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EFFECTS OF 6 WEEKS ELASTIC RESISTANCE TRAINING ON CHANGE OF DIRECTION, AGILITY AND SPEED PERFORMANCE IN SOCCER PLAYERS#

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Research Article

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ABSTRACT

The study aimed to investigate the effectiveness of elastic resistance agility training program designed to improve change of direction speed, speed, and reactive agility. Forty-eight healthy males actively play soccer and had at least five years experience participated in the study (Height: 177,04± 5,06 cm; Weight: 71,75 ± 8.88 kg; Training Age: 9,83 ± 3,23 years; Age: 21 ± 1,84 Years). After the pre-test Participants split into groups of Elastic Resisted Agility Group-(ERAG) (n=14), Agility Group (AG) (n=12), Control Group (CG) (n=22). Two experimental groups, both ERAG and AG, participated in training biweekly for six weeks. CG only continued their routine soccer training without any strength and conditioning activity. Pre-test, mid-test (after three weeks), and post-test (after six weeks) were taken on selected days on change of direction (COD), 15m sprint, and reactive agility (RA). Due to the nonparametric distribution of the groups, the Friedman test used to analyze the effect of training interventions on dependent variables (3rd and sixth weeks). Differences between measurements analyzed with the Wilcoxon Post Hoc test. Between groups (CG, ERAG, AG), Kruskal-Wallis analysis used to assess the effects of the training interventions on dependent variables. There was no significant difference in performance measurements of groups in the pre-test (p> 0.05); however, after mid-test and post-test, there was a significant difference between groups (p <0.01). There was a significant decrement CG's COD and RA values (p<0,01), however no significant difference in 15m sprint (p>0.05). There was a significant decrement AG's COD, RA, and 15m sprint (p<0,01). There was a significant difference in ERAG's COD and 15m sprint, while no significant difference found in RA (p>0,05). Based on results, could say that elastic resisted agility training may be more effective to train COD and speed (15m sprint) performance than general accepted agility training interventions.

Keywords: Sprinting, Elastic Band, Horizontal Resistance, Quality of Movement, SAQ, Postural Control

Futbolcularda 6 Haftalık Elastik Direnç Antrenmanının Yön Değiştirme Hızı, Reaktif Çeviklik ve Sürat Performansı Üzerine Etkileri

Bilgi
#Bu çalışma yüksek lisans tezinin bir parçasıdır.
**Sorumlu yazar*

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ÖZ

Bu çalışmanın amacı, yön değiştirme hızı, sürat ve reaktif çeviklik performansını geliştirmek amacıyla tasarlanan elastik dirençli çeviklik antrenman programının etkinliğini araştırmaktır. Çalışmaya en az beş yıllık futbol geçmişi olan, aktif olarak futbol oynayan 48 sağlıklı erkek katılmıştır (Boy: 177,04 ± 5,06 cm; Kilo: 71,75 ± 8,88 kg; Antrenman Yaşı: 9,83 ± 3,23 yıl; Yaş: 21 ± 1,84 yıl). Ön testin ardından katılımcılar Elastik Dirençli Çeviklik Grubu (ERAG) (n=14), Çeviklik Grubu (AG) (n=12) ve Kontrol Grubu (CG) (n=22) olmak üzere gruplara ayrılmıştır. ERAG ve AG grupları, altı hafta boyunca haftada iki kez antrenman yaparken, kontrol grubu yalnızca rutin futbol antrenmanlarını sürdürmüş, herhangi bir kuvvet ve kondisyon çalışması yapmamıştır. Katılımcılara yön değiştirme (COD), 15 m sprint ve reaktif çeviklik (RA) testleri; ön test, 3. hafta (ara test) ve 6. hafta (son test) olmak üzere belirlenen günlerde uygulanmıştır. Grupların dağılımı parametrik olmadığından, bağımlı değişkenler üzerindeki antrenman etkilerini incelemek için Friedman testi kullanılmıştır. Ölçümler arasındaki farklılıklar Wilcoxon Post Hoc testi ile analiz edilmiştir. Gruplar arası farkların değerlendirilmesinde Kruskal-Wallis testi kullanılmıştır. Ön testte gruplar arasında anlamlı bir fark bulunmazken (p>0,05), ara test ve son test sonuçlarında gruplar arasında anlamlı farklılıklar gözlenmiştir (p<0,01). Kontrol grubunun COD ve RA değerlerinde anlamlı bir düşüş görülmüştür (p<0,01), ancak 15 m sprintte anlamlı bir fark bulunmamıştır (p>0,05). AG grubunda COD, RA ve 15 m sprint değerlerinde anlamlı azalmalar olmuştur (p<0,01). ERAG grubunda ise COD ve 15 m sprint performanslarında anlamlı gelişmeler saptanmış, ancak RA performansında anlamlı bir fark görülmemiştir (p>0,05). Elde edilen bulgulara göre, elastik dirençli çeviklik antrenmanının, geleneksel çeviklik antrenmanlarına kıyasla yön değiştirme hızı ve kısa mesafe sprint performansını geliştirmede daha etkili olabileceği söylenebilir.

Anahtar Kelimeler: Sprint, Elastik Bant, Yatay Direnç, Hareket Kalitesi, HÇÇ, Postüral Kontrol

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Introduction

In soccer, which is one of the popular sport in the world, change of direction, strength, and speed are highly crucial abilities (Dawes & NSCA, 2019; Taşkin, 2008; Turner & Stewart, 2014; Yıldız et al., 2018). Strength and conditioning coaches aim to improve the physical capabilities of players and push the limits so that they can improve performance (Bangsbo, 2014; Dawes & NSCA, 2019). A soccer player performs a high number of speed and change of direction efforts during competition and averagely covers 10-13km distances, performs 1200-1400 change of direction and acceleration 76 ± 22, and deceleration 54 ± 16 and spends 1-11% of the total time with sprinting and sprint effort averagely is 15m (Ekblom, 1994; Taşkin, 2008). During the competition, accelerations, change of directions, and high-intensity runnings directly change the scoreboard (Bangsbo, 1992; Brito et al., 2014). So it is essential to know what are methods to improve these athletic abilities for strength and conditioning coaches and sports scientists.

Various training methods have used to improve speed and change of direction abilities of soccer players (Appleby et al., 2020; Gil et al., 2018; Thomas et al., 2009), and studies generally focused on improving the speed of the movement with sport-specific distances so that following intensity levels of competition. SAQ programs focused on described characteristics (Brown & Ferrigno, 2005). In a study (Milanović et al., 2014) reported that 12 weeks of SAQ training improved sprint in 5-10m but did not improve 20m+ performance. Another study with youth soccer players (age: 14.2 ± 0.9), reported that six weeks of SAQ training improved sprint, change of direction, and agility (Chaouachi et al., 2014). In another study with young soccer players indicated that SAQ training during 12 weeks improved the change of direction (Milanović et al., 2013). Besides the popularity of SAQ training, also there is a tendency to improve these abilities with horizontal force-producing requiring exercises (Morin et al., 2017). Elastic resistance also is one of the methods that use to improve horizontally force production.

It was not new to the use of elastic resistance in training. Nevertheless, it was being used mostly as a rehabilitation tool previously (Hintermeister, Bey, et al., 1998; Hintermeister, Lange, et al., 1998). However, by the development of new methods in training, it has been used to improve strength (Janusevicius et al., 2017; Wallace et al., 2006), power (Aloui et al., 2019a; Azmi & Kusnanik, 2018) and stretch-shortening cycle (SSC) mechanism with plyometric and recently even it used as a part of planned and periodized programs to improve desired ability (Khodaei et al., 2017; McMaster et al., 2009). A study showed that plyometric training with elastic resistance improved sprint and change of direction abilities in 4 weeks (McMaster et al., 2009). Another study showed that during eight weeks, biweekly performed training with elastic bands improved change of direction and sprint performances even though it has a small positive effect (Aloui et al., 2019a). In elastic resistance training, performers should resist a high amount of horizontal force depending on the structure and level of bands, and it is alternative equipment for soccer players to improve the ability of force-producing in the horizontal plane.

The study aimed to investigate the effectiveness of elastic resistance training to improve change of direction, speed, and reactive agility. It hypothesized that in a short time like six weeks biweekly performed elastic resistance training intervention improves change of direction, speed, reactive agility performance. In the study, the elastic resisted agility group (ERAG) compared with the Agility (AG) and Control Group (CG). There was experimentally no similar design and comparing training programs with appropriate methods, and lack of comparisons of programs was born the current study

Methods

Experimental Approach to the Problem

Students of the Manisa Celal Bayar University who actively play soccer split into three groups as Elastic Resisted Agility Group (ERAG), Agility Group (AG), and Control Group (CG). CG for six weeks only participated in their club training. ERAG and AG participated in their experimental group training additional to club training. It is necessary to add a control group to describe differences between groups. All group's measurements were taken on selected days as pre-mid (after the third week)-post-test on change of direction, reactive agility, and 15m sprint tests. All participants, as a prerequisite, had an experience of at least five years in soccer. Our study aimed to prove the effectiveness of the new agility training method as an important aspect of soccer training. We hypothesized that horizontally applying elastic resistance would increase speed, change of direction, and agility performance of the soccer players. The question of the study was, "will horizontally applying resistance improve soccer player's performance?"

Subjects

Forty-eight males who are healthy and actively play soccer and had at least 5years experience participated in the study (Height: 177,04± 5,06 cm; Weight: 71,75 ± 8.88 kg; Training Age: 9,83 ± 3,23 years; Age: 21 ± 1,84 Years). There was no injury throughout the study. After the pre-test participants split into groups of ERAG (n=14), AG (n=12), CG (n=22). There were no statistical differences between groups in age, height, weight, and training age. Before the study, participants informed about potential risks and benefits of the study and asked consuming a non-caffeine meal before 3 hours of test day and not to join any training session 24 hours before. This study was approved as ethically appropriate by the Health Sciences Ethics Committee of the Faculty of Medicine at Manisa Celal Bayar University, with the decision dated 14.02.2018 and numbered 2018/20.478.486. Additionally, this research was supported by the Scientific Research Projects (BAP) Unit of Manisa Celal Bayar University within the scope of the project titled "Investigation of the Effects of Elastic

Resistance on Agility and Reaction" with the project number 2018-047. and approval was taken from each participant.

Procedures

There was a short familiarization period (3 training sessions) for both ERAG and AG before training interventions. Training continued biweekly for six weeks on non-consecutive days and the same days for experimental groups (ERAG and AG). Training programs of both experimental groups shaped in three phases according to OPT Model of NASM (Clark et al., 2012); 1) Stabilization 2) Strength 3) Power, the ERAG group, followed training variables of resistance training while AG following training variables of SAQ based on the recommendation of NASM (Clark et al., 2012) AG followed a soccer-specific training program to improve SAQ recommended by L.E. Brown and V.A. Ferrigno in "Speed, Agility and Quickness 2nd edition" (Brown & Ferrigno, 2005). We were very aware that there was a 3rd edition of the book; however, in that edition, authors changed the program with an eight weeks training intervention. Researchers of the study prepared the ERAG training program. CG did not participate in strength and conditioning activities except for their training routines (technical and tactical training) during the study.

ERAG and AG's training sessions consisted of three phases which are 1) Dynamic warm-up (according to the recommendation of Gelen (Gelen, 2010)), 2) Main (40-50min.), 3) Cool-Down (5-10min. jogging and static stretching)

Control Group Training Program

CG continued to training routines; however, they asked not to participate in any strength and conditioning activities in their soccer club. During the training period, they also asked to report any injury in their training sessions.

Elastic Resisted Agility Group Training Program

Sanctband Brand Super Loop Elastic bands used for ERAG during the study. The pink color used for the upper body while purple and blue for the lower body.

The training program included upper and lower body stabilization exercises during the first and second weeks, in third and fourth-week stabilization exercise for the upper body while eccentric and concentric strength for lower body and final two weeks in fifth and sixth, concentric and eccentric power and transitive explosiveness (ecc-con, con-ecc). The athlete used similar movement patterns used in the change of direction. All training sessions performed in the soccer field on the pitch.

Training sessions focused on form and quality of movement patterns. Until participants cannot maintain the form and quality of the movement pattern, before stopping exercise, once feedback was given to fix if athletes were still unable to control and fix it, repetitions stopped (all range of repetition was as described in Table 1). During training, elastic bands attached to a stable metal platform, a solid rack, or a goal with proper equipment in the training facility. Every training session, the feedback has been taken from athletes by the trainer on their physical status.

Table 1. (a) Training Program of Elastic Resisted Agility Group (ERAG)

WEEKS	PHASE	TYPE OF CONTRACTION	BODY PART	CODE OF EXERCISE	EXERCISE
1-2.Weeks	STABILIZATION	Isometric	Lower Body	1A	The elastic band pulls forward – walking in the opposite direction of resistance (backward)
		Strength		1B	The elastic band pulls backward – walking in the opposite direction of resistance (forward)
				1C	The elastic band pulls laterally (left and right) – walking in the opposite sideways of resistance
				1D	The elastic band pulls forward – first walking in the opposite direction of resistance then sideways left and right on the line
				1E	The elastic band pulls backward - first walking in the opposite direction of resistance then sideways left and right on the line
				1F	The elastic band pulls laterally – walking back and forth on the line
			Upper Body	2A	The elastic band pulls laterally (left-right) – Stabile elastic band holding in the middle of the chest
				2B	The elastic band pulls laterally – elastic band moving up and down in the middle of the chest
				2C	The elastic band pulls forward - elastic band pulling up and down in the middle of the chest
				2D	The elastic band pulls forward – pulling elastic band left and right (slightly rotation)
3.-4.Weeks	STRENGTH	Eccentric	Lower Body	3A	The elastic band pulls forward – deceleration through pulling direction of the band
		Strength		3B	The elastic band pulls backward – deceleration through pulling direction of the band
		(Deceleration)		3C	The elastic band pulls laterally (right and left) – deceleration through pulling direction of the band
		Concentric		3D	The elastic band pulls forward- acceleration through the opposite direction of the band (backpedal acceleration)
		Strength		3E	The elastic band pulls backward – acceleration through the opposite direction of the band (forward acceleration)
		(Acceleration)		3F	The elastic band pulls laterally (right and left) – acceleration through the opposite direction of the band
		Stabilization	Upper Body	4A	The elastic band pulls forward – trunk rotation to the left and right (right and left)
				4B	The elastic band pulls forward – transverse band pulling from down to up
				4C	The elastic band pulls forward - transverse band pulling from up to down
				4D	The elastic band pulls laterally – trunk rotation to the left and right (right and left)
				4E	The elastic band pulls laterally - transverse band pulling from up to down
				4F	The elastic band pulls laterally – transverse band pulling from down to up

Table 1. (b) Training Program of Elastic Resisted Agility Group (ERAG)

WEEKS	PHASE	TYPE OF CONTRACTION	BODY PART	CODE OF EXERCISE	EXERCISE
5.-6.Weeks	POWER	Concentric Explosiveness	Lower Body	5A	The elastic band pulls forward-backward (backpedal) acceleration–coming back to start position
				5B	The elastic band pulls backward –opposite acceleration direction (forward) –coming back to start position
				5C	The elastic band pulls laterally (right and left) –acceleration opposite sideways –coming back to start position
		Eccentric Explosiveness		6A	The elastic band pulls backward – first walking forward then fast deceleration through pulling direction of the band
				6B	The elastic band pulls forward – first walking backward then fast deceleration through pulling direction of the band
				6C	The elastic band pulls laterally - first walking the opposite sideways then fast deceleration through pulling direction of the band
		Transitive Explosiveness Conc.- Ecc.		7A	The elastic band pulls forward – first backward (backpedal) acceleration then deceleration through pulling direction of the band (Con - Ecc)
				7B	The elastic band pulls backward - first forward acceleration then deceleration through pulling direction of the band (Con - Ecc)
				7C	The elastic band pulls laterally (right and left)- first acceleration to the opposite sideways then deceleration through pulling direction of the band (Con - Ecc)
		Transitive Explosiveness Ecc.- Conc.		8A	The elastic band pulls forward –first walking backward then deceleration through pulling direction of the band and again backpedal acceleration (Ecc-Con)
				8B	The elastic band pulls backward - first walking forward then deceleration through pulling direction of the band and again forward acceleration (Ecc-Con)
				8C	The elastic band pulls laterally (left and right) - first walking sideways (left and right) then deceleration through pulling direction of the band and again acceleration to the opposite sideways (Ecc-Con)

1.and 2. Weeks: 10 exercises for each training session, 12-20* Reps, 50-70% of 1RM, Slow tempo (4 ecc/ 2 iso/ 1 con), 1 set, 30 sec. Rest between exercises, two-session/week, 10min warm-up/ 40-50 min main training phase / 10 min cool-down
3.and 4. Week: 12 exercises for each training session, 8-12* Reps, 70-80% of 1RM, Normal Tempo (2 ecc/0 iso/ 2 con), 2 set, 60 sec. Rest between sets and exercises, two-session/week, 10 min warm-up/ 40-50 min main training phase / 10 min cool-down
5.and 6. Week: 12 exercises for each training session, 1-5* Reps, 85-100% of 1RM, Explosive Tempo, 3 Set, 90 sec. Rest between sets and exercises, two-session/week, 10 min warm-up/ 40-50 min main training phase/ 10 min cool-down
*Every step of participant counted as one repetition and they continued range of reps at the top until cannot maintain the form of the movement

** participants maintained their position 15-20 secs during isometric contraction in the phase of stabilization

Note: In the exercise section, the elastic band's pulling direction arranged according to the anterior side of the participants. The elastic band's direction of pulling mentioned as "the elastic band pulls forward/backward/laterally" means "the elastic band tries to pull (athlete) in directions forward, backward and lateral."

Agility Group Training Program

AG followed an SAQ training program, training variables of OPT model followed within an order 1-2 weeks; stabilization, 3-4 weeks; strength, 5-6 weeks power, and all training sessions performed in the soccer field on the pitch.

Table 2. Training Program of Agility Group (AG)

NEEDS	1.WEEK Drill Name	2.WEEK Drill Name	3.WEEK Drill Name
Speed	Straight-Leg Shuffle Wall Drills (Acceleration Marches)	Single-Leg Run-Through Uphill Acceleration Run	Run-Through Heavy Sled Pulls
Agility	Four-Point Pop-Up 15-Yard (13.71m) Turn Drill	Squirm Z-Pattern Cuts	Squirm V-Drill
Quickness	Plyo Push-Ups Medicine-Ball Wall Chest Passes	Stability-Ball Cyclic Impact Lockouts Medicine-Ball Wall Chest Passes, Single Arm(v)	Stability-Ball Hops Medicine-Ball Lateral Shuffle/Pass
NEEDS	**4.WEEK Drill Name**	**5.WEEK Drill Name**	**6.WEEK Drill Name**
Speed, Agility, and Quickness	Star Drill-Sprint, Backpedal, Shuffle Bag Weave	Star Drill-Sprint, Carioca, Backpedal Lateral Weave	Star Drill-Sprint, Bear Crawl, Shuffle Bag Hops With 100 Degree Turn
Speed and Quickness	Medicine-Ball Lateral Shuffle/Pass to sprint Medicine-Ball Wall Scoop Toss	Medicine-Ball Lateral Shuffle/Pass to sprint Medicine-Ball Squat, Push Toss, Bounce, and Catch	Sprint to Plyo Push-Ups Medicine-Ball Forward Scoop Toss, Bounce, and Catch
Agility and Quickness	Forward Roll Over Shoulder to ball catch(v) Four-Point Pop-Up to ball catch (v)	Forward Roll Over Shoulder Sprawl-to-Stand Pop-Up to ball catch (v)	Running Start and Tumbling Over Barrier (v) Sprawl-to-Stand Pop-Up to sprint(v)

Week 1-2: Stabilization: 1-2 Sets, 2-3 reps, 0-60 sec. rest between sets
Week 3-4: Strength: 3-4 Sets, 3-5 reps, 0-60 sec. rest between sets
Week 5-6: Power: 3-5 Sets, 3-5 Reps, 0-60 sec. rest between sets
v: Variation

Measurement Procedure

All measurements of the groups were taken on selected days before the study (pre-test), after third (mid-test) and sixth week (post-test) on Change of Direction Speed (Zigzag test), Reactive Agility Test (RAT), 15m Sprint test. Before the testing procedure, participants followed a dynamic warm-up protocol for related muscles as the recommendation of Gelen (Gelen, 2010). Measurements were taken between 14:00-16:00 with local time.

Change of Direction Test Protocol

Zigzag shaped change of direction test used. There was a 5m distance between each crossed slalom sticks in a total of the course 30m — two photocell gates used at the entrance and exit (Fusion Sport, Smart Speed). Participants positioned approximately 30-40 cm away from the gate. When ready, they started to test.

Reactive Agility Test Protocol

In the study, reactive agility protocol of Fusion Sport, Smart Speed used, and four photocell gates placed to collect the data from the test. There was a 5m distance between each photocell gate. As participants reached the second gate, one of the gates (left or right) gave a light stimulus, and participants run through the lighted gate to finish the test.

15m Sprint Test Protocol

In the 15m sprint test, two photocell gates (Fusion Sport, Smart Speed) used to collect the data. There was 15m distance between gates. The participant started from the first gate and, when passed through the second gate, finished the test.

Statistical Analysis

The study pattern designed around intra-intergroup analysis with repeated measurements [A x (B x C)]. Due to nonparametric distribution in groups, Friedman test used with repeated measurements in the study to assess effects of training programs between weeks (first, third and sixth weeks) on dependent variables and differences in means analyzed with Wilcoxon Post Hoc test. Due to nonparametric distribution in groups to assess the effect of training programs between groups (ERAG, AG, CG) on dependent variables, Kruskal-Wallis test used and differences in means analyzed with Mann-Whitney U post hoc test. Descriptive statistics used for each parameter (mean, standard deviation).

The significance level was p<0.05, and SPSS 25.0 package program for Windows used for statistical analysis.

Results

The data obtained in this study given in the tables below. Besides, test-retest reliability for the data obtained was within the acceptable range for all measurements (0.87 <ICCR> 0.94).

Table 3. Pre-test, mid-test and post-test Friedman Test analysis values of all groups

		Change of Direction	Reactive Agility	15 Meter Sprint
CG	Pre-Test	9,98 ± 0,33	2.52 ± 0.25	2.38 ± 0.15
	Mid-Test	9.76 ± 0,39	2.82 ± 0.23	2.44 ± 0.15
	Post-test	10,26 ± 0,54	2.66 ± 0.15	2.44 ± 0.12
	p value	,000	,000	,483
AG	Pre-Test	9,73 ± 0,40	2.47 ± 0.26	2.35 ± 0.07
	Mid-Test	9.50 ± 0.50	2.39 ± 0.11	2.35 ± 0.08
	Post-test	10.25 ± 0.31	2.60 ± 0.17	2,42±0,03
	p value	,000	005	,017
ERAG	Pre-Test	9,79 ± 0,41	2.48 ± 0.15	2,39±0,11
	Mid-Test	9.33 ± 0.37	2.48 ± 0.15	2,32±0,10
	Post-test	9,26 ± 0,32	2.49 ± 14	2,29 ± 0,10
	p value	,000	,319	,000

According to the data in Table 3, while there was a significant difference in the CG in the change of direction and reactive agility (p<0.01), there was no significant difference in the 15m sprint (p> 0.05). In the ERAG, there was a significant difference in change of direction and 15m sprint (p <0.01), but no significant difference in reactive agility (p> 0.05). In the AG, a significant difference found in the change of direction, reactive agility (p<0.01), and 15m sprint (p<0.05).

Table 4. Comparison of parameters of pre-test, mid-test and post-test performances of control group with Wilcoxon Test and differences between measurements

Parameters		Pre-Test - Mid Test	Mid Test – Post Test	Pre-Test – Post Test
Change of Direction	*z*	-2,712	-4.012	-1.641
	p	,007	,000	,101
Reactive Agility	*z*	-3.103	-3.135	-2.615
	p	,002	,002	,009
15 Meter Sprint	*z*	-1.381	-, 146	-1.153
	p	,167	,884	,249

The Wilcoxon post hoc values of the Control group analyzed in Table 4, and there was a significant difference between the pre-test, mid-test, and post-test (p<0.01), but no significant difference found between the pre-test and the post-test (p>0.05) A significant difference found in the reactive agility performance between all measurements (p <0.01). There was no significant difference in all of the 15m sprint performance between measurements (p> 0.05).

Table 5. Comparison of parameters of pre-test, mid-test and post-test performances of Agility Group with Wilcoxon Test and differences between measurements

Parameters		Pre-Test - Mid Test	Mid Test - Post Test	Pre-Test – Post Test
Change of Direction	*z*	-,785	-3,059	-2,982
	p	,433	,002	,003
Reactive Agility	*z*	-1.022	-3.066	-1.966
	p	,307	,002	,049
15 Meter Sprint	*z*	-, 157	-2,670	-2,199
	p	,875	,008	,028

According to the data in Table 5, there was no significant difference between the pre-test and the mid-test in the change of direction (p> 0.05), the difference between the mid-test and the post-test , and the pre-test and post-test values were significant (p <0.01). While there was no significant difference between the pre-test and the mid-test in the reactive agility (p> 0.05), the difference between the mid-test and the post-test found to be significant (respectively: p <0, 01, p <0.05), for 15m sprint, there was no significant difference between the pre-test and the mid-test (p> 0.05), the difference between the mid-test and the post-test and the pre-test and post-test were significant (p <0, 01).

Table 6. Comparison of parameters of pre-test, mid-test and post-test performances of elastic resisted agility group with Wilcoxon Test and differences between measurements

Parameters		Pre-Test - Mid Test	Mid Test - Post Test	Pre-Test – Post Test
Change of Direction	*z*	-3,297	-2,798	-3,297
	p	,001	,005	,001
Reactive Agility	*z*	-, 912	-, 157	-, 031
	p	,362	,875	,975
15 Meter Sprint	*z*	-2,921	-2,607	-3,297
	p	,003	,009	,001

In Table 6. parameters with significant differences in the pre-test, mid-test, and post-test performances and z and p values showing differences between measurement analyzed with the Wilcoxon test for ERAG. According to these values, a significant difference found between the pre-test and the mid-test and the pre-test and the post-test in the change of direction and 15m sprint (p <0.01). In the reactive agility, there was no significant difference between the pre-test, mid-test, and post-test measurements (p> 0.05).

Table 7. Relationship of parameters between measurements with Kruskal –Wallis test analysis

		Change of Direction	Reactive Agility	15 Meter Sprint
Pre-Test	CG	9,98±0,33	2.52±0.25	2.38 ± 0.15
	AG	9,73±0,40	2.47 ± 0.26	2.35 ± 0.07
	ERAG	9,79±0,41	2.48 ± 0.15	2,39±0,11
	p value	,063	,979	,485
Mid-Test	CG	9.76 ± 0,39	2.82 ± 0.23	2.44 ± 0.15
	AG	9.50 ± 0.50	2.39 ± 0.11	2.35 ± 0.08
	ERAG	9.33 ± 0.37	2.48 ± 0.15	2.32 ± 0.10
	p value	,014	,000	,074
Post-Test	CG	10,26 ± 0,54	2.66 ± 0.15	2.44 ± 0.12
	AG	10.25 ± 0.31	2.60 ± 0.17	2,42±0,03
	ERAG	9.25 ± 0.34	2.49 ± 14	2,29±0,10
	p value	,000	,041	,001

The p values obtained by comparing the differences of the pre-test performance with the Kruskal-Wallis test between groups and the arithmetic means of the pre-test values of the groups given in Table 7, According to these values, no significant difference found in the pre-test performance between the groups in any parameters (p> 0.05). It shows that groups distributed homogeneously.

The p values obtained by comparing the difference between the mid-test performance between the groups analyzed with Kruskal Wallis test and the arithmetic means of the mid-test values of the groups given in Table 7, According to these values, there was no significant difference in the 15m sprint between the groups after the mid-test (p> 0.05); There was a significant difference in change of direction (p <0.05) and reactive agility (p <0.01).

The arithmetic means of the intergroup performance values of the post-test and the p-values obtained by the Kruskal -Wallis test shown in Table 7 intergroup differences between the performance values in the post-test a significant difference found in all parameters. There was a significant difference in reactive agility (p<0,05) and a significant difference found in the change of direction and 15m sprint (p<0,01).

Table 8. Comparison of the parameters with significant differences in the mid-test measurement with Mann- Whitney U test and the differences between the groups

Parameter with Significant Difference		Elastic Resisted Agility Group - Agility Group	Elastic Resisted Agility Group - Control Group	Agility Group - Control Group
Change of Direction	*z*	-,617	-2,858	-1,731
	p	,537	,004	,083
Reactive Agility	*z*	-1.856	-4.093	-3.897
	p	,063	,000	,000
15 meters Sprint	*z*	-,258	-2,112	-1.589
	p	,797	,035	,112

According to post-test values, there was no significant difference between ERAG and AG in all parameters (p>0,05). However, there was a significant difference between ERAG and CG in all parameters (p<0,05). There was a significant difference between AG and CG in reactive agility (p<0,01), while no significant difference found in the change of direction and 15m sprint in all values (p>0,05).

Table 9. Comparison of parameters with significant differences in post-test measurement with Mann- Whitney U test and differences between groups

Parameter with Significant Difference		Elastic Resisted Agility Group Agility Group	Elastic Resisted Agility Group - Control Group	Agility Group - Control Group
Change of Direction	*z*	-4,321	-4,806	000
	p	,000	,000	1,000
Reactive Agility	*z*	-1.237	-2.404	-1.299
	p	,216	,016	,194
15 Meters Sprint	*z*	-3,448	-3,377	-,361
	p	,001	,001	,718

For the change of direction, there was a significant difference between ERAG and AG (p<0,01), however no significant difference found between AG and CG (p>0,05).

For reactive agility, there was no significant difference between ERAG and AG and AG and CG (p>0,05). However, no significant difference found between ERAG and CG (p<0,05).

For the 15m sprint, there was a significant difference between ERAG and AG, and ERAG and CG (p<0,01). No significant difference found between AG and CG (p>0,05).

Discussion

The study aimed to find the effects of 6 weeks of elastic resistance training on speed, change of direction, and reactive agility performance in active soccer players. In conducted study comparisons made between Elastic Resisted Agility Group (ERAG), Agility Group (AG), and control group (CG). In this case, it was possible to tell which training regimen was more effective than others. First, third, and sixth weeks of ERAG measurements showed that there was an increase in change of direction speed and 15m sprint (P<0.01).

Elastic resistance bands cause curvilinear load increments due to its structure (28). This structure of elastic resistance bands let earlier and higher load increment in phases of movement when compared to other used equipment in strength training. That may explain why athletes gain better strength (Aloui et al., 2019b; Soria-Gila et al., 2015; Wallace et al., 2006). The abilities of change of direction and speed benefit from the strength and reactive strength (Dawes & NSCA, 2019; Jeffreys, 2013; Sheppard & Young, 2006). Elastic resistance bands provide resistance in vertical (ground reaction force), horizontal and transverse planes as athletic performance trainers and academicians who are working in the field, gaining improvements in a short time with elastic resistance was born the current study. According to recommendations of NASM within order phases of stabilization, strength, and power (explosiveness) and related training variables followed with planned and periodized programs (Table 1). In other studies indicated that the planned and periodized training program with elastic resistance could cause desired improvements (Joy et al., 2016; Khodaei et al., 2017). One of the studies reported that change of direction and speed improved (Khodaei et al., 2017). In our study, similar results were found and showed that planned and periodized training programs with elastic resistance bands may cause improvement in the change of direction and speed.

ERTG's training programs designed to improve different abilities biweekly. During four weeks of training, participants improved their capacity of stabilization and strength (concentric-eccentric) with the elastic resistance band, and the last two weeks focused on power with transitive explosiveness (Table 1.). Transitive explosiveness exercises include a transition from concentric to eccentric, eccentric to concentric with dynamic movement. Transitive cycle intended to improve the stretch-shortening cycle (SSC) mechanism of athletes, which is activated by a concentric contraction following an eccentric. Due to the nature of elastic resistance bands, they require deceleration with greater loaded (McMaster et al., 2009), which may cause higher force production to stimulate the SSC. As known, SSC is an essential and needed mechanism for change of direction and speed (Dawes & NSCA, 2019). In a study, indicated that agility and speed might improve in plyometric training with elastic resistance bands (Khodaei et al., 2017), another study similar to our findings reported that explosively performed resistance training with elastic bands improved explosiveness of the lower body (Andersen et al., 2018).

Unilateral and bilateral exercises have used to improve the change of direction and speed of the athletes in strength training. It has known that lunge and squat are fundamental movement patterns, and also similar patterns those used during the change of direction and running-like activities (Cook, 2010). Studies controversially found that bilateral (Appleby et al., 2020) and unilateral (Wallin & Fjellman, 2014) patterns, including exercises, are better to improve change of direction performance. One of these studies mixed exercises both horizontally and vertically performed (Wallin & Fjellman, 2014) other one used only vertical force-producing requiring exercises (Wallin & Fjellman, 2014). However, in the current study, exercises performed with only horizontal load and similar movement patterns used during the change of direction and speed, which are similar to lunge (unilateral) and squat (bilateral). Unsupportingly our findings only horizontally loaded exercises may not always positively influence the change of direction and speed (Gil et al., 2018; Myer et al., 2007). In the current study, additionally, emphasizing the correct form of movement technique is given by feedback during exertions. Throughout the exercise, by giving feedback, and changing the position of the athlete load may be manipulated if required (player-based load adjustment). It is also another advantage of elastic resistance bands. Finally, it may say that horizontal load, focusing quality of the movement (Dos'Santos et al., 2019; Yildiz, Pinar, & Gelen, 2019), using specific patterns, and providing proper feedback during exercise are essentials of elastic resistance training when the change of direction and speed performance want to be improved. In this way, elastic resistance bands allow us to improve the performance of the movement while protecting the nature of the techniques and patterns of related movements.

One more advantage of elastic resistance bands is to teach the athlete how to position the center of mass. Transfer of center of mass quickly and effectively is vital for the change of direction performance. Before and after the change of direction throughout the phase of deceleration, stop, and acceleration momentum of the trunk needs to be controlled (Sasaki et al., 2011). Moreover, the spinal column should not be defeated by momentum (Hewit et al., 2011). Kinematically athlete's posture should be in an erect position for a better change of direction (Hewit et al., 2013). If the trunk is beaten by momentum, and triple extensor muscles of the lower body may be used for postural adjustment and cause leakage of the force and extra energy cost so athletes may never reach the desired level of performance.

Speaking with the results ($P<0.01$), which means the method of elastic resistance training may cause training improvements in a short time. In other words, it may gain athletes' performance in the time half of a mesocycle for six weeks. It is also a valuable result for other sports that are requiring a limited time of preparation. We think that improvements obtained through elastic resistance band training in a short time were due to the establishment of the specific form of the movement and muscle sequencing that would cause proper muscle activation, and so improved performance of the movement causes enhanced performance of the athlete. Physiologically speaking for short-term improvements in the change of direction and speed, performance may be caused by learning and adequately coordinating movement patterns in a sequence (Rutherford & Jones, 1986). As a result of learning, specific movement patterns will cause faster motor unit activation to conduct the movement pattern (Rutherford & Jones, 1986; Sale, 1988).

Agility Group's change of direction performance timely improved even though it was not significant between pre-test and mid-test (P>0.05); There also was no improvement between mid-test and post-test (P>0.05). Since the first day of the SAQ training, athletes performed exercises explosively and concentrated on increasing the speed of the movement. However, they did not maintain a small time-related gain in the change of direction for six weeks in an incremental trend (Table 3.). Their change of direction performance may reach to a performance plateau in the third week. While globally, thousands of strength and conditioning coach is using these SAQ training programs and takes advantages of it, results cannot directly associate with the quality of training program and exercises for six weeks. It may be an explanation for fluctuation in the performance of AG that participants were competing in different divisions and leagues from each other, so they may follow different periodization models, training plans, periods of tapering and peaking (Gamble, 2006). Other studies demonstrated that SAQ training, especially in youth, was an effective training method to improve speed and change of direction (Azmi & Kusnanik, 2018; Milanović et al., 2013; Milanović et al., 2014; Milanovic Z. et al., 2011). In another study, the range of participants ages similar to ours proved that SAQ training improved speed performance (Jovanovic et al., 2011).

There were no improvements both in reactive agility of ERAG and AG (P>0.05). For ERAG, it was probably because they never performed an exercise, including reactive tasks. As known, reactive agility and change of direction speed are independent skills (Young, Dawson, & Henry, 2015). Even though AG exposures to reactive drills did not make any improvement, maybe the number of exercises was not enough. Considering other studies, when focusing on specific cognitive tasks in agility training, reactive agility can be improved (Spiteri et al., 2018).

Practical Applications

Based on the results of our study;

- The most critical feedback that we got from ERAG's athletes was that they were quickly able to position their center of mass (COM) and had a better standing tackle with improved balance. The athletes that had a problem with the orientation of COM may use the elastic resisted agility program of the study.
- We had an improvement in three weeks in the change of direction and speed (15m sprint). The athletes and teams have a limited time of preparation can add the first three weeks of the study into their program.
- We think that positioning COM is related to the dynamic stabilization capacity of the athlete. The first two weeks of elastic resistance training included stabilization exercises, and if we assume an improvement in the COD was due to improved performance of dynamic stabilization at the end of the third, we can suggest that elastic resisted agility training program can perform to increase the capacity of dynamic stabilization.

Effectiveness of the reactive agility training with elastic resistance may test in another study. There also may be another study that if what percentage of an agility program includes reactive tasks, reactive agility could be improved.

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