EFFECTS OF FIVE WEEKS OF FUNCTIONAL VS. TRADITIONAL RESISTANCE TRAINING ON ANTHROPOMETRIC AND MOTOR PERFORMANCE VARIABLES

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Abstract:

Functional training (FT) refers to exercise training programs designed to imitate the activities and movement patterns that occur in an athlete's characteristic activity. Its purpose is to make training adaptations more specific and applicable. There is a lack of studies on the effects of FT in young and previously trained subjects. The aim of this study was to determine the training-specific effects of FT and traditional strength training (TRT) on a subset of anthropometric measures, explosive strength, agility, and sprint performance in young (22-25 years of age), previously trained male subjects (N=23) that were divided randomly into two groups (FT, n=11; TRT, n=12). The variables included anthropometric measures (body height, body weight, body fat percentage, lean body mass, and total body water), two agility tests (5-10-5 meter shuttle run and the hexagon test – HEXAGON), jumping ability (air time, peak power – PEAKPWR, jump height, ground contact time – GCT), throwing ability tests (standing overarm medicine ball throw (SMB) and lying medicine ball throw), and sprint variables (10m and 20m dash and 10-20m split time results). The training program consisted of three either FT or TRT training sessions per week through 5 weeks. Pre- and post-training intra-group differences were established using the dependent samples *t*-test. The independent samples *t*-test was calculated to detect inter-group differences. Anthropometric variables did not change significantly during the training period. Intra-group comparisons revealed significant improvements in the SMB and HEXAGON values for FT group, whereas TRT significantly improved GCT, PEAKPWR, and HEXAGON performance but decreased achievement in SMB. In conclusion, FT and TRT influenced differently the explosive strength and agility variables. More precisely, the results demonstrated that TRT increased the energetic potential of trained musculature, which resulted in an overall increase in power qualities, while FT improved postural control and precise coordination. Certain limitations of the study are noted.

Key words: *agility, strength, students, hexagon test*

Introduction

Functional training (FT) is a relatively novel form of specific training for fitness. The main idea of FT is mostly referred to as the SAID Principle, which stands for *Specific Adaptation to Imposed Demands*. More precisely, functional exercise training programs should be designed to imitate the activities and movement patterns that occur in an athlete's (person's) characteristic activity (sport, job, etc.), with the purpose to make training adaptations more specific and therefore more applicable. The word "functional" refers to the performance of an action, work, or activity (Weiss, et al., 2010). Although originally developed to prevent and partially cure functional and overall motor deterioration in older adults, the idea and concept of FT is also widely accepted in sports training and conditioning. Brill (2008) defined *functional fitness* as emphasizing multiple muscle and joint activities, combining upper and lower body movements, and utilizing more of the body in each movement. This idea promotes the notion that FT should be designed to improve movement and should include movement-based exercises, thus avoiding focusing exclusively on specific muscular adaptations, as in traditional resistance/strength training (TRT). While TRT approaches have been typically designed to isolate individual muscles using free weights in "supported" and/or stable positions or machine-based training protocols, FT is generally oriented toward the athlete's performance improving goals using unstable exercises and also by trying to improve motor control in sport-specific athlete's tasks.

However, studies that have investigated the effects of FT were mostly focused on older adults and/or persons with specific health problems and rarely included healthy individuals of an advanced fitness level. Briefly, de Vreede, Samson, van Meeteren, Duursma, and Verhaar (2005) concluded that functional-task exercises were more efficient than resistance exercises at improving functional-task performance and should be considered an effective method to help maintain an independent lifestyle of older women. Very similar conclusions were reported by Milton, Porcari, Foster, Gibson, and Udermann (2008). Bale and Strand (2008) indicated that FT of the lower extremities improved physical performance more than traditional training in 18 sub-acute post-stroke patients. Kibele and Behm (2009) studied healthy, younger, but untrained subjects during a 7-week program, and showed that there was no overall difference between unstable and stable resistance training and that the training effects were independent of gender. In a more recent study Sparkes and Behm (2010) concluded that instability resistance training, which reportedly uses lower forces, can increase strength and balance in previously untrained young individuals similarly to the more stable training exercises on machines employing heavier loads. In one of the rare studies that dealt with healthy, relatively trained individuals, Weiss et al. (2010) suggested that both the traditional and functional training programs are equally beneficial for increasing endurance, balance, and traditional measures of strength. However, changes in various girth measures, muscular endurance and flexibility appeared to be program-specific.

From this brief literature review it is evident that there is a lack of studies on the effects of FT in young and previously trained subjects. Moreover, data are scarce for the different effects of FT and TRT training programs on certain specific athletic performance variables, such as jumping, throwing (e.g. explosive strength), agility and/or sprint achievements. Therefore, the aim of the current study was to determine the training-specific effects of FT versus TRT on a subset of anthropometric measures, indicators of explosive strength, agility, and sprint performance in young, previously trained subjects.

Materials and methods

Subjects

The male subjects in this study, who were kinesiology students (N=23, 22-25 years of age), were divided randomly into two groups: the functional training group (FT, n=11) and the traditional resistance/strength training group (TRT, n=12). The subjects self-reported being moderately trained athletes with limited FT experience (i.e. they were familiar with FT exercises but had not participated in any systematic FT). A moderately trained athlete was defined as having lifted weights two to three times per week, having one to two endurance-based exercise sessions per week, and having done so for at least six months. In addition, the subjects reported that they did not take any performance-enhancing drugs and nutritional supplements at the time of the experiment and had no musculoskeletal disorders that would prohibit an exercise testing and training regimen. Although more subjects were involved in the original investigation, in this study we included only those subjects that participated in at least 80% of the training sessions. The subjects were required to abstain from food for at least 3 hours before testing and from strenuous activity on the day of testing. Since we studied young previously trained adults, where no significant deterioration, as well as no significant growth and development-induced changes (i.e. improvement) in the studied variables were expected in this experiment, we did not include a control–passive group.

Variables

The sample of variables included anthropometric measures, two agility variables, explosive strength variables (jumping ability and throwing ability), and sprinting ability variables.

Anthropometric variables

In this study, we included body height (BH) and body mass (BM). BH was measured using a stadiometer (in cm), and BM was measured using a digital scale (in kg). Additionally, using a bioelectrical impedance analysis system (Maltron Body Fat Analyzer; BF-905; Maltron International Ltd.), we measured body fat percentage (BF%, percent of the total BM), total body fat mass (BF, in kg), lean body mass (LBM, in kg), and total body water (H_2O in l).

Agility variables

AG5-10-5: The shuttle-run agility test was included as a measure of the ability to sprint and change direction. The contact mat was used to measure the time. The subjects started the electronic clock when they left the contact mat, sprinting for five meters. At the end of the 5-m section, the subjects reversed their running direction and sprinted back for 10 meters. After the 10-meter section, the subjects sprinted back for five meters (starting position) and stood on the contact mat to stop the electronic clock. The best of three consecutive trials (in one-hundredths of a second) was used for the statistical analysis.

HEXAGON: A hexagon with 61-cm sides and 120-degree angles was marked with a tape on a hard surface floor with a 30.5-cm tape strip in the middle to mark the starting position. The test began with the subject standing on the tape strip placed in the middle of the hexagon (center). The tester gave the command “Ready, go!” and started the stopwatch. On the “Go!” command each participant began to double-leg hop from the center of the hexagon over each side and back to the center in a clockwise direction until the participant went around the hexagon three times and returned to the center (18 jumps). The stopwatch was stopped once the participant was back at the center mark after three revolutions around the hexagon. The participants were required to face the same direction during the course of the test, and the feet could not land on the taped edges of the hexagon or the trial was stopped and restarted. The subject's score (in one-hundredths of a second) was recorded for the fastest time of three trials.

Sprint variables

Sprint variables were measured using timing photo gates (Brower Timing System USA). The subject started on the sound signal, which started the electronic timing system. Two sets of photocells were used, and they were placed at the 10-m and 20-m gates. The timing results from each of the gates were recorded as a result of the SPRINT10, or SPRINT 20, and the numerical difference between the 10- and 20-m results was noted as the SPRINT10-20 result. The subject's score (in one-hundredths of a second) was recorded for the fastest time of three trials.

Explosive strength – throwing ability

SMB: The subjects stood at a line with their feet slightly apart and facing the direction to which the ball should be thrown. They were instructed to perform the overarm throw of the 1-kg medicine ball with their dominant hand. The subjects were permitted to step forward over the line after the ball had been released and were, in fact, encouraged to do so to maximize the distance of the throw. The distance was measured to the closest 0.1 m, and the best of three consecutive trials was recorded.

LMB: The subjects were lying down on their backs and held a 3-kg medicine ball on the floor above their head with the arms fully extended. The shoulders were on the zero-line. The throwing action was similar to that used for a soccer throw-in. The ball was thrown forward as vigorously as possible, while the head was kept on the floor. The best of the consecutive trials was recorded as the final result (to the nearest 0.1 m).

Explosive strength – jumping ability

The Newtest Powertimer System (Newtest Oy, Oulu, Finland) was used. All the subjects performed a countermovement jump (CMJ) without arm swing from the contact mat while being measured for the air time (AIRTIME), peak power (PEAKPWR), jump height (JH), and ground contact time (GCT). As suggested by other authors (Sattler, Sekulic, Hadzic, Uljevic, & Dervisevic, 2011), the best of three consecutive trials, with appropriate rest between them, was used as a final result. In the starting position of the CMJ the subject stood straight with the hands on the hips; then he squatted down rapidly to a 90° knee angle position and jumped up as explosively as possible keeping the hands on his hips. During the ascending phase the subjects had to keep the upper body as erect as possible and they had to land on the contact mat with the balls of the feet keeping their knees straight. AIRTIME and GCT were automatically measured in seconds. JH (in cm) and PEAKPWR (in W) were calculated (JH=9.81 x Flight time^2 /8; PEAKPWR =60.7 x JH + 45.3 body mass (kg) - 2055).

Experimental design

The 5-week training period consisted of 3 training sessions per week. The participants were monitored during training by one of the authors to ensure that full effort was invested in each session. The training warm-up consisted of 10 to 15 minutes of medium-to-sub-maximal intensity aerobic activity on exercise bikes and treadmills. The subjects performed five to ten moderate intensity repetitions of dynamic stretching for the whole body.

The subjects included in the TRT group performed two types of training sessions consecutively. The A session included free-weight squats (to a knee angle of approximately 90 degrees), T-bar rowing, bench press and leg flexion. The B session consisted of free-weight lunges, dead lifts, lat pulldowns, and leg extensions. Four sets of six to ten repetitions each with 80% of 1RM were performed. More precisely, in the first set the subjects did 10 repetitions per exercise, but due to exhaustion, the subjects lifted the applied load (80% of 1RM) six to seven times in the 3rd and the 4th set. Both sessions included three types of stable sit-ups and lumbar hyperextensions.

FT was also organized throughout consecutive A and B sessions. The A session consisted of specific unstable functional exercises, namely: one-leg TRX-squats (Figure 1), suspension rowing (Figure 2), push-ups (Figure 3), and power-wheel leg flexion (Figure 4). The B session included flow-in lunges (Figure 5), one-leg dead lifts, rubber band-assisted pull-ups, and functional one-leg good-mornings (Figure 6). The FT group also differed from the stable resistance training group in that they performed fours trunk stabilization exercises on a Swiss ball. Trunk stabilization exercises included a supine hip extension–knee flexion combination, T-bridge fall-off (with the arms abducted and extended, supine trunk and the knees flexed at a right angle, the shoulders are rolled to the left and right on a Swiss ball), a prone hip and knee flexion combination using both legs, and a prone hip and knee flexion combination using a single leg. The intensity of the FT exercises was self-administered by the participants, but they were asked to perform eight to twelve repetitions (10-15 repetitions for trunk stabilization exercises) using the correct technique, which was controlled by the authors. In summary, the FT group trained with unstable exercises, whereas the TRT group utilized exercises with a stable base, while the training programs were anatomically matched as much as it was possible. Also, both programs mostly included upper-body exercises. This was done because we tried to simulate a realistic situation in competitive sports. Briefly, from our professional experience in most of the team sports (team handball, basketball, volleyball), in-season conditioning period is rarely oriented toward lower extremities, because of the: (1) short duration of the preparation period; and (2) relatively high volume of endurance workouts where lower extremities are mostly engaged. The authors will gladly provide more details for the training program and exercise explanations.

Prior to the inception of training (pre-training), the subjects were tested on anthropometric measures, agility tests, explosive strength (first day), jumping ability and sprinting (second day). Repeated assessments (post-training) were performed on the third and fourth days following a 5-week training protocol (see later text) in the same manner as the pre-training testing.

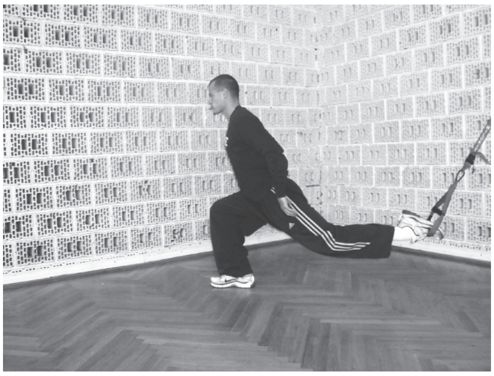

Figure 1. One-leg TRX-squats

Figure 2. TRX suspension rowing

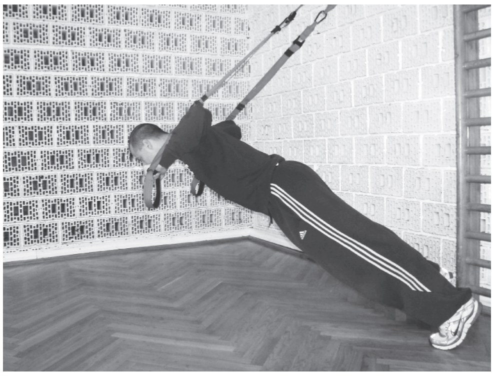

Figure 3. TRX push-ups

Figure 4. Power-wheel leg flexion

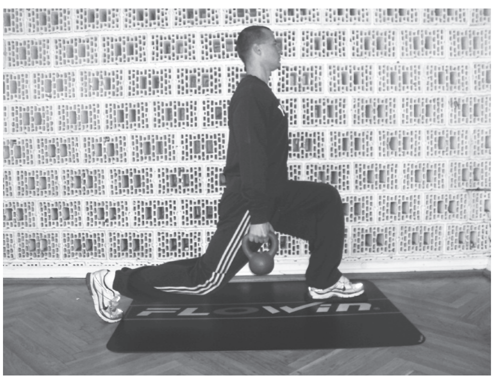

Figure 5. Flow-in lunges

Figure 6. One-leg good morning

Statistical analysis

Statistical analysis included descriptive analyses (means and standard deviations for the sample as a whole, and separately for the FT and TRT) for the pre- and post-training status. The normality of the distribution was tested using Kolmogorov-Smirnov test and it showed an appropriate normality of the distributions for all the studied variables. The reliability of the motor-status variables was calculated prior to the training process by means of the Cronbach Alpha coefficient.

Training effects were analyzed using a two-way analysis of variance (ANOVA) (2 x 2) with repeated measures. Factors included training groups (FT and TRT) and time (pre- and post-training). When the significant ANOVA interactions were found, additional independent *t*-tests were applied to determine inter-groups differences.

All coefficients were considered significant at a level of 95% (p<.05). Statsoft's Statistica version 7.0 was used for all calculations.

Results

The Cronbach Alpha coefficients ranged from .77 (for HEXAGON) to .97 (for the jumping ability parameters), which suggested moderate to high reliability of the tests.

There were no significant overall effects for any of the studied anthropometric variables (Table 1).

Significant ANOVA effects for the measurement (pre-post training effects) were evidenced for one agility variable (HEXAGON), one of the studied throwing ability variables (SMB), and three parameters of the jumping explosive strength (JH, GCT and PEAKPWR). All these measures improved during the course of the study (Table 2).

Significant training group effects were found for GCT and PEAKPWR, where analysis indicated that TRT improved their performance. At the same time, group effects were significant for SMB also, where FT achieved significant improvement (Table 2). Additional independent *t*-test found: (1) significant pre-testing differences between groups

Table 1. Descriptive values for the anthropometric variables (means and standard deviations – SD)

	TOTAL		FUNCTIONAL TRAINING		TRADITIONAL RESISTANCE TRAINING	
	PRE-	POST-	PRE-	POST-	PRE-	POST-
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
BM (kg)	80.61±12.51	81.05±13.11	78.89±12.32	79.29±13.18	82.42±12.92	82.19±13.05
BH (cm)	183.04±8.14	183.21±8.15	179.69±6.39	180.89±6.20	185.00±10.58	185.02±10.93
BF% (%)	16.20±3.78	15.44±3.77	14.12±3.32	15.13±3.95	17.01±4.34	15.76±3.61
BF (kg)	13.01±4.72	12.82±5.02	11.46±5.07	12.30±5.63	14.14±4.37	13.21±4.35
LBM (kg)	67.85±9.01	68.02±9.11	67.41±7.55	66.99±8.11	68.29±10.62	69.21±10.40
H_2O (l)	49.71±6.33	49.96±6.54	49.41±5.47	49.04±5.93	49.97±7.77	50.66±7.07

Table 2. Descriptive values for the motor-performance variables (means and standard deviations – SD), main and specific effects for time

	TOTAL		FUNCTIONAL TRAINING		TRADITIONAL RESISTANCE TRAINING	
	PRE-	POST-	PRE-	POST-	PRE-	POST-
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
AIRTIME (s)	0.60±0.03	0.61±0.03	0.59±0.03	0.61±0.03	0.61±0.05	0.62±0.05
JH (cm)	37.09±6.21	38.34±6.05*	36.93±5.77	37.97±5.85	37.40±6.42	38.76±6.95
GCT (s)	0.59±0.11	0.50±0.16*	0.52±0.16	0.51±0.18	0.64±0.10	0.50±0.15¥
PEAKPWR (W)	1.11±0.41	1.24±0.41*	1.22±0.46	1.25±0.46	0.95±0.21#	1.22±0.35¥
SMB (m)	25.44±4.58	26.01±5.22*	25.32±4.63	27.68±4.40¥	25.55±4.51	24.47±6.28#
LMB (m)	9.82±1.55	10.30±1.64	9.73±1.52	10.07±1.51	9.93±1.59	10.47±1.79
AG 5-10-5 (s)	5.00±0.29	4.91±0.31	4.92±0.32	4.81±0.36	5.18±0.26	5.13±0.41
HEXAGON (s)	11.88±1.01	10.44±0.87*	11.24±1.20	10.24±1.26¥	12.29±0.77	11.65±0.48
SPRINT10 (s)	1.95±0.13	2.00±0.14	1.92±0.13	2.00±0.15	1.98±0.12	2.00±0.12
SPRINT20 (s)	1.37±0.13	1.37±0.12	1.35±0.12	1.38±0.11	1.40±0.13	1.37±0.14
SPRINT10-20(s)	3.33±0.25	3.39±0.24	3.29±0.24	3.39±0.26	3.39±0.24	3.37±0.24

Legend: * significant overall (sample as a whole) pre-post training effects; ¥ significant training group effects; # significant *t*-test inter--groups differences (all at p<.05) for PEAKPWR and GCT (FT dominancy), with no significant post-differences between groups; and (2) significant post-differences for SMB between groups (FT dominancy).

Discussion and conclusions

Anthropometric measures

As presented previously, the anthropometric variables did not change significantly in either the FT or TRT groups. In comparison, Weiss et al. (2010) recently reported a significant increase in body weight and several circumference (girth) measures in the TRT group. However, Weiss and her colleagues did not study the gender-specific effects (e.g. their FT and TRT groups were composed of both men and women). Studies dealing with the metabolic response to FT found an average caloric expenditure of 0.14 kcal/kg per minute of training, which results in an average expenditure of approximately 289 kcal for a 28.5-minute FT session (Lagally, Cordero, Good, Brown, & McCaw, 2009). The mean expenditure in kilocalories per minute for men was 12.0, and this was found to be higher than the caloric expenditure reported in studies examining either traditional resistance exercise (Bloomer, 2005) or circuit weight training (Beckham & Earnest, 2000), which found energy expenditures ranging from five to nine kcal/min. Therefore, our data, showing that the TRT group slightly decreased in body fat while the FT group slightly increased their body fat measure, do not seem logical. Most probably the reason should be sought in the fact that the TRT group we studied included a high-intensity workout in which participants regularly used free weights and performed at least a few sets of six to ten repetitions per training until exhaustion while the cited authors studied circuit weight training (Beckham & Earnest, 2000) and moderate-intensity resistance exercise (Bloomer, 2005). Consequently, we suppose that the caloric expenditure of our TRT group was a somewhat higher than those observed in the studies of our respected colleagues.

Motor status variables

Studies performed thus far have regularly found that traditional weight training improves jumping abilities (Blakey & Southard, 1987; Fatouros, et al., 2000; Hakkinen & Komi, 1985; Wilson, Newton, Murphy, & Humphries, 1993). However, the effects of FT on vertical jumping abilities were rarely studied. In one of the rare studies that dealt with such an objective, Sparkes and Behm (2010) found some improvement tendencies in countermovement jump performance among subjects that performed unstable weight training, but the statistical significance of the pre-to-post differences did not reach an appropriate level. Therefore, our results support their observances regarding the effect of FT on jumping abilities in trained subjects (note that the FT we studied did not improve jumping abilities). We believe that there are two main reasons why the FT group did not improve their jumping abilities. First, our FT mostly included upper-body-exercises (see Methods part). Second, we studied the previously trained subjects that may not have experienced the same degree of stress from instability training as the untrained individuals (see Wahl & Behm, 2008, for more details). As a result of these circumstances, we found no significant change in jumping abilities within the FT group. At the same time, previous studies found that weight training can improve vertical jumping performance, in most cases by 5–15% (Blakey & Southard, 1987; Hakkinen & Komi, 1985; Wilson, et al., 1993). Therefore, it seems that our TRT increased energetic capacities (e.g. the force produced by joints in action), which consequently improved performance in some of the measured jumping parameters.

Several factors have been established as major determinants of power/explosive strength performance, including the force developed by joints in action, the rate of force development (muscle power) produced by the muscles, and the neural coordination of the movement (Fatouros, et al., 2000). Knowing that our FT program consisted of mostly upper-body exercises, it seems that, contrary to jumping abilities, the FT group achieved appropriate training stress for this variable, which allowed them to improve their throwing abilities significantly. This improvement is probably mostly related to the improved neural coordination of the movement. In short, when observing FT exercises more precisely, it is clear that most place special emphasis on postural control and muscular coordination. Because multiple joint action occurs during the SMB test, either in eccentric-concentric contractions throughout the stretch-shortening cycle (the shoulders and trunk regions mostly) and/or to ensure stability of the non-active parts of the locomotor system (the hip and lower body regions), the significant positive effects of our FT on throwing performance is logical.

Agility, as measured by the HEXAGON test, improved significantly in FT only. Kibele and Behm (2009) used 4 x 9m shuttle run test and found no significant improvement in untrained subjects with unstable (i.e. FT) and stable (i.e. TRT) resistance training. When Yaggie and Campbell (2006) studied the effects of balance training performed on BOSU equipment, they found a significant improvement for young, previously trained individuals in the multidirectional zig-zag agility test. However, we must note that Yaggie and Campbell's FT program consisted of balance exercises exclusively, while our FT program consisted of mostly unstable resistance upper-body exercises. Therefore, the improvements in agility were somewhat less likely to be expected in our case. To explain the positive changes in agility measured by the HEXAGON test, we deemed two possible mechanisms as particularly interesting: (a) improved power qualities and (b) enhanced postural control of the subjects. The first possibility relates to the possible influence of power characteristics and their improvement on agility. Explosive strength and power qualities contribute significantly, although not highly, to agility performance (Marković, Sekulić, & Marković, 2007), which is expected for the variables and agility skills in which subjects have to repeatedly apply a high level of force to execute the movement pattern similar to the HEXAGON test. Contrary to that notion, the influence of power and explosive strength is lower for agility performances in which speed qualities prevail (e.g. the unidirectional shuttle-run tests such as AGIL5-10-5). However, this result could explain improvements in the HEXAGON for the TRT group exclusively because only the TRT group changed significantly in power characteristics. The TRT program probably influenced the ability to effectively perform the repeated jumps during the HEXAGON test and, consequently, to achieve better results post-training. The second possible explanation for the improvement of the FT group was enhanced postural control, which is mainly related to neurological adaptations of the proprioceptors and sensory enhancements. Consistent activity and training of the lower extremities may influence reaction time, proprioception, and muscle activation of the crural musculature (Lentell, Katzman, & Walters, 1990; Lephart, Pincivero, & Rozzi, 1998; Lundin, Feuerbach, & Grabiner, 1993). Peroneal muscle reaction time has been examined in multiple research models and disease states, and the loss of reactionary control of the lateral musculature of the crurum is known to be one of the main causes of poor muscle activation, joint motion, and alteration in the pressure center of the foot (Yaggie & Campbell, 2006). Lentell et al. (1990) reported that instability of the ankle is not a result of muscle weakness but is associated with the presence of proprioceptive deficits. These kinematic outcomes result in modifications throughout the kinetic chain that alter the inverse dynamics of the knee and hip. These changes resulted in a delay in the inherent mechanisms and reflex loops used to control posture and balance. Previous studies noted that the training of these muscles, among others, enhances reaction and proprioception of lower extremities and results in improved postural control. During the HEXAGON test, there were two main parameters of efficacy: (a) quick application of force while jumping in and out of the hexagon, and (b) control of kinematic outcomes of explosive multidirectional lateral movements that disrupt postural balance. It is clear that some of the exercises applied throughout FT directly stimulated propriceptive qualities in the knee, hips, and torso leading to enhanced postural control and consequent improvement in the HEXAGON test performance within the FT group.

Study limitations

In conclusion, we have to note some study limitations. First, the study period (training period) was relatively short (only five weeks). Therefore, one can argue that changes in some measures (anthropometric ones mostly) are hardly to be expected as a result of such a short training period. However, the focus of our research was eventual training effects that would suggest the applicability of the training program to competitive sports. Therefore, because (a) in competitive sports athletes are not able to perform the conditioning program for more than a month or so and (b) we intended to observe eventual training-induced changes within a "realistic" time period, we believe that a training period of five weeks is suitable for the purpose of our study. Next, in this study we observed a limited number of variables. However, we studied those variables that are known to be of interest to competitive team sports like football, basketball and/or handball (Šibila, Vuleta, & Pori, 2004; Jones, & Drust 2007; Hucinski, Lapszo, Tymanski, & Zienkiewicz 2007).

Finally, the sample size was relatively small. However, the objective of this study was to provide evidence for changes in previously trained subjects (i.e. athletes). Therefore, the available subjects were limited to subjects of advanced training status that were also highly committed to the investigation and training regime. Additionally, although the sample originally involved more subjects, we have included in this study only those subjects that completed 80% of the training sessions.

Although the study was performed during a short study period and utilized a relatively small sample of subjects, it allows us to highlight some interesting findings. Mainly, it seems that FT and TRT provide different effects on the explosive strength and agility indicators. While TRT increased energetic potential in trained musculature and resulted in an overall increase in power qualities, FT most likely affected postural control. Therefore, the effect of TRT is evident in those variables in which the subjects had to produce force in a short time period (e.g. contact time and peak power indexes during jumping and hexagon agility tests). In addition, the effects of FT can be expected for those performance variables in which overall postural control and precise control of the kinematic outcomes of explosive movements are necessary (e.g. overhand throwing, the hexagon agility test). Therefore, we suggest the use of TRT when participants are able to perform a high-intensity workout (e.g. off-season preparation periods). Meanwhile, the FT program seems to be more appropriate during the competitive season when athletes are not able to control overall training, competitive engagements, and characteristic sport stress.

Because this investigation involved a limited number of performance variables, it would be interesting to include additional motor tests (e.g. static and dynamic balance, and multidirectional agility running tests) in future research. In addition, it is possible that the FT training produced even more significant changes than those we observed here but in postponed phases. Therefore, in forthcoming investigations, it would be interesting to examine the possibility of delayed training effects on specific motor-performance variables induced with functional training.

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EFEKTI 5-TJEDNOG FUNKCIONALNOGA I TRADICIONALNOGA TRENINGA S OPTEREĆENJEM NA ANTROPOMETRIJSKE KARAKTERISTIKE I MOTORIČKE SPOSOBNOSTI

Funkcionalni trening je trenažni program oblikovan tako da imitira aktivnosti i kretne strukture koje se pojavljuju u karakterističnoj sportskoj aktivnosti. Cilj mu je izazvati adaptaciju na trening što specifičniju za sport te zato primjenjiviju u konkretnom sportu. Evidentan je nedostatak znanstvenih studija koje su proučavale efekte funkcionalnoga treninga u mladih, treniranih ispitanika. Cilj je ovoga istraživanja bio utvrditi specifične efekte funkcionalnoga treninga (FT) i tradicionalnoga treninga snage (TTS) na sklopu antropometrijskih varijabli, varijabli eksplozivne snage, agilnosti i na rezultatima sprinta mladih (22-25 godina), prethodno treniranih muških ispitanika (N=23) koji su nasumično bili podijeljeni u dvije grupe (FT, n=11; TTS, n=12). Uzorak varijabli je uključivao varijable antropometrijskih karakteristika (tjelesna visina, tjelesna težina, postotak masnoga tkiva, bezmasna masa i ukupna tjelesna voda), dvije varijable za procjenu agilnosti (5-10-5 metara shuttle run i heksagon test - HEXAGON), varijable za procjenu skakačkih sposobnosti (vrijeme leta, vršna snaga - PEAKPWR, visina skoka i vrijeme kontakta sa tlom - GCT), testove snage tipa bacanja (bacanje medicinske lopte jednom rukom stojeći - SMB, bacanje medicinske lopte iz ležanja) te varijable za procjenu eksplozivne snage tipa sprinta (sprint na 10m i 20m te međuvrijeme trčanja između 10. i 20. metra). Eksperimentalni program treninga trajao je 5 tjedana, a obje grupe provodile su 3 eksperimentalne trenažne jedinice tjedno. Razlike između inicijalnih i finalnih stanja unutar grupa utvrđene su t-testom za zavisne uzorke. Za utvrđivanje razlika između grupa korišten je t-test za nezavisne uzorke. Varijable antropometrijskih karakteristika nisu se statistički značajno promijenile tijekom primjene eksperimentalnog trenažnog programa. Značajni pozitivni efekti uočeni su unutar grupe FT za varijable SMB i HEXAGON, dok su unutar grupe TTS uočeni pozitivni efekti u varijablama GCT, PEAKPWR i HEXAGON, ali i negativni efekti za varijablu SMB. Zaključno, FT i TTS utječu diferencijalno na eksplozivnu snagu i agilnost. TTS povećava energetske potencijale trenirane muskulature, što rezultira ukupnim povećanjem parametara snage, dok FT trening pretežno djeluje na posturalnu kontrolu i poboljšanje koordinacije. Određena ograničenja ovoga istraživanja su zabilježena u članku.

Ključne riječi: *agilnost, snaga, studenti, heksagon test*