Research Article/Araştırma Makalesi

Spor Hekimliği Dergisi, 55(4):321-331;2020
Turkish Journal of Sports Medicine
DOI: 10.5152/tjsm.2020.193

Effects of Functional Training on Performance in Professional Basketball Players

Fonksiyonel Antrenmanının Profesyonel Basketbolcularda Performansa Etkisi

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Geliş Tarihi/Date Received:
01.05.2020
Kabul Tarihi/Date Accepted:
04.06.2020
Yayın Tarihi/Published Online:
24.09.2020

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ABSTRACT

Objectives: The purpose of this study was to determine whether functional training had any effects on performance and related various physical components of basketball players.

Materials and Methods: 28 athletes participated from first and second division professional basketball teams of one club. While first division basketball team players (n=14, average age: 26.6 ± 5.9 years) were assigned into functional training group (FTG), second division basketball team players (n=14, average age: 22.4 ± 4.2 years) were assigned into control group (CG). FTG completed a functional training program which included core strengthening and specific basketball task-related exercises with/without equipment. CG followed traditional strength training consisted of machine and free weight lifting based exercises. Both groups performed trainings for 20 weeks (2 days/week with 75-85 min. duration) along with the routine basketball practice. Anthropometric measurements, sit and reach flexibility test, 20 m speed test, T-drill and Lane-agility tests, horizontal and vertical jump tests, one-repetition maximum bench press and leg press strength tests were assessed before and after the 20-week program.

Results: The results of this study was indicated that the FTG significantly improved upper and lower body strength, flexibility, vertical jump ability and T-drill agility scores relative to the CG ($p<0.05$).

Conclusions: These findings demonstrate that the functional training (FT) can be an alternative method to traditional resistance training for improving performance-related parameters such as flexibility, vertical jump ability, agility, and strength. Further researches are needed to study with the different parameters about athletic performance in other sport disciplines and with larger sample size.

Keywords: Physical fitness, functional training, basketball

ÖZ

Amaç: Bu çalışmanın amacı fonksiyonel antrenmanın (FA), profesyonel basketbol oyuncularının performanslarına ve ilişkili alt parametrelere olan etkisini araştırmaktır.

Gereç ve Yöntemler: Aynı spor kulübünün birinci ve ikinci lig takımlarından 28 profesyonel basketbol oyuncusu çalışmaya dahil edildi. Birinci lig basketbol takımı oyuncuları (n=14, ortalama yaş: 26.6 ± 5.9 yıl) fonksiyonel antrenman grubunu (FAG), ikinci lig basketbol takımı oyuncuları (n=14, ortalama yaş: 22.4 ± 4.2 yıl) kontrol grubunu (KG) oluşturdu. FAG, "core" kuvvetlendirme ve ekipmanlı/ekipmansız basketbola özel hareket kalıplarını içeren egzersizlerden oluşan programı tamamladı. KG, makine bazlı ağırlık kaldırma egzersizlerinden oluşan geleneksel kuvvet

çalışmalarını yaptı. Her iki grup antrenman programlarını rutin basketbol antrenmanlarıyla birlikte 20 hafta boyunca (2 gün/hafta,75-85 dk.) gerçekleştirdi. Fiziksel özellikler, antropometrik ölçümler, otur-uzan esneklik testi, 20 m sürat testi, T-drill ve Lane-agility çeviklik testleri, yatay sıçrama ve dikey sıçrama testleri, bir maksimum tekrar (1MT) göğüs ve bacak itme kas kuvveti testleri 20 haftalık programın başlangıcı ve sonunda tekrarlandı.

Bulgular: FAG'nin KG'ye göre üst ve alt ekstremite kuvveti, esneklik, dikey sıçrama ve T-drill çeviklik skorlarında anlamlı artış gözlendi ($p < 0,05$).

Sonuç: Fonksiyonel antrenman esneklik, dikey sıçrama kabiliyeti, çeviklik ve kuvvet gibi performansla ilgili parametrelerde geleneksel kuvvet yöntemine göre alternatif olabilir. Farklı performans parametreleriyle ve diğer spor branşlarıyla, örneklemin geniş olduğu daha fazla çalışmaya ihtiyaç vardır.

Anahtar Sözcükler; Fiziksel uygunluk, fonksiyonel antrenman, basketbol.

Available at: http://journalofsportsmedicine.org and http://dx.doi.org/10.5152/tjsm.2020.193

Cite this article as: Usgu S, Yakut Y, Kudas S. Effects of functional training on performance in professional basketball players. *Turk J Sports Med*. 2020;55(4):321-31.

INTRODUCTION

Basketball players perform several multi-directional movements such as dribbling, shuffling, sprinting and rebounding at various velocities and intensities (1). These specific movements are related to the functional performance that requires well-developed fitness and exercise programs for achieving better performance and success (2). Many studies have shown that progressive resistance training improved the physical fitness of athletes (3, 4). In progressive resistance training, load is increased gradually over the training course to strengthen major muscle groups used for weight-bearing or lifting. However, improving muscle strength yields only a small change, sometimes even non-significant change, in performance or in the outcome of sports activities (5). The transferring benefits of strength training to athletic performance seems to be limited. It has been suggested that the relationship between muscle strength and physical performance is nonlinear (6). When the muscle strength has reached a certain threshold, a further increase in muscle strength did not add to better performance (7). Additionally, athletes may not explicitly learn how to transfer increased muscle strength to improve athletic performance when the training primarily focuses on increasing muscle strength (8).

Alternatively, functional training (FT) may be more beneficial for improving athletic performance in sports. FT attempts to train muscles in coordinated, multiple movement patterns and incorporates joints, dynamic tasks, and consistent alterations for functional improvement (9). FT was defined as purposeful training stating that "function is, essentially, purpose" (9). Therefore, FT can be any type of training that is performed for enhancing a certain task or activity. The principle of FT is the specificity of training, which means that training is the best way to maximize the performance in that specific activity (10). According to this definition, in order to improve performance, exercise training should be performed in specific movement patterns required by different sports. The basketball player needs synchronized movement patterns of upper and lower body for lay-up, shooting, and dribbling etc. Therefore, the fundamental workout is a part of technical training in basketball practice.

There is a growing body of literature on FT in which sedentary people, older adults (11-13), child and young athletes (14, 15) and different sport disciplines (16-18) are trained on specific tasks. However, there remains a need for further studies focusing on FT and performance outcomes in professional athletes. Therefore, the purpose of this study is to investigate the effects of FT versus traditional resistance training on the development of athletic performance in professional basketball players.

MATERIALS and METHODS

Subjects

Athletes were selected from the first and second division professional basketball teams of a sports club. The selection criteria of the teams were specificity and proximity (the non-

randomization of the sample was for the sample's accessibility). The teams were assigned into two groups as functional training group (FTG) and control group (CG). While first division basketball team players (n=14, average age 26.6 ± 5.9 years) were assigned into FTG, second division basketball team players (n=14, average age 22.4 ± 4.2 years) were assigned into CG. Athletes who had an injury over three weeks diagnosed by sport physician, had a previous surgery within the last 3 months, had a neurological or systemic disease were excluded. The groups were assessed at pre-season and at the end of the 20-week training period. During the experimental period, practice sessions or matches were recorded weekly; both groups completed 6-7 basketball practice sessions and played one official game per week.

Procedures

FTG and CG performed FT and traditional strength training two times per week for twenty weeks, respectively. Both groups participated in routine basketball training and FTG did not receive any traditional strength training during the study. Athletes attended 40 training sessions in both groups. The six repetitions maximum method was used to assess the training level and the intensity to be used in main training sessions for each athlete. All study procedures were explained to participants, then they read and signed consent form. This study was approved by Hasan Kalyoncu University Ethics Committee for Research on Human Subjects. (Protocol ID; LUT 12/99-24)

Outcome measures

Athletes were asked to dress in a workout outfit, well-hydrated, avoiding vigorous exercises 48 hours before the testing. The testing protocol included the following assessments and methods: Body mass index was calculated as weight in kilograms divided by square of height in meters (kg/m^2). Upper and lower body strength were evaluated with one repetition maximum (1RM) bench press and leg press tests, respectively (19). Flexibility was assessed with sit and reach test, the mean value of three trials was recorded in centimeters (cm). Agility was assessed with 'T-drill' and "Lane-Agility" tests, a handheld stopwatch was used, and the mean value of three trials was recorded in seconds (sec) (19). Speed was assessed via 20 meters (m) sprint test timed using photocells and recorded in sec (Power Timer, New Test Oy, FINLAND). Vertical jump (VJ) was measured with countermovement jump test on an electronic mat (Power Timer, New Test Oy, FINLAND) and the mean of three trials of jump height was recorded in cm (20). The horizontal jump was measured with standing broad jump test and the mean value of three trials was recorded in meters (m) (21).

Intervention

Both groups performed the same warm-up (15 min), stretching and cool-down (10 min) exercises. Directly after the warm-up, FTG conducted specific FT, CG performed routine traditional training. Close supervision and precise monitoring were provided for eliminate any potential mistake during trainings.

The traditional training program consisted of machine and free weight lifting based exercises. The exercises were performed in sitting, standing, prone and supine positions (Table 1). Progression of the load was arranged monthly by 5% for upper body and 10% of total weight lifted for lower body, 3 set repetitions were used and 1 to 3 min. rest intervals were given (22).

The FT program was adapted from the Optimum Performance Training Model (23). The FT program comprised of specific basketball task-related exercises with/without equipment (e.g. exercise mat, swissball, elastic tube band). The FT was designed in 5 phases. The first phase was focused on enhancing spinal stabilization and muscle activation for neuromuscular control. The second and third phases were aimed to develop peripheral muscle strength and intramuscular coordination. The fourth and fifth phases were focused on enhancing the speed of movement, coordination and postural control in dynamic exercises (Tables 2-3). The selected exercise examples from the FT program can be seen in Figures; 1-3.

Table 1. Traditional Training Program with 50-70% Intensity

	Bench Press	Shoulder Press	Lat. Pull Down	Tri-ceps& Biceps	Rowing	Bench Squat	Leg Curl	Abd. Crunch &Back Ext.	Dead Lift	Calf Raise	Box Jump
Rep/ Set	8	10	8	8	8	8	8	10	10	8	8
	10	10	10	10	10	10	10	15	10	10	10
	12	10	12	12	12	12	12	20	10	12	12

Lat: lateral; Ext: extension; Rep: repetition; min; minute; Abd: abdominal

Figure 1. Kneeling position with shoulder rise

Figure 2. Lunge position with upper body rotation.

Figure 3. Stance position with upper body rotation

Statistical Analysis

SPSS (Version 17.0) statistic program was utilized (SPSS, Chicago, IL, USA). The descriptive statistical method was used, and results were presented as mean ± standard deviation. The normality was analyzed with the Kolmogorov-Smirnov test. The pre and post-differences in groups were analyzed using a non-parametric Wilcoxon signed-rank test. Additionally, non-parametric Mann-Whitney U test was used for comparing pre and post differences between groups. P-value was set at $p<0.05$. The effect size was calculated with the Cohen's D formula.

Table 2. Functional training exercises on mat, swissball and loop band.

Mat/Swissball		**Push-Up**	**Abdominal Crunches**	**Jack Knife**	**Hip bridge**	**Russian Twist**	**Planks**
P1	Rep/Set	10 / 2	10 / 2	10 / 2	10 / 3	10 / 2	10 / 2
	Prog	Hands on floor	Hook lying position, raise the chest to knees	Lying on floor, asymmetrical lower legs movement	Hook lying position	Hook lying position and rotation to sides	Forearms on floor
P2	Rep/Set	10 / 2	10 / 2	8 / 3	10 / 3	10 / 2	8 / 3
	Prog	Roll the ball to other hand and push up	Hook lying position, move the chest and legs, closer each other's	Lying on floor, asymmetrical diagonal extremities movement	Hook lying position (with single leg)	Hook lying position and rotation with diagonal pattern	Hands on floor
P3	Rep/Set	10 / 2	10 / 3	8 / 3	6 / 3	8 / 3	8 / 3
	Prog	On swissball	On swissball	On swissball with kettlebell (5 kg)	On swissball (bilaterally)	On swissball with kettlebell (5 kg)	Single leg raise position hands on swissball
P4	Rep/Set	8 / 3	8 / 3	8 / 3	8 / 3	6 / 3	6 / 3
	Prog	Single leg raise position on swissball	Single leg raise position on swissball	On swissball with kettlebells (7 kg)	On swissball (unilateraly)	On swissball with kettlebells (7 kg)	Single leg raise with loop band, hands on floor
P5	Rep/Set	8 / 4	8 / 4	8 / 4	8 / 4	6 / 4	6 / 4
	Prog	Increase rep.	Increase rep.	Increase rep.	Increase rep.	Increase rep.	Increase rep.
Loop band		**Forward Lunge**	**Backward Lunge**	**Side Lunge**	**Cross- Lunge**	**High Knee Pull**	
P1	Rep/Set	15/ 3	15 / 3	15 / 3	---	15 / 3	
	Prog	---	---	---	---	---	
P2	Rep/Set	10 / 4	10 / 4	10 / 4	10 / 4	10 / 4	
	Prog	Increase rep.	Increase rep.	Increase rep.	Increase rep.	Increase rep.	
P3	Rep/Set	10 / 3	10 / 3	10 / 3	10 / 3	---	
	Prog	With ball	With ball jumps	With ball jumps	With ball jumps	---	
		Forward & Backward Lunge Walk	**Stance Walk**	**Slide Close-Out**	**Squat Jump**	**Single Leg Squat Jump**	**Lay-up**
P4	Rep/Set	5 m / 3	5 m / 3	5 m / 3	5 m / 3	---	---
	Prog	Distance increase	Distance increase	Distance increase	Distance increase	---	---
P5	Rep/Set	5 m / 5	5 m / 5	5 m / 5	---	5 m / 5	5 m / 5
	Prog	Dribbling with ball	Dribbling with ball	V- shape dribbling	---	---	---

P: phase; Rep: repetition; Prog: progression; kg: kilogram; m: meter

Table 3. Functional training exercises with elastic band, medicine ball and suspension tool.

Elastic Band		**Upper body rotation**	**Core stabilisation**	**Shoulder Rise**	**Windwill**	**Lay-Up**	**Hands up & Reverse**
P1	Rep/Set	15 / 2	15 / 2	15 / 2	15 / 2	15 / 2	15 / 2
	Prog	With bended arms	Laterally hold the band, wrist flexion and extension	Laterally hold the band, with straighted arms	Clockwise	-----	-----
P2	Rep/Set	15 / 2	15 / 3	15 / 2	15 / 2	15 / 2	15 / 2
	Prog	With straighted arms	Increase rep.	From forward and lateral positions	Clockwise	-----	-----
P3	Rep/Set	15 / 2	15 / 2	15 / 2	15 / 2	15 / 2	15 / 2
	Prog	With bended arms	Wrist flexion and extension	From lateral positions	Clockwise	-----	-----
P4	Rep/Set	15 / 3	15 / 3	15 / 2	15 / 2	15 / 2	15 / 2
	Prog	With straighted arms	Increase rep.	From forward and lateral position	Clockwise	-----	-----
P5	Rep/Set	15 / 3	15 / 4	15 / 2	15 / 2	15 / 2	15 / 2
	Prog	Increase rep.	Increase rep.	Increase rep.	Clockwise& counter clockwise	Increase rep.	Increase rep.
Medicine Ball		**Wood & Reverse Chooper**	**Choops**	**Chest Pass**	**Valslide Lunge**		
P1	Rep/Set	10 / 2	10 / 2	10 / 2	-----	-----	-----
	Prog (kneeling position)	medicine ball (3 kg)	medicine ball (3 kg)	medicine ball (3 kg)	-----	-----	-----
P2	Rep/Set	8 / 3	8 / 3	8 / 3	10 / 2	-----	-----
	Prog (Lunge position)	medicine ball (4 kg)	medicine ball (4 kg)	medicine ball (4 kg)	medicine ball (3 kg) two-direction	-----	-----
P3	Rep/Set	8 / 3	8 / 3	8 / 3	10 / 2	-----	-----
	Prog (Stance position)	medicine ball (5 kg)	medicine ball (5 kg)	medicine ball (5 kg)	medicine ball (3 kg) three-direction	-----	-----
P4	Rep/Set	6 / 3	6 / 3	6 / 3	-----	-----	-----
	Prog (Single Leg)	Increase rep.	Increase rep.	Increase rep.	-----	-----	-----
P5	Rep/Set	6 / 4	6 / 4	6 / 4	-----	-----	-----
	Prog (Single Leg)	Increase rep.	Increase rep.	Increase rep.	-----	-----	-----

Suspension Tool		**Push-up**	**Pull-Up**	**T-Row & Fly**	**Squat**	**Single leg squat**	**Triceps &Biceps**	**Calf Raise**	**Hip Raise &Pull**	**Knee Pull**	**Pull Over Back-Side**
P4	Rep/Set	10 / 2	10 / 2	10 / 2	10 / 2	10 / 2	10 / 2	10 / 2	10 / 2	10 / 2	-----
	Prog	Incline	Incline	Incline	-----	One leg behind	Incline	Bilateral	Bilateral	Bilateral & Asym.	-----
P5	Rep/Set	6 / 3	6 / 3	-----	10 / 2	8 / 3	8 / 3	8 / 3	6 / 3	6 / 3	6 / 2
	Prog	Horizontal (Handle & Reverse Unilat.)	Horizontal (Unilat.& bilateral)	-----	Side Squat	İncrease Rep.	İncrease Rep.	Unilat.	Unilat. & Asym.	Unilat. & Asym.	Multi direction

P: phase; Rep: repetition; Prog: progression; kg: kilogram; Unilat: unilaterally; Asym: asymmetrical

RESULTS

Of the 28 initial professional basketball players who completed the study, there was no dropout in any of the groups. The CG athletes were found younger than FTG athletes ($p<0.05$), other physical parameters were found similar ($p>0.05$) (Table 4).

When the pre-test values of the groups were considered, just Lane-agility score was found higher in CG ($p<0.05$), other parameters were found similar ($p>0.05$). When post-test values were compared; T-drill and Lane-agility scores were found lower and Leg-press scores were found higher in FTG ($p<0.05$), other parameters were found similar ($p>0.05$). When the pre and post-test values were compared into groups, there were observed significant improvements in flexibility, VJ, speed, T-drill and Leg-press performances of FTG ($p<0.05$), while there was no significant difference in other parameters ($p>0.05$). In CG, there were significant improvements in speed, Lane-agility and Leg-press performances ($p<0.05$), whereas no significant difference was found in other parameters ($p>0.05$) (Table 5).

Table 4. Pre-testing physical characteristics of athletes, Mean ± SD.

	FTG	CG	z	p
Age (y)	26.64 ± 5.90	22.42 ± 4.18	-2.032	0.042*
Sport age (y)	13.85 ± 5.89	11 ± 4.52	-1.175	0.240
Height (cm)	196.53 ± 10.92	199.28 ± 7.59	-0.460	0.646
Arm span (cm)	200.17 ± 12.47	199.39 ± 8.25	-0.737	0.461
Body mass index (kg/m²)	24.68 ± 1.67	24.45 ± 2.23	-0.130	0.896

** p < .05. FTG: functional training group; CG: control group*

The FTG showed higher performance in the sit-and-reach test distance and VJ height than the CG ($p<0.05$). However, there was no change in the horizontal jump distance ($p>0.05$). The FTG presented better performance in the 20m sprint and T-drill test than the CG ($p<0.05$). The CG presented higher improvement in Lane-agility test than the FTG ($p<0.05$). The FTG increased all strength parameters significantly than the CG ($p<0.05$) (Table 6).

Table 5. Pre and post-testing comparison of athletic performance, Mean ± SD

	FTG			CG		
	Pre-test	**Post-test**	**p**	**Pre-test**	**Post-test**	**p**
Flexibility (cm)	12.46±7.66	13.89±7.70	0.047*	13.21±5.22	13.17±5.56	1.000
Horizontal Jump (cm)	2.52±0.189	2.58±0.23	0.064	2.37±0.21	2.39±0.28	0.181
Vertical Jump (cm)	49.72±7.25	52.27±6.94	0.001*	47.91±6.06	48.80±5.54	0.065
Speed (sec)	3.21±0.122	3.09±0.134	0.005*	3.18±0.22	3.11±0.17	0.005*
T-Drill (sec)	9.27±0.39	8.92±0.39β	0.009*	9.50±0.47	9.41±0.42	0.783
Lane-Agility (sec)	12.07±0.68	11.88±0.74β	0.093	12.74±0.89α	12.47±0.66	0.006*
Bench Press (kg)	106.42±19.15	116.78±17.38	0.001*	103.92±20.77	107.85±18.78	0.013*
Right Leg Press (kg)	107.50±20.26	122.3±16.37β	0.001*	99.64±16.92	109.28±16.39	0.003*
Left Leg Press (kg)	105.71±18.38	119.21±15.79β	0.001*	98.27±14.64	106.71±11.57	0.002*

* p < 0.05, FTG: functional training group; CG: control group α P < 0.05, Significant pre-testing differences between FTG and CG β P < 0.05, Significant post-testing differences between FTG and CG

Table 6. Pre and post-test change and main effect size comparison of the study groups.

	Change	p	d
Flexibility (cm)			
CG	-0,03	0,924	0,02
FTG	1.42*	0,033	0,63
Horizontal Jump (cm)			
CG	0,02	0,964	0,01
FTG	0.06	0,580	0,15

Vertical Jump (cm)			
CG	0,89	0,802	0,06
FTG	2.55*	0,003	0,95
Speed (sec)			
CG	-0,07	0,802	0,42
FTG	-0,12*	0,005	0,91
T-Drill (sec)			
CG	-0,09	0,121	0,44
FTG	-0,35*	0,002	1,04
Lane-Agility (sec)			
CG	-0,27*	0,025	0,67
FTG	-0,18	0,159	0,39
Bench Press (kg)			
CG	3.92	0,401	0,23
FTG	10.35*	0,001	2,83
Right Leg Press (kg)			
CG	9.64*	0,001	0,80
FTG	14.80*	0,001	2,89
Left Leg Press (kg)			
CG	8.44*	0,010	1,41
FTG	13.50*	0,001	2,41

(p <0.05) FTG: functional training group; CG: control group*

DISCUSSION

The results of current study demonstrated that the FT improved following parameters: Upper body strength (9.7%), lower body strength for each side (14%), agility (13%), VJ height (5%) and flexibility (11.5%) compared with the traditional training.

The physical characteristics of an athlete are important predictive factors for the athlete to reach the top level in their sports discipline. Basketball players' physical characteristics and athletic performances of different divisions were found similar in this study, except in age and Lane-agility. These findings were supported by previous studies. Koklu et al. compared the physical fitness characteristics of Turkish professional basketball players by divisions. They did not find significant differences in physical performance among first and second division players, except in VJ and 10m sprint (24). Also, French and Greek first and second division basketball players demonstrated similar physical characteristics and athletic performance (25, 26). We believed that the division differences of our group may not directly affect the study results.

A worthwhile finding in the FTG was the improvement in flexibility test following training. This may be explained by the fact that functional exercises, especially including the hip joint, can improve flexibility in the lumbo-pelvic-hip complex. Also, the dynamic and multiplane movement patterns promote muscular activation and core activation (12, 13) and alter physiological conditions such as raised neuromuscular excitation and neural transmission rate that possibly decrease soft tissue viscosity (27, 28). Therefore, muscles of core act more like springs that function as elastic storage and it is believed that there is an increased capacity of lumbo-pelvic-hip complex. The similar improvements were demonstrated in flexibility after a FT program for older and younger adults (12). Shaikh et al. observed that flexibility was one of the physical fitness components that could improve (23%) through an 8-week-long FT on male college students (29). However, we cannot state that with our data but FT has potential effects or benefits on specific joint's range of motion.

We observed improvement in VJ values of the FTG. This improvement was possibly related with increased lower and upper body strength. We speculate that functional exercises increased the strength of the hip, knee and ankle exten-

sors, thus improved leg-press and VJ performance. Also, the VJ had been assessed with arm swing that may contribute to jumping performance. The upper and lower body movements interact with each other via body linkage system, the capacity of force transferring was enhanced with functional exercises.

Two studies focusing on this topic revealed some improvements in the jump performance of the participants who did functional and unstable exercises with statistical insignificance (30, 31). The insignificant improvement in jumping abilities in these studies could have several reasons. Firstly, their FT program mostly included upper body exercises and secondly, these studies included 5 and 7 weeks of training programs those were possibly not long enough to reveal significant improvements. Prepubertal tennis (14) and senior soccer players (17) showed improvements in VJ performance with long term FT those were compatible with the findings of our study.

Nevertheless, the horizontal jumping performance was not improved in the current study. Professional basketball players are very well accustomed to vertical jumping than horizontal jumping which is not a specific task for basketball. Therefore, it can be assumed that motor coordination and technical performance have a great influence on the outcome of the standing long jump, rather than the explosive strength of the individual (32). We have seen that increase in strength was not concomitant with improvement in a functional task.

Improved agility and decreased elapsed time in the T-drill and 20 m speed test following the FT are other important changes that need to be highlighted. These improvements could be resulted from improved muscular strength, coordination and neural control. Tomljanovic et al. concluded that FT significantly improved postural control and coordination of athletes (30). Muscles communicate and cooperate with each other when training and performing a specific sport task. The proprioceptive and neuromuscular control may be influenced by kinetic chain or cross-linkage system of body. This is the impact of power output on agility performance with high force execution in dynamic movements and postural position which is similar to the T-drill test (33). Kibele and Behm used specific shuttle run test in untrained sedentary people following the FT program (7-weeks) and found no significant improvements in agility (34). Baron et al. found improvements in the parameters of acceleration and velocity (0-15-30 m distance) in young footballers after 12-weeks of training (15). We believe that long-time training adaptation is needed for benefits of the FT, and it is important to achieve a certain quality of movement pattern that is highly related with force and power production.

The evidence of the current study showed that FTG and CG demonstrated significant increase in all strength parameters throughout to study, but FT program demonstrated higher improvements in 1RM bench press and leg press. This could be related to the specificity of our exercises. The FT exercises targeted especially kneeling and standing positions on the basketball court. We did not add an unstable surface to the FT program. The studies show that the addition of an unstable surface at an exercise can decrease the production of muscle strength and thus could potentially decrease the training stimulus and muscle adaptations over time (35, 36).

Previous studies reported similar benefits in the 1RM squat and bench press, supporting the results of the current study (13, 34, 37). The significant improvements in lower body strength (18%) and functional task performance were observed following 12-weeks of functional resistance exercises in older populations (11, 38). However, it was difficult to compare the data of the current study with previous studies found in the literature due to using different exercises, testing batteries, methods and study populations. According to the structure of the body, FT can be divided into the upper, lower, whole body and ration types. A basketball player has a wide range of functional movements from shuffling to layup. Simulating a sport task has different meanings (technical quality, cognitive and physiology) for basketball players than isolated muscle strengthening exercises. It was believed

that this integrity plays an actual role for strength gain.

The main limitation of this study was the non-randomized group assignment. It is difficult to do a randomized study with elite teams due to their management board or coaches because they probably do not let change of their training program in a long term. Therfore, we selected two teams from same club organization. This selection was resulted with division differences between teams. However, pre-testing results showed that there were no differences on skill levels and physical characteristics. On the other hand, if both groups were selected from first division teams, it could be difficult to follow the same training routine and control the teams to perform basketball practice similarly during the 20-weeks.

CONCLUSION

FT could be an alternative exercise training method for improving physical fitness parameters in professional basketball. There were significant improvements in the variables namely strength, flexibility, speed, agility, vertical jumping between pre-test and post-tests. This study demonstrated that FT had significantly improved the selected performance-related physical fitness parameters on professional athletes.

Conflict of interest

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

Financial disclosure

The authors received no financial support for the research and/or publication of this article.

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