Effects of 8-Week Functional vs. Traditional Training on Athletic Performance and Functional Movement on Prepubertal Tennis Players

Suat Yildiz,[1] Salih Pinar,[2] and Ertugrul Gelen[3]

[1]Department of Coaching Education, Faculty of Sport Sciences, Manisa Celal Bayar University, Manisa, Turkey; [2]Department of Coaching Education, Faculty of Sport Sciences, Marmara University, Istanbul, Turkey; and [3]Department of Coaching Education, Faculty of Sport Sciences, Sakarya Uygulamali Bilimler University, Sakarya, Turkey

Abstract

Yildiz, S, Pinar, S, and Gelen, E. Effects of 8-week functional vs. traditional training on athletic performance and functional movement on prepubertal tennis players. *J Strength Cond Res* 33(3): 651–661, 2019—In recent years, studies on functional training (FT) have gained importance among older adults and health care services, but there is a lack of research on the athletic performance of children. Fundamental movement skills are basic skills that need to be improved by the age of 10, and these skills are fundamental to every sport. While developing these basic movement skills, some athletic abilities of children should not be neglected and will be a basis for the future. In this way, children will have the ability to perform their sport-specific movement skills easily when the age of specialization comes. Our hypothesis is that increased functional movement will enhance athletic performance of child tennis players. Question of the study is "will increased functional movement enhance athletic performance of child tennis players?" The purpose of this study is to investigate the effects of the FT model on the athletic performance of young athletes. This study included 28 young tennis players (mean age: 9.6 ± 0.7, height: 134.1 ± 6.8, body mass: 31.3 ± 4.1, and fitness age: 3.1 ± 1.1) who have an 80% or more dominant side based on the lateralization test and a functional movement screen (FMS) score below 75%. Ten subjects were included in each of the FT group (FTG) and the traditional training group (TTG), 8 subjects were included in the control group (CG). The training program was implemented on 3 nonconsecutive days in a week for 8 weeks. All subjects performed CG exercises; FTG performed additional exercises based on the FT model, and TTG performed additional exercises based on the TT model. Flexibility, vertical jump, acceleration, agility, balance, and FMS tests were conducted before the training program, at the end of the fourth and the eighth week. The Friedman test analysis method bearing intragroup repeated measurements was used to evaluate the effects of the training program on the dependent variables among weeks (beginning the fourth week and the eighth week) since groups display distribution in nonparametric order. The differences between the averages were tested with Wilcoxon post hoc analyses. The Kruskal-Wallis Test analyses method was used to evaluate the effects of the training program on dependent variables among the groups (CG, TTG, and FTG). The differences between the averages were tested with Mann-Whitney *U* post hoc analyses. Intraclass correlation coefficient (ICC) values were calculated to determine the test-retest reliability of all measurements. According to the data, there was no difference in performance measurements between CG, TTG, and FTG before the exercise program ($p > 0.05$), but the differences between the groups were significant ($p < 0.01$) after 4 weeks and 8 weeks. A significant decrease was found in FMS score in CG ($p < 0.01$), while no difference was found in other parameters ($p > 0.05$). In TTG, FMS score significantly decreased ($p < 0.01$), dynamic right balance ($p < 0.01$) and dynamic left balance ($p < 0.05$) increased. But, no statistically significant difference was found in other parameters ($p > 0.05$) in TTG. In FTG, all parameters improved, and differences were statistically significant ($p \leq 0.001$). Based on these results, the FT model seems to be more effective than the TT model in terms of increasing athletic performance.

Key Words FMS, functional training, muscular imbalance, unitlateral loading

Introduction

Functional training (FT) can be considered as a new training method for athletes, although it is often used especially for older adults (13,17,18,25,37), patients with stroke (4,26,33,34), and postoperative patients (2,5). In FT, the traits such as strength, flexibility, balance, and coordination required in the target movement are

Address correspondence to Dr. Suat Yildiz, drsuatyildiz@gmail.com.

33(3)/651–661

Journal of Strength and Conditioning Research

Table 1. Control group's training program.*

Workouts	Time (min)	Sets	Rest	Intense
Forehand groundstroke ball feeding	1	3	1:1	%60–80
Backhand groundstroke ball feeding	1	3	1:1	%60–80
Forehand-backhand groundstroke rally	1	3	1:1	%60–80
Forehand-backhand volley rally	1	3	1:1	%60–80
Smash	1	3	1:1	%60–100
Service	1	3	1:1	%60–100
Return	1	3	1:1	%60–100
Kind of game points combinations	1	2	1:1	%60–100
Match combinations	5	1	1:1	%60–100

*The training program lasted 8 weeks. During the training program, ball feeding is performed to prevent the loss of time and resting frequency. The training program started with 10-minute warm-up (running + stretching) and ended with 10-minute cooling (stretching). The main training session lasted for 45 minutes.

trained (9,10,14,36,38,40). Through this training method, which is usually performed in the form of simulating the target movement, the target movement itself is improved rather than a specific muscle (3). The traditional training (TT) method, however, involves exercises to increase the strength and durability of a certain muscle. These exercises are performed unidirectionally, and usually, the sagittal axis is used. Thus, with intensive loading, improvement is rapid only in the relevant muscle (40). Besides, the TT is designed for exercise with free weights in supported or at fixed position or with fixed training machines (39). However, movements in daily life or sporting events are performed on multiple axes using multiple muscle groups and joints at the same time. Moreover, these movements are performed without any support and not in a fixed position. For this reason, it can be considered that the TT method alone cannot suffice in achieving the desired performance level.

Table 2. Traditional training program.*†

Workouts	Reps	Sets	Rest	Explanation
Chest press	10	3	1:2	With resistance band
Shoulder press	10	3	1:2	With resistance band
Lateral pull-down	10	3	1:2	With free weight
Biceps curl	10	3	1:2	With resistance band
Triceps push-down	10	3	1:2	With resistance band
Seated leg extension	10	3	1:2	With resistance band
Leg curl	10	3	1:2	With resistance band
Standing calf rise	10	3	1:2	With body weight
Modified push-up	10	3	1:2	With body weight
Sit-up	10	3	1:2	With body weight

*RM = repetition maximum.

†The training program lasted 8 weeks. Resistance band levels of the participants were identified with 6RM test before starting the training program. At the end of each session, the resistance of the participant who is able to repeat much more has been increased. The training program started with 10-minute warm-up (running + stretching) and ended with 10-minute cooling (stretching). The main training session lasted 45 minutes.

While movements were performed on a fixed floor in the TT method, they continue from a fixed floor through a nonfixed floor in the FT method. Balance, coordination, and proprioception develop along with strength and endurance because of the increased requirement for balance (30). In their study with female soccer and volleyball players, Oliver and Di Brezzo (30) investigated the effects of a training program involving functional balance training during the season. They added functional balance training to the training program of volleyball players who continue to receive strength and conditioning training. There was no additional exercise for soccer players. According to pre-test and post-test values, there was a significant improvement in sit-up and single-leg hop performances of volleyball players while a significant increase was observed only in sit-up performance of soccer players. These results suggest that it would be worthwhile to include FT in the TT program.

Because of the competitive nature of tennis, professional athletes exceedingly push the physiological limits throughout the year (21,24). To achieve this competence, athletes start to overload at a young age. However, in bilateral sports such as tennis, unilateral loading from a young age leads to muscular imbalances and associated injuries in athletes (1,19,20,28,32). The implementation of sport-specific

TABLE 3. Eight-week functional training program.*

	Week 1	Week 2	Week 3	Week 4
Squat	Nonresistance	With res. band	Single leg	S. leg with chair
Dead bug	Symmetric and asymmetric limbs up	Symmetric and asymmetric limbs up and touch	Symmetric and asymmetric limbs up and touch	Symmetric and asymmetric limbs up and touch
Climbing man	Table position with trunk flx and ext.	Table position with trunk flx and ext.	Walking on four limbs, limbs not ext.	Walking on four limbs, upper limbs extended.
Plank	Standard position	Standard and side plank	One lower limb up and side plank	One lower limb up and side plank
Bridge	Standard position	Hip up and down in standard pos.	One leg extended	Hip up and down with one leg extended
Chop	Chop with body ext.	Chop with body ext.	Chop with squat pos.	Chop with squat pos.
Lift	Lift with body ext.	Lift with body ext.	Lift with squat pos.	Lift with squat pos.
Push up	Wall push-up (60–70°)	Wall push-up (40–50°)	Hands on chair	Standard position
Pull up	Lateral pull-up, legs on ground	Lateral pull-up, legs on ground	Lateral pull-up, one leg up	Lateral pull-up, one leg up
Med. Ball throw	To up in squat pos.	To up in squat pos. with jumping	To back with body ext.	To back in squat pos.
	Week 5	**Week 6**	**Week 7**	**Week 8**
Squat	S. leg with Swiss ball	Single-leg hop	S. leg on balance pad	S.L. on b. pad with handling R.B.
Dead bug	Single-side limbs up	Single-side limbs up	Combined limbs up	Combined limbs up
Climbing man	Walking on four limbs, limbs extended.	Walking on four limbs, limbs extended.	Walking on four limbs, limbs extended.	Walking on four limbs, limbs extended.
Plank	One lower limb up and side plank	Cross limbs up and one leg up	Cross limbs up and one leg up side plank	Cross limbs up and one leg up side plank
Bridge	Hip up and down with one leg extended	Hip flex-ext. One leg extended	Hip add-abd. One leg extended	Hip add-abd. One leg extended
Chop	Chop with squat pos. with plantar flex.	Chop with squat pos. with plantar flex.	Chop with squat pos. with plantar flex.	Chop with squat pos. with plantar flex.
Lift	Lift squat pos. to ext. pos.	Lift squat pos. to ext. pos.	Lift squat pos. to ext. pos. with plantar flexion	Lift squat pos. to ext. pos. With plantar flexion
Push-up	Feet on chair	One leg up and extended	Feet on Swiss ball	Feet on Swiss ball
Pull-up	Lateral pull-up, feet on Swiss ball	Lateral pull-up, feet on Swiss ball	Standard pull-up	Standard pull-up
Med. ball throw	To wall with squat pos. FH-BH side	To wall with squat pos. FH-BH side	To wall with squat pos. FH-BH side	To wall with squat pos. FH-BH side

*Week 1–2: Every session has 10 exercises. 16–20 rep., 50–70%, 4-2-1 (ex.-iso-con.), 1 set, 30 seconds. Rest, 3 session/week, 10 minutes. Warm-up/40–50 minutes of training/10 minutes of cooling; Week 3–4: Every session has 10 exercises. 14–18 rep., 50–70%, 3-1-1 (ex.-iso-con.), 1 set, 40 seconds. Rest, 3 session/week, 10 minutes. Warm-up/40–50 minutes of training/10 minutes of cooling; Week 5–6: Every session has 10 exercises. 12–14 rep., 50–70%, 2-1-2 (ex.-iso-con.), 1 set, 50 seconds. Rest, 3 session/week, 10 minutes. Warm-up/40–50 minutes of training/10 minutes of cooling; Week 7–8: Every session has 10 exercises. 10–12 rep., 60–70%, 1-0,5-2 (ex.-iso-con.), 1 set, 60 seconds. Rest, 3 session/week, 10 minutes. Warm-up/40–50 minutes of training/10 minutes of cooling. Players were on off-season while this research had been conducted. This is general preparing season. After 8 weeks, they can continue to tennis-specific preparing season.

training at early ages, when basic mobility skills should be developed in line with a child's developmental stages, negatively impacts the basic level of mobility in children (16). This may either result in poor performance later when children are supposed to be elite-level athletes or lead to career ending injuries at an early age (22). As with all sports, tennis sports can be the cause of injury if the athlete does not have the necessary competence. Athletes competing in various age groups will be at risk of serious injury to both upper and lower extremities (42). Although studies on the

Table 4. All group's pre-test, mid-test, and post-test values with Friedman test analyses.*

	Flexibility (cm)	CMJ (cm)	10-m acceleration (s)	Agility (s)	Right dynamic balance	Left dynamic balance	Static balance	FMS (total score)
CG								
Pre-test	0.6 ± 5.5	18.2 ± 5.7	2.74 ± 0.3	15.8 ± 1.6	43.3 ± 4.3	39.2 ± 8.7	21.3 ± 8.4	13.1 ± 2.5
Mid-test	1.9 ± 3.6	18.0 ± 4.5	2.73 ± 0.3	15.7 ± 1.4	43.0 ± 4.4	39.7 ± 8.0	22.0 ± 6.4	12.1 ± 2.3
Post-test	0.6 ± 4.7	19.5 ± 4.9	2.67 ± 0.3	15.8 ± 1.5	42.8 ± 4.4	40.0 ± 7.5	24.7 ± 5.0	10.3 ± 1.6
p	0.197	0.368	0.197	0.798	0.798	0.687	0.223	0.002
TTG								
Pre-test	3.4 ± 4.8	23.4 ± 5.8	2.45 ± 0.4	15.0 ± 1.3	44.2 ± 9.6	41.3 ± 7.6	17.5 ± 6.4	13.0 ± 2.4
Mid-test	3.8 ± 3.9	23.1 ± 4.8	2.48 ± 0.4	14.9 ± 0.6	43.8 ± 8.3	41.1 ± 7.5	16.3 ± 6.7	12.4 ± 2.4
Post-test	3.4 ± 5.1	24.8 ± 3.9	2.52 ± 0.4	15.1 ± 0.6	46.6 ± 8.7	43.9 ± 8.3	17.2 ± 5.2	11.4 ± 1.5
p	0.497	0.056	0.202	0.122	0.008	0.014	0.717	0.006
FTG								
Pre-test	3.5 ± 5.1	22.4 ± 3.6	2.56 ± 0.2	15.3 ± 0.9	43.8 ± 3.6	42.0 ± 5.4	19.4 ± 3.9	14.0 ± 1.8
Mid-test	4.9 ± 3.8	23.9 ± 3.0	2.56 ± 0.2	15.2 ± 0.7	45.0 ± 3.9	43.2 ± 4.5	14.5 ± 5.0	15.6 ± 0.7
Post-test	12.2 ± 3.7	28.9 ± 1.9	2.25 ± 0.2	14.3 ± 0.5	54.8 ± 3.5	52.9 ± 4.7	6.6 ± 2.2	19.3 ± 0.8
p	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000

*CMJ = countermovement jump; FMS = functional movement screen; CG = control group; FTG = functional training group; TTG = traditional training group.

implementation of FT for adult athletes exist, no studies on children were found in the literature. Most of these studies are aimed at identifying disability risks and rehabilitation (27). As a tennis player, they need to develop ground reaction force and transfer this force to the upper body vertically. After that, they need to change direction of force to the transverse plane for follow-through phase of any stroke in tennis. So, for that reason, tennis players need to put multidirectional movements in their training sessions. Basic mobility skills are basic skills that need to be improved by the age of 10, and these skills are almost fundamental to every sport (41). While developing these basic movement skills, some athletic abilities of children should not be neglected and will be a basis for the future. In this way, children will have the ability to perform their special mobility skills easily when the age of expertise comes. After 10 years of age, it is important to develop some athletic abilities such as agility, strength, mobility, flexibility, speed, balance, coordination, and should be a continuum of age and sport-related skills (43). Our hypothesis is that increased functional movement will enhance athletic performance of child tennis players. Question of the study is "will increased functional movement enhance athletic performance of child tennis players?" The purpose of our study is to investigate the effects of FT and TT implementations on the development of athletic performance and functional movement in children.

Methods

Experimental Approach to the Problem

Participants were divided into 3 groups as FT group (FTG), TT group (TTG), and control group (CG). Control group practiced routine tennis training 3 days a week for 8 weeks. In addition to the same routine tennis training, FTG and TTG participated in FT and TT programs, respectively. It is important to put CG to define difference between experimental groups. All group performed functional movement screen (FMS), balance, jumping, acceleration, and flexibility tests before the training at the end of the fourth and the

Table 5. Comparison of differences between the measures of significant differences in the control group (CG) performances of the CG with Wilcoxon test.*

Parameters with significant difference		Mid-test, pre-test	Post-test, pre-test	Post-test, mid-test
FMS (total score)	*z*	−1.841	−2.384	−2.226
	p	0.066	0.017	0.026

*FMS = functional movement screen.

Table 6. Comparison of differences between the measures of significant differences in the TTG performances of the TTG with Wilcoxon test.*

Parameters with significant difference		Mid-test, pre-test	Post-test, pre-test	Post-test, mid-test
Right dynamic balance	*z*	−0.051	−2.395	−2.803
	p	0.959	0.017	0.005
Left dynamic balance	*z*	−1.070	−2.497	−2.701
	p	0.285	0.013	0.007
FMS (total score)	*z*	−2.449	−2.354	−1.709
	p	0.014	0.019	0.088

*FMS = functional movement screen; TTG = traditional training group.

eighth weeks of the training. Participants in the study consisted of athletes who did not receive any fitness training, but only tennis-specific technical and tactical training. The aim of our research is to demonstrate the effects of a training program that solves muscular imbalance and similar problems resulting from unilateral loading with tennis training in these athletes. Our hypothesis is that increased functional movement will enhance athletic performance of child tennis players. Question of the study is "will increased functional movement enhance athletic performance of child tennis players?"

Subjects

A total of 28 male healthy child tennis players (mean ± *SD*; age: 9.6 ± 0.7 years; height: 134.1 ± 6.8 cm; body mass: 31.3 ± 4.1 kg; and training duration: 3.1 ± 1.3 years) who voluntarily participated in tennis training for at least 2 years, who were at least 80% dominant based on the lateralization test, and who had an FMS test score of 15 or below were included in the study in November and December in 2012. All participants had competed in tennis tournaments in 10 years and under category, notably the Marmara region in Turkey before the study. The participants had to be free of injury in order to participate in the study. Participants were asked to quit all resistance workouts outside the study. Participants were divided into 3 groups, FTG ($n = 10$), TTG ($n = 10$), and CG ($n = 8$), after pre-test measurements. There was no statistical difference between the groups with respect to athletic performance, age, height, body mass, or training duration. Before participating in the study, subjects were informed of the potential risks and benefits and provided

Table 7. Comparison of differences between the measures of significant differences in the FTG performances of the FTG with Wilcoxon test.*

Parameters with significant difference		Mid-test, pre-test	Post-test, pre-test	Post-test, mid-test
Flexibility	*z*	−1.682	−2.803	−2.803
	p	0.093	0.005	0.005
CMJ	*z*	−2.209	−2.809	−2.814
	p	0.027	0.005	0.005
10-m acceleration	*z*	−0.765	−2.812	−2.805
	p	0.444	0.005	0.005
T-test–agility	*z*	−1.632	−2.803	−2.803
	p	0.103	0.005	0.005
Right dynamic balance	*z*	−1.682	−2.803	−2.803
	p	0.093	0.005	0.005
Left dynamic balance	*z*	−1.244	−2.803	−2.803
	p	0.214	0.005	0.005
Static balance	*z*	−2.510	−2.809	−2.805
	p	0.012	0.005	0.005
FMS (total score)	*z*	−2.209	−2.809	−2.831
	p	0.027	0.005	0.005

*FTG = functional training group; CMJ = countermovement jump; FMS = functional movement screen.

Table 8. Intergroup relations of athletic performance with Kruskal-Wallis Test analysis.*

	Flexibility (cm)	CMJ (cm)	10-m acceleration (s)	T-test–agility (s)	Right dynamic balance	Left dynamic balance	Static balance	FMS (total score)
Pre-test								
CG	0.6 ± 5.5	18.2 ± 5.7	2.74 ± 0.3	15.8 ± 1.6	43.3 ± 4.3	39.2 ± 8.7	21.3 ± 8.4	13.1 ± 2.5
TTG	3.4 ± 4.8	23.4 ± 5.8	2.45 ± 0.4	15.0 ± 1.3	44.2 ± 9.6	41.3 ± 7.6	17.5 ± 6.4	13.0 ± 2.4
FTG	3.5 ± 5.1	22.4 ± 3.6	2.56 ± 0.2	15.3 ± 0.9	43.8 ± 3.6	42.0 ± 5.4	19.4 ± 3.9	14.0 ± 1.8
P	0.348	0.082	0.082	0.659	0.438	0.803	0.325	0.584
Mid-test								
CG	1.9 ± 3.6	18.0 ± 4.5	2.73 ± 0.3	15.7 ± 1.4	43.0 ± 4.4	39.7 ± 8.0	22.0 ± 6.4	12.1 ± 2.3
TTG	3.8 ± 3.9	23.1 ± 4.8	2.48 ± 0.4	14.9 ± 0.6	43.8 ± 8.3	41.1 ± 7.5	16.3 ± 6.7	12.4 ± 2.4
FTG	4.9 ± 3.8	23.9 ± 3.0	2.56 ± 0.2	15.2 ± 0.7	45.0 ± 3.9	43.2 ± 4.5	14.5 ± 5.0	15.6 ± 0.7
P	0.168	0.022	0.120	0.427	0.545	0.595	0.050	0.000
Post-test								
CG	0.6 ± 4.7	19.5 ± 4.9	2.67 ± 0.3	15.8 ± 1.5	42.8 ± 4.4	40.0 ± 7.5	24.7 ± 5.0	10.3 ± 1.6
TTG	3.4 ± 5.1	24.8 ± 3.9	2.52 ± 0.4	15.1 ± 0.6	46.6 ± 8.7	43.9 ± 8.3	17.2 ± 5.2	11.4 ± 1.5
FTG	12.2 ± 3.7	28.9 ± 1.9	2.25 ± 0.2	14.3 ± 0.5	54.8 ± 3.5	52.9 ± 4.7	6.6 ± 2.2	19.3 ± 0.8
p	0.000	0.000	0.027	0.008	0.001	0.002	0.000	0.000

*CMJ = countermovement jump; FMS = functional movement screen; CG = control group; TTG = traditional training group; FTG = functional training group.

written informed consent to participate in accordance with the policies and procedures of the Helsinki Declaration. The written consent was also completed by the parents of all underage participants who participated in the study. The subjects were told not to exercise on the day before a test and to consume their last (caffeine-free) meal at least 3 hours before the scheduled test time. The study was approved by the Human Research Ethics Committee of the Marmara University.

Procedures

An orientation/trial period was used for subjects in FTG and TTG at the beginning of the training program to introduce the training process and to demonstrate the implementation of FT and TT, respectively. In this process, the 6 repetition maximum method was used to determine the training level and the intensity (load level-weight) to be used in training sessions for each subject. Repetition numbers were rechecked weekly. Resistance was increased by 5–10% for participants who could increase repeat numbers by +2. The training program continued for 3 nonconsecutive days in a week for 8 weeks. Functional training and TT program is developed on the base of stabilization and endurance phase of optimum model of the National Academy of Sports Medicine's suggestions. At this point of view, programs were developed with FT approach. We aimed to eliminate the children's unbalance due to unilateral loading and to increase their total athletic performance. The purpose of this program was to establish the connections between the trunk, upper body, lower body and the extremities. We tried to generate these connections by using the kinetic chain in force generation and force transfer. These participants also continued their routine training programs (CG training program) simultaneously.

All 3 training programs in the study included 3 phases: (a) warm-up period (10 minutes of running and stretching exercise), (b) main exercise period (45–50 minutes), and (c) cool-down period (10 minutes of stretching exercise). Warm-up and cool-down exercises were performed according to the recommendations of Gelen (15). All players were on off-season, and there were no tournament schedule while this research was held. When they finished their 8-week training program, the subjects were able to start tennis-specific high-performance training through the macrocycle training program.

Control Group Training Program. The routine training program, which is implemented by all 3 groups, started with a 10-minute warm-up phase followed by the main phase in which tennis-specific stroke techniques are exercised and ended with a 10-minute cool-down phase. The athletes were requested to play approximately 60–100% intensity. Support of their coaches ensured the attendance of subjects for 8 weeks. During the training period, the coaches threw a ball to the subjects constantly watching the time and rest frequency (Table 1).

TABLE 9. Intergroup relations of parameters with significant difference in mid-test performance values with Mann-Whitney *U* post hoc analyses.*

Parameters with significant difference		TTG-CG	FTG-CG	FTG-TTG
CMJ	*z*	−2.278	−2.552	−0.153
	p	0.023	0.011	0.878
FMS (total score)	*z*	−0.135	−3.223	−3.496
	p	0.892	0.001	0.000

*TTG = traditional training group; CG = control group; FTG = functional training group; CMJ = countermovement jump; FMS = functional movement screen.

Traditional Training Program. Previous studies were used in the preparation of the TT program (40). The training program involved single-joint movements that engage local muscle groups uniaxially or sagittally. Bearing in mind the age group of the subjects, the main exercise period was formed with 3 sets of 10–12 repetitions and breaks to allow them to relax. The main period lasted 45–50 minutes after 10 minutes of warm-up phase. The exercise was terminated with 10 minutes of cool-down (Table 2).

Functional Training Program. The training program consisted of movements that will complement the kinetic chain and bring the dominant and recessive traits of the athletes to the same level. Athletes and trainers can use this program on the off-season or on the preseason phase (Table 3). These movements involved exercises that the athlete will perform on 3 planes for the muscle and muscle groups that are used in stroke techniques in tennis and form the kinetic chain of this technique such as push, pull, rotation, crouch, lift, and jump (8). To increase the resistance of the athlete against gravity and to develop their proprioception, these movements were performed in environments that require increasing levels of balance. Participants used their own body weight, elastic resistance band, and medicine ball to develop their functional movement capacity.

It is important to consider the functional capacity of the subject when planning the FT program. However, it is time-consuming and expensive to determine the characteristics of each individual muscle. The observation-based FMS test that was developed by Cook et al. was used instead (6,7). In this assessment method, the 7 basic movements (deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotatory stability) used in sports are evaluated. Each movement is assessed out of 3 points, and a total of 21 points can be earned.

Measurement Procedure. The FMS test was conducted after the level of dominance in tennis players was determined with a lateralization questionnaire. Then, the balance (dynamic and static), jumping (countermovement jump [CMJ]), acceleration (10-m sprint), flexibility (sit and reach), and agility (T-test) test batteries were utilized during the subjects' athletic performance assessment. After the measurements, an 8-week training program was started. At the end of the fourth and eighth weeks of the training program, the FMS test and the athletic performance test batteries were repeated. The subjects were prepared before the measurements by implementing a dynamic warm-up protocol in accordance with the recommendations of Gelen (15).

Functional Movement Screen. A person's functional capacity was assessed with a FMS test using the total score obtained from a total of 7 movements (8). Each movement was scored between 0 and 3 points, which means that a participant could have a score total between 0 and 21 points (Table 1). The scores obtained from each movement are added to calculate the total FMS score of the individual (6,7).

The Y Balance Test that was developed through modification of the Star Excursion Balance Test was used to measure the dynamic balance (31). The Balance Error Scoring System (BESS) test was used for static balance measurement (35). The CMJ technique was used to determine the jump performance. Jumps were performed on the jump mat (Newtest 2000; Newtest Ltd., Oulu, Finland) where flight and time of contact were measured. Subjects' hands were on their waist during both jumping techniques. Subjects' acceleration performances were measured using a photocell in a distance of 10-m length (Newtest 2000). Subjects' lower extremity flexibilities were assessed by the sit and reach (Takei Sci., Co., Ltd, DGTK-5403, JP) test as in Ellis et al. (12). T-test was preferred to measure agility performance. The agility performance of subjects was measured using Newtest equipment, specifically the photocells that use fixed sensors (Newtest 2000).

Statistical Analyses

The structure of the study follows an intragroup and intergroup pattern [A × (B × S)] containing repeated measurements. The Friedman test analysis method, bearing repeated intragroup measurements, was used to evaluate the effects of the training program beginning during the fourth and eight week of training, since groups display distribution in nonparametric order. The differences between the averages were tested with Wilcoxon post hoc analyses. The Kruskal-Wallis Test analysis method was used to evaluate the effects of the training program on dependent variables among the groups (CG, TTG, and FTG). The differences between the averages were tested with Mann-Whitney *U* post hoc analyses. Intraclass correlation coefficient result (ICCR) values were calculated to determine the test-retest reliability of all measurements. The significance level for the whole procedure was established as $p \leq 0.05$.

Table 10. Intergroup relations of parameters with significant difference in post-test performance values with Mann-Whitney *U* post hoc analyses.*

Parameters with significant difference		TTG-CG	FTG-CG	FTG-TTG
Flexibility	*z*	−2.001	−3.378	−3.326
	p	0.045	0.001	0.001
CMJ	*z*	−2.521	−3.573	−2.744
	p	0.012	0.000	0.006
10-m acceleration	*z*	−1.247	−2.535	−1.666
	p	0.213	0.011	0.096
T-test–agility	*z*	−0.667	−2.757	−2.460
	p	0.505	0.006	0.014
Right dynamic balance	*z*	−1.688	−3.465	−2.646
	p	0.091	0.001	0.008
Left dynamic balance	*z*	−0.889	−3.288	−2.646
	p	0.374	0.001	0.008
Static balance	*z*	−2.586	−3.573	−3.790
	p	0.010	0.000	0.000
FMS (total score)	*z*	−1.220	−3.626	−3.841
	p	0.222	0.000	0.000

*TTG = traditional training group; CG = control group; FTG = functional training group; CMJ = countermovement jump; FMS = functional movement screen.

Results

The data obtained in this study are given in the following tables. Also, test-retest reliability for the obtained data was within the acceptable range for all measurements (0.82 < ICCR > 0.96).

When the pre-test, mid-test, and post-test values of the groups were considered, there was a significant decrease in FMS scores in CG ($p < 0.05$) (Table 4) while there was no significant difference in other parameters ($p > 0.05$). In TTG, there was a significant increase in dynamic balance ($p < 0.05$) while a significant decrease in FMS scores ($p < 0.05$) was observed. No significant difference was observed in other parameters ($p > 0.05$). In FTG, a significant increase was observed in all parameters ($p < 0.05$).

Wilcoxon post hoc values have shown that improvement has occurred especially after the mid-test (Tables 5–7).

In the mid-test measurements, CMJ, static balance, and FMS scores were significantly different ($p < 0.05$), whereas no significant difference was observed in other parameters. In the mid-test measurements of the vertical jump performances, there was a significant difference between CG and TTG and between CG and FTG ($p < 0.05$) whereas no difference was found between TTG and FTG ($p > 0.05$).

When the post-test performance values were compared between groups, significant differences were found in all parameters ($p < 0.05$). In the post-test measurements, there was a significant difference between the vertical jump performances of CG and TTG ($p < 0.05$); however, the difference between CG and FTG and between TTG and FTG was more pronounced ($p < 0.001$ and $p < 0.01$, respectively). When the flexibility data were evaluated, significant differences were found between CG and TTG ($p < 0.05$), CG and FTG, and TTG and FTG ($p < 0.001$). When the acceleration data were evaluated, no significant difference was found between CG and TTG and between TTG and FTG ($p > 0.05$) while there was a significant difference between CG and FTG ($p < 0.05$). When the agility data were analyzed, no significant difference was found between CG and TTG ($p > 0.05$). However, there were significant differences between CG and FTG and between TTG and FTG ($p < 0.05$). When the right dynamic balance data were analyzed, no significant difference was found between CG and TTG ($p > 0.05$) while highly significant differences were found between CG and FTG as well as between FTG and TTG ($p < 0.01$). When the left dynamic balance data were analyzed, no significant difference was found between CG and TTG ($p > 0.05$), but highly significant differences were found between CG and FTG and between TTG and FTG ($p < 0.01$). When the static balance data were analyzed, statistically significant differences were found between CG and TTG ($p < 0.05$); however, more pronounced differences were observed between CG and FTG and between TTG and FTG ($p < 0.001$). When the FMS data were considered, no significant difference was observed between CG and TTG ($p > 0.05$) while there were highly significant differences between CG and FTG and between TTG and FTG ($p < 0.001$).

Pre-test, performance variable's differences compared with Kruskal-Wallis test between groups and p values obtained, arithmetically means of groups in pre-test were shown in Table 8. According to these data, no significant difference was found in any parameter in preseason ($p > 0.05$). This situation showed that groups were homogeneously distributed.

Midseason, performance variable's differences compared with Kruskal-Wallis test intergroups and p values obtained, arithmetical means of groups in midseason were shown in Table 9. According to these data, there was no significant differences for the parameters of flexibility, speed, agility, right side dynamic balance, left side dynamic balance, and right-left balance ($p > 0.05$), but there was a significant difference between vertical jump and FMS scores ($p < 0.001$). Even if there was statistically no difference for the static balance, the value was very close to the significant difference ($p = 0.05$).

Mann-Whitney *U* test analyze results were given in the Table 9, showing which group caused the significant difference in midseason parameters. According to these data in midseason, there is significant difference between CG and TTG, and CG and FTG ($p < 0.05$); but there was no significant difference between TTG and FTG ($p > 0.05$).

The FMS scores during midseason showed a significant difference between CG and TTG, and CG and FTG. however, there was no significant difference between TTG and FTG ($p > 0.05$).

There was no significant difference found for right-left dynamic balance difference ($p > 0.05$), but there was significant difference found for the parameters of flexibility ($p < 0.001$), vertical jump ($p < 0.001$), static balance ($p < 0.001$), FMS ($p < 0.001$), agility ($p < 0.01$), right dynamic balance ($p < 0.01$), left dynamic balance ($p < 0.01$), and speed ($p < 0.05$).

Postseason, performance variable's differences between groups compared with the Kruskal-Wallis test and p values obtained, arithmetical means of groups in postseason were shown in Table 10.

Mann-Whitney *U* test analyze results were given in the Table 10, showing which group caused significant differences in postseason parameters. According to these data: flexibility, there was the significant difference between CG and TTG ($p < 0.05$), and a very significant difference was found between CG and FTG ($p < 0.001$), and TTG and FTG ($p < 0.001$).

Vertical jump, there was a very significant difference found between all groups, CG and TTG ($p < 0.01$), CG and FTG ($p < 0.001$), TTG and FTG ($p < 0.01$).

Speed, there was no significant difference found between CG and TTG, and TTG and FTG ($p > 0.05$), but a significant difference found between CG and FTG ($p < 0.05$).

Discussion

The most striking result of this study was the statistically significant changes in the FMS scores of the participating child athletes during the 8-week period.

When the changes between measurements were examined, FMS scores of FTG increased ($p < 0.01$) while those of CG and TTG decreased ($p < 0.01$). This may be explained by the fact that there was more sport-specific loading instead of focusing on the development of basic mobility skills in childhood when development is rapid. Adverse effects of early specialization as explained in the long-term athlete development model (16) have also been observed in our study. Only 8 weeks of FT has eliminated these negative effects. The FMS scores of normal and overweight, preadolescent, and sedentary children in primary school were compared in a study (11). The mean FMS score for normal-weighted children who are not involved sports was reported as 15.5. The children in the same age group had lower FMS scores based on pre-test values in this study, although they were involved in sports (CG: 13.1, TTG: 13.0, FTG: 14.0). Previous studies suggested a threshold FMS score of 14.0 for FT (23,29). Individuals who score below this value, especially for child athletes in development phase, should be included in practices for FT. It is believed that there may be a decrease in the level of functional movement in individuals otherwise.

When the athletic performance was examined in light of the data, it was found that all values were significantly improved in FTG ($p < 0.01$); there were significant increases in the vertical jump and balance values in TTG ($p < 0.05$). No significant difference was found in any athletic performance values of CG and the other athletic performance values of TTG ($p > 0.05$). No previous study was found in the literature on implementation of FT in preadolescent athletes. Song et al. (36) implemented a 16-week FT program in elite high school baseball players and reported an increase in strength and flexibility. Weiss et al. (40) investigated the effects of FT and TT methods on muscular strength and endurance, flexibility, agility, balance, and anthropometric measures by implementing a 7-week FT and TT program to a group of 38 mixed-gender participants aged between 18 and 32 years. In that study, there was a significant increase only in the flexibility features of the FTG; unlike the current study, no significant differences were found in other features. The fact that the subjects in the current study had been involved in sports may explain the differences. Besides, other studies (39) have suggested that including a mixed-gender group and sedentary subjects might have limited the effect of training in the work by Oliver et al. (30) have investigated the effects of functional balance training on unstable grounds on the single-leg squat and the 1-minute sit-up test in athletes in the collegiate women's volleyball and soccer teams in the National Collegiate Athletic Association (NCAA) Division I. Significant increases were observed in the functional balance training group compared with the CG. The results obtained in this study support the conclusions of the current study. Yıldız (42) had examined the relationship between FMS and athletic performance in elite karate athletes. The results showed that there is a significant relationship between FMS and flexibility, squat jump, core stabilization ($p < 0.01$), and back and leg strength ($p < 0.05$). There is no significant correlation between handgrip strength. With FMS test battery of the deep squat that requires vertically force production, potential performance outputs of vertical jumping ability could be predicted. The athlete has to have both good mobility and stability in the ankle, knee, and hip areas to perform jumping continuously. This is important for power output not to outflow and maintain the quality of movement during dynamic movement (41).

There were no previous studies comparing CG with TTG and FTG in the literature, which highlights the significance of the current study. There was no significant difference between the performance values of groups in pre-test measurements ($p > 0.05$), which indicates that the subjects were homogeneously distributed throughout the groups. In the mid-test measurements, however, CMJ, static balance, and FMS scores were significantly different ($p < 0.05$), whereas other parameters were not significantly different. Significant differences were found between CG and TTG and between CG and FTG in vertical jump performance ($p < 0.05$); there was no difference between TTG and FTG ($p > 0.05$). The results of the current study suggest that even a 1-month fitness-training program can be effective for young athletes in their developmental period. This effect was observed in both TTG and FTG compared with CG. When the end of 8-week training period's data was evaluated, there were significant differences between all performance values of the groups. Significant increases were found in flexibility, vertical jump, and static balance values of TTG compared with CG ($p < 0.05$). When FTG and CG were compared, FTG was found to have significant increases in all performance data. These increases were found normal when the fitness-training programs (TT and FT) were taken into consideration. When FTG and TTG were compared, there was no significant difference in flexibility values, but FTG had a significant increase in all other performance values. When FMS data were analyzed, no significant difference was found between CG and TTG ($p < 0.05$), but there were significant differences between CG and FTG and between TTG and FTG ($p < 0.001$). According to this result, our hypothesis has been proved. In their comparison of 5-week FT and TT exercises, Tomljanovic et al. (39) did not find a significant difference, which might in part be explained by the duration of the study. In the current study, the effect of FT exercises on athletic performance and functional movement could be observed especially between the fourth and eighth weeks. There was a significant difference between TTG and FTG at the end of the eighth week, although there was no significant difference between the performances after 4 weeks. This suggests that FT exercises for young tennis players should be designed for at least 8 weeks. Furthermore, the decrease in FMS scores in the CG and TTG after the mid-test at the fourth week is noteworthy. This may be explained by the muscular tension created by intense exercise loads at a time of rapid development of the body. Individual motor skills of working muscles may develop, but the quality of movement may decrease if exercises are not performed in accordance with the principles of functional movement (if exercises are mostly performed on single joints and on a single plane). Muscles that do not communicate and cooperate with each other as a result of single joints and single plane exercises will lead to problems in movement. For this reason, it is recommended that the athletes and coaches perform the exercises according to the FT principles.

Practical Applications

Tennis is performed with movement patterns just like other sports. Because of this, it is very helpful to see athlete's movement pattern's quality who competes in underage categories. If there is any problem about pattern, it would be corrected at that time, and improved quality of movement pattern would provide the increase in athletic performance.

There should be exercises aimed at improving the performance of the movement, not the performance of the muscles during training of children.

When designing exercises for the children before puberty, care should be taken to improve the characteristics of the movement rather than improving those of individual muscles.

Care must be taken to ensure that movements included in the designed training program are those that engage multiple joints, continue in the different axes, and train the entire body.

The implemented FT program takes effect between the fourth and the eighth weeks. Thus, exercises should be planned for at least 8 weeks.

In bilateral sports branches such as tennis, training should be designed to include the exercise that trains the non-dominant side of the body and the movements to eliminate muscular imbalance.

Exercises and games should be designed following the FT principles that enhance basic mobility skills rather than the intensive training of sport-specific skills in preadolescent children.

References

1. Abrams, GD, Renstrom, PA, and Safran, MR. Epidemiology of musculoskeletal injury in the tennis player. *Br J Sports Med* 46: 492–498, 2012.
2. Ageberg, E, Thomeé, R, Neeter, C, Silbernagel, KG, and Roos, EM. Muscle strength and functional performance in patients with anterior cruciate ligament injury treated with training and surgical reconstruction or training only: A two to five-year followup. *Arthritis Rheum* 59: 1773–1779, 2008.
3. Beckham, SG and Harper, M. Functional training fad or here to stay? *ACSM's Health Fit J* 14: 24–30, 2010.
4. Blundell, SW, Shepherd, RB, Dean, CM, Adams, RD, and Cahill, BM. Functional strength training in cerebral palsy: A pilot study of a group circuit training class for children aged 4–8 years. *Clin Rehabil* 17: 48–57, 2003.
5. Borsa, PA, Sauers, EL, and Lephart, SM. Functional training for the restoration of dynamic stability in the PCL-injured knee. *J Sport Rehabil* 8: 362–378, 1999.
6. Cook, G, Burton, L, and Hogenboom, B. The use of fundamental movements as an assessment of function: Part 2. *N Am J Sports Phys Ther* 1: 132–139, 2006.
7. Cook, G, Burton, L, and Hogenboom, B. The use of fundamental movements as an assessment of function: Part 1. *N Am J Sports Phys Ther* 1: 62–72, 2006.
8. Cook, G, Burton, L, Kiesel, K, Rose, G, and Bryant, MF. Functional Movement Screen Descriptions. In: *Movement: Functional Movement Systems–Screening, Assessment, Corrective Strategies.* Aptos, CA: On Target Publications, 2010. pp. 87–106.
9. DE Matos, DG, Mazini Filho, ML, Moreira, OC, DE Oliveira, CE, DE Oliveira Venturini, GR, DA Silva-Grigoletto, ME, and et al. Effects of eight weeks of functional training in the functional autonomy of elderly women: A pilot study. *J Sports Med Phys Fitness* 57: 272–277, 2017.
10. do Rosario, JT, da Fonseca Martins, NS, Peixinho, CC, and Oliveira, LF. Effects of functional training and calf stretching on risk of falls in older people: A pilot study. *J Aging Phys Act* 25: 228–233, 2017.

11. Duncan, MJ and Stanley, M. Functional Movement is negatively associated with weight status and positively associated with physical activity in british primary school children. *J Obes* 2012: 5, 2012.

12. Ellis, L, Gastin, P, Lawrance, S, Savage, B, Buckeridge, A, Stapff, A, et al. Protocols for the physiological assessment of team sport players. In: *Physiological Tests for Elite Athletes.* CJ Gore, ed. Champaign, IL: Human Kinetics Publ, 2000. pp. 128–144.

13. Fahlman, MM, McNevin, N, Boardley, D, Morgan, A, Topp, R. Strength training vs. Combination training: Both result in improved functional ability in functionally limited elderly. *Med Sci Sports Exerc* 38: S43, 2006.

14. Frost, DM, Beach, TA, Campbell, TL, Callaghan, JP, and McGill, SM. Can the Functional Movement Screen™ be used to capture changes in spine and knee motion control following 12 weeks of training? *Phys Ther Sport* 23: 50–57, 2017.

15. Gelen, E. Acute effects of different warm-up methods on sprint, slalom dribbling, and penalty kick performance in soccer players. *J Strength Cond Res* 24: 950–956, 2010.

16. Granacher, U, Lesinski, M, Büsch, D, Muehlbauer, T, Prieske, O, Puta, C, and et al. Effects of resistance training in youth athletes on muscular fitness and athletic performance: A conceptual model for long-term athlete development. *Front Physiol* 7: 164, 2016.

17. Gudlaugsson, J, Gudnason, V, Aspelund, T, Siggeirsdottir, K, Olafsdottir, AS, Jonsson, PV, and et al. Effects of a 6-month multimodal training intervention on retention of functional fitness in older adults: A randomized-controlled cross-over design. *J Aging Phys Act* 20: S89, 2012.

18. Hashidate, H, Shiomi, T, and Sasamoto, N. Effects of 6 Months combined functional training on muscle strength, postural balance and gait performance in community-dwelling individuals with chronic stroke hemiplegia. *J Phys Ther Sci* 23: 617–623, 2011.

19. Hjelm, N, Werner, S, and Renstrom, P. Injury risk factors in junior tennis players: A prospective 2-year study. *Scand J Med Sci Sports* 22: 40–48, 2012.

20. Hofmann, A and Weishaupt, P. High-performance sports and back pain: The significance of functional analysis and progressively dynamic power training of the trunk musculature–Case report on a 15-year-old tennis athlete. *Sportverletz Sportschaden* 13: M7–M9, 1999.

21. Hornery, DJ, Farrow, D, Mujika, I, and Young, W. An integrated physiological and performance profile of professional tennis. *Br J Sports Med* 41: 531–536, 2007.

22. Joyce, D and Lewindon, D. *High-performance Training for Sports.* Champaign, IL: Premier Print Group, Human Kinetics, 2014.

23. Kiesel, K, Plisky, P, and Butler, R. Functional movement test scores improve following a standardized off-season intervention program in professional football players. *Scand J Med Sci Sports* 21: 287–292, 2011.

24. Kovacs, MS. Tennis physiology: Training the competitive athlete. *Sports Med* 37: 189–198, 2007.

25. Krebs, DE, Scarborough, DM, and McGibbon, CA. Functional vs. strength training in disabled elderly outpatients. *Am J Phys Med Rehabil* 86: 93–103, 2007.

26. Lee, JA, You, JH, Kim, DA, Lee, MJ, Hwang, PW, Lee, NG, and et al. Effects of functional movement strength training on strength, muscle size, kinematics, and motor function in cerebral palsy: A 3-month follow-up. *Neurorehabilitation* 32: 287–295, 2013.

27. Moran, RW, Schneiders, AG, Mason, J, and Sullivan, SJ. Do functional movement screen (FMS) composite scores predict subsequent injury? A systematic review with meta-analysis. *Br J Sports Med* 51: 1661–1669, 2017.

28. Niederbracht, Y, Shim, AL, Sloniger, MA, Paternostro-Bayles, M, and Short, TH. Effects of a shoulder injury prevention strength training program on eccentric external rotator muscle strength and Glenohumeral joint imbalance in female overhead activity athletes. *J Strength Cond Res* 22: 140–145, 2008.

29. O'Connor, FG, Deuster, PA, Davis, J, Pappas, CG, and Knapik, JJ. Functional movement screening: Predicting injuries in officer candidates. *Med Sci Sports Exerc* 43: 2224–2230, 2011.

30. Oliver, GD and Di Brezzo, R. Functional balance training in collegiate women athletes. *J Strength Cond Res* 23: 2124–2129, 2009.

31. Plisky, PJ, Rauh, MJ, Kaminski, TW, and Underwood, FB. Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *J Orthop Sports Phys Ther* 36: 911–919, 2006.

32. Pluim, BM, Staal, JB, Windler, GE, and Jayanthi, N. Tennis injuries: Occurrence, aetiology, and prevention. *Br J Sports Med* 40: 415–423, 2006.

33. Scholtes, VA, Dallmeijer, AJ, Rameckers, EA, Verschuren, O, Tempelaars, E, Hensen, M, and et al.. Lower limb strength training in children with cerebral palsy–a randomized controlled trial protocol for functional strength training based on progressive resistance exercise principles. *BMC Pediatr* 8, 2008: 41.

34. Scholtes, VA, Becher, JG, Janssen-Potten, YJ, Dekkers, H, Smallenbroek, L, and Dallmeijer, AJ. Effectiveness of functional progressive resistance exercise training on walking ability in children with cerebral palsy: A randomized controlled trial. *Res Dev Disabilities* 33: 181–188, 2012.

35. Sheehan, DP. The impact of a six week exergaming curriculum on balance with pre adolescent school children. Doctoral thesis, University of Calgary. Calgary, AL, 2011. pp. 237.

36. Song, HS, Woo, SS, So, WY, Kim, KJ, Lee, J, and Kim, JY. Effects of 16-week functional movement screen training program on strength and flexibility of elite high school baseball players. *J Exerc Rehabil* 10: 124–130, 2014.

37. Thompson, C and Blackwell, J. Effect of an eight-week functional training program on static balance in community-dwelling older adults. *Med Sci Sports Exerc* 37: S161, 2005.

38. Thompson, CJ, Cobb, KM, and Blackwell, J. Functional training improves club head speed and functional fitness in older golfers. *J Strength Cond Res* 21: 131–137, 2007.

39. Tomljanovic, M, Spasić, M, Gabrilo, G, Uljević, O, and Foretić, N. Effects of five weeks of functional vs. traditional resistance training on anthropometric and motor performance variables. *Kinesiology* 43: 145–154, 2011.

40. Weiss, T, Kreitinger, J, Wilde, H, Wiora, C, Steege, M, Dalleck, L, and et al. Effect of functional resistance training on muscular fitness outcomes in young adults. *J Exerc Sci Fitness* 8: 113–122, 2010.

41. Yıldız, S, Pınar, S, and Gelen, E. *Tennis by Functional Training.* Saarbrücken, Germany: Lambert Academic Publishing, 2017. pp. 7–8.

42. Yıldız, S. Relationship between functional movement screen and some athletic abilities in karate athletes. *J Edu Train Stud* 6: 66–69, 2018.

43. Yıldız, S. Relationship between functional movement screen and athletic performance in children tennis players. *Universal J Educ Res* 6: 1647–1651, 2018.