they performed a turn to the left and ran on to the finishing line-point. The track was 15 m long, the distance between the start line and the first flag was 3 m, between the second and the third 2 m, between the third and the fourth 2 m, between the fourth and the fifth 5 m, between the fifth and the sixth 3 m, between the sixth and the seventh 3 m, between the seventh and the eight 2 m, and between the flag nine 2 m. The intraclass correlation coefficient for test-retest reliability for Sprint With 90° Turns was 0.92.

Sprint With 90° Turns with ball: The test structure was the same as the S90° test, but differed only in that it was performed with the ball. The intraclass correlation coefficient for test-retest reliability for Sprint With 90° Turns with ball was 0.86.

Sprint with 180° turns

Each participant started after the sound signal and ran 9 m from starting line A to line B (the lines were white, 3 m long, and 5 cm wide). The 180° turn was performed with the participants being asked to put a foot over the line on inversion. Having touched line B with one foot, they made either a 180° left or right turn. All the following turns had to be performed in the same direction. The players then ran 3 m to line C, made another 180° turn, and ran 6 m forward. They then made another 180° turn (line D) and ran another 3 m forward (line E), before performing the final turn and running the final 9 m to the finish line (line F). The intraclass correlation coefficient for test-retest reliability for the Sprint With 180° Turns was 0.96.

Sprint with backward and forward running

The distance covered was the same as in the previous test (S180°). The only difference was that instead of making a turn, the players shifted from forward to backward

Table 3. Framework of SAQ program.

Dynamic flexibility	Mechanics	Innervations
Toe Walk	**Arm mechanics-Arm Drive**	*Single Walk*
Heel Walk	*Partner Drills*	*Single Run*
Jogging and Hug	*Arm Drive for Jumping*	*Single Lateral Steps*
Small Skip	*Buttocks Bounce*	*Up and Back*
Wide Skip	**Leg Mechanics**	*Lateral Step In-Out*
Single Knee Dead-Leg Lift	*Knee-Lift Development*	*Small Dead Leg Run*
Knee-Across Skip	*Dead Leg Run*	*Icky Shuffle*
Lateral Running	*Leading Leg Run*	*Double Run*
Pre-Turn	*Pre-Turn*	*Hopscotch*
Carioca	*Quick Sidestep*	*Two Step Forward and One Step Backward*
Hurdle Walk	*Sidestep*	*Single Space Jumps*
Russian Walk	*1-2-3 Lift*	*Two Jumps Forwards and One Jump Backward*
Walking Lunges	*Single Jumps*	*Twist Again*
	Single Jump Over and Back	*Hop In and Out*
	Single Jump with 180-degree Twist	*Carioca*
	Lateral Single Jumps	*Spotty Dogs*
	Forward Multiple Jumps	***Line Drills***
	Lateral Multiple Jumps	*Line Drills (Spit Steps)*
	Multiple Hops	*Two-footed Jumps*
	180 - Degree Twist Jumps	***Box Drills***
		Split Step
		Two-Footed Jumps
Accumulation of potential	**Explosion**	**Expression of potential**
Agility Disc	**Vision and Reaction**	*Robbing the nest*
Seated Agility Disc	*Fast Hand Games*	*Shadow*
Swerve Development Runs	*Reaction Ball*	*Cone Game*
Fast Feet Zigzag Run	*Get-Ups*	*Fielding Skill - Specific*
Four Turn, Four Angle Run	*Chair Get-Ups*	
Combination Runs	*Let-Goes*	
Team Combination Runs	*Parachute Running*	
	Ball Drops	
	Buggy Runs	
	Flexy Cord - Overspeed	
	Flexy Cord - Out and Back	
	Side-Steper – Resisted Lateral Runs	
	Side-Stepper-Jockeying Throw and Catch Drill	

running. After the starting sound signal, they ran 9 m from starting line A to line B (the lines were white, 3 m long, and 5 cm wide). Having touched line B with one foot, the players shifted from running forward to running backward. Then, they ran 3 m to line C and changed from backward running to forward running. After 6 m, the players made another change (line D) and ran another 3 m backward (line E) and then made the final change and ran the final 9 m forward to the finishing line (line F). The intraclass correlation coefficient for test-retest reliability for Sprint with Backward and Forward Running was 0.92.

Sprint 4 x 5 m

The test required players to perform constant changes in direction. Five cones were set up 5 m apart. The players stood with their feet apart and the cone between their legs. Every player started after the sound signal and ran 5 m from point A to point B. After reaching point B, he made a 90° turn to the right and then shuffled 5 m to point C. At point C, he made a 90° turn and ran to point D, where he made a 180° turn and ran on to point E (the finish line). The intraclass correlation coefficient for test-retest reliability for Sprint 4 x 5 m was 0.90.

Participants performed 2 trials for the agility tests, with a recovery of approximately 3 minutes between trials. All tests used in this study have previously been shown to be reliable and valid (Sporis et al., 2010a).

Training programme

The experimental group performed a total of 48 SAQ workouts (4 x 12) while the control group undertook approximately the same volume of regular training. We assumed that there would be no difference in the training volume, which represents an important factor when comparing the effects of these two groups. In addition to the specific training each group undertook technical, tactical and strength training. During the preparation period participants participated in 8–10 training sessions per week each lasting 90–105. Strength training was conducted in a gym twice a week, each session lasting 90 minutes (30 minutes of warm up; 40 minutes of circuit training; 20 minutes of stretching exercises). Endurance training was performed three times a week during the preparation period. The intensity of training was monitored using polar heart rate monitors (Polar S-610; Polar Electro, Kempele, Finland) and supervised by team coaches. The in-season strength training program targeted the major muscle groups and was undertaken twice a week (i.e. legs, back, chest) and consisted of varied workouts with exercises focusing on muscular power development (e.g. jump

squats, back squats, bench throws) using loads of up to 75–85% of 1 repetition maximum (1RM). Endurance training was performed once a week. The high intensity training consisted of 4 x 4 minute maximal running using different drills at exercise intensity levels of 90–95% of the maximal heart rate, separated by 3 minute 'rest' periods where technical drills were undertaken at 55–65% of the maximal heart rate. During the 3 minute technical drills, participants were required to work in pairs and perform inside-of-the-foot passes (first drill), control the ball on the chest (second drill), and perform headers (third drill).

Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (v13.0, SPSS Inc., Chicago, IL, USA). Descriptive statistics, Kolmogorov–Smirnov (normality of the distribution) and Levene's (homogeneity of variance) tests (Stone and O'Bryant, 1984) were calculated for all experimental data before inferential testing. Changes in agility, with and without ball, were compared over the training period for players in the experimental and control groups using two factor (group x time) univariate analysis of variance (ANOVA). Statistical significance was set at $p < 0.05$.

Results

The Kolmogorov-Smirnov tests showed that data were normally distributed and no violation of homogeneity of variance found using Levene's test. The experimental and control groups were well matched on the pre-training tests with no significant differences found for any variable between the two groups. The experimental group significantly improved ($p < 0.05$) their performance from pre- to post-training on all measures with the exception of the sprint with backward and forward running (Table 4) whereas performance in the control group remained similar levels for all tests. The experimental groups therefore outperformed the control group in all of the final tests with the exception of the Sprint with backward and forward running.

Discussion

This study has shown that 12 weeks of SAQ training had positive effects on agility with and without ball in soccer players. Players in the experimental group improved their performance significantly regardless of the time that was necessary to complete the agility test with and without ball. These results demonstrate that specific speed and agility training (SAQ), as part of the overall training process, can be considered a useful tool for the improvement of speed and agility among young soccer players. They also confirm Bloomfield et al.'s (2007) viewpoint that the SAQ regimen is an important training method for the improvement of speed and quickness. Importantly, the tests used in this study assessed sprinting performance in a very soccer specific manner i.e. with changes of direction from 5 to 15 meters, with and without the ball, as this type of movement represents 90% of all sprint activities during soccer matches (Bangsbo, 1994). Furthermore, Weineck (2000) suggested that agility along with quickness and speed during the first three steps represent the most significant motor ability of a soccer player.

Although it is considered that the best period for the development of agility is at the age of 16 (Marković et al., 2007), this study has shown that agility can also be improved in later years using an appropriate training programme. This confirms previous findings by Sporiš (2010b) where a poly-structural complex training programme produced improved performance in young soccer players.

Whilst recent studies (Bloomfield et al 2007; Jovanovic et al., 2011; Polman et al., 2004; Sporis, 2010b) have tended to show that SAQ training methods have a positive impact on power, speed and quickness these did not consider agility with and without the ball. Consequently the finding that SAQ training had a positive impact on agility in more realistic soccer specific tests than previously used (i.e. sprinting with 90^0,turns, 180^0 turns and more complex movements with turns in different directions, both with and without ball) provides strong support for the efficacy of this training. Interestingly, no improvement was found when only linear movement was tested (backward and forward sprint test) suggesting that this form of training has specific benefits related to turning movements. This result is in agreement with Polman et al. (2004) who found that SAQ training was effective in the physical conditioning of female soccer players due to a significant improvement in lateral agility. It seems, therefore, that speed, agility and quickness should be viewed as independent motor abilities, which have limited influence on each other, and thus specific training is required for each (Little and Wiliams, 2006).

The SAQ training protocol used in this study included a large number of complex coordination exercises with the ball deemed important by Weineck (2000) as these included relevant technical elements within the conditioning training. This training protocol was shown to

Table 4. Differences between experimental and control group. Data are means (±SD).

	Experimental group (n = 66)		Control group (n = 66)	
	Initial	Final	Initial	Final
Sprint with 180° turns	7.40 (.33)	7.29 (.35) **	7.46 (.35)	7.49 (.36)
Sprint with backward and forward running	7.84 (.39)	7.74 (.39)	7.76 (.41)	7.80 (.43)
Sprint 4x5 m	5.93 (.38)	5.86 (.39) **	6.04 (.35)	6.07 (.34)
Slalom test with ball	10.93 (1.11)	10.67 (1.06) **	10.95 (1.21)	11.24 (1.23)
Slalom test	7.83 (.74)	7.77 (.76) *	7.85 (1.06)	7.95 (1.13)
Sprint with 90° turns with ball	9.92 (.60)	9.67 (.58) *	9.85 (.64)	9.91 (.65)
Sprint with 90° turns	7.83 (.51)	7.67 (.48) *	7.72 (.63)	7.75 (.65)

* and ** denote significant difference ($p < 0.05$ and $p < 0.01$ respectively) between initial and final testing.

improve performance, which was thought to be primarily as a consequence of improved agility. Agility is one of the key components of contemporary soccer, which requires high levels of endurance, power performance and agility (Jeffreys, 2004; Meckel et al., 2009). Whilst one might expect that training protocols would attempt to enhance all three of these components, Jovanovic et al. (2011) suggest a tendency for emphasis on non-specific endurance and power training and less emphasis on agility. They also argue that this may be a cause for overtraining in soccer, as coaches do not recognise the importance of agility training. Clearly this is something that needs to be addressed in the research literature on soccer, specifically how SAQ training could improve agility, but also the extent to which this form of training should make up typical training regimens.

The specific programme used in this study demonstrated benefits for agility performance but what are the long-term costs and/or benefits of such training? One might hypothesise that on the ball training has advantages for both skill development and would have motivational benefits over and above similar training without a ball. This may well result in improvement of players' performances during matches in specific situations as well as decreasing rather increasing the risks of overtraining.

A limitation of this study is that reactive agility (agility in reaction to a stimulus) was not assessed. This is thought to be a more game-related assessment of agility since movements in soccer play tends to be a consequence of something happening, such as the ball being deflected off an opponent. Thus, in open skills situations like soccer, it is thought that cognitive activity is required and therefore preplanned change of direction speed tests, like those used in this study, might not fully assess game specific skills.

Conclusion

The seven different phases of a specific speed and agility (SAQ) training programme (Pearson, 2001) contributed to a statistically significant improvement in performance in different agility tests with and without the ball in U19 soccer players. Whilst it is impossible to determine which any individual components had significant or non-significant contributions the overall effect led to an improvement in agility. These findings support the contention that the SAQ programme should be a part of routine soccer training. The extent to which SAQ training features in both pre-season and in-season training needs to be further investigated as it appears anecdotally that agility training, for many teams, is not undertaken to the extent that it should be. Research suggests that appropriate SAQ training will improve soccer players' agility and condition them to cope with the actual demands of the game.

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Key points

- SAQ training appears to be an effective way of improving agility with and without the ball in young soccer players
- Soccer coaches could use this training during pre-season and in-season training
- Compared with pre-training, there was a statistically significant improvement in all but one measure of agility, both with and without the ball after SAQ training

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