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THE EXAMINATION OF THE EFFECTS OF FUNCTIONAL TRAINING PROGRAM APPLIED ON INSTABLE GROUND ON ANAEROBIC CAPACITIES OF ELITE MARTIAL ARTS ATHLETES

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Abstract:
The aim of this study is to measure both dynamic balance of elite martial arts athletes doing functional strength exercises on instable ground and the effects of circuit training program on their anaerobic capacities, and compare them with those following classical training program. Students studying in Faculty of Sport Sciences at Duzce University and doing martial arts (kick box and muay-thai) constituted the study group. In the study conducted in 6 weeks with 24 sessions, while experimental group (EG) included 14 individuals (age: 19.78±1.36, height: 1.68±0.06) control group (CG) included 14 individuals (age: 19.92±2.09, height: 1.67±0.07) similar to those in experimental group. While athletes in EG followed circuit training program including strength exercises on instable ground in 6 weeks with 24 sessions, those in CG followed classical training program. Pre and posttests were applied before and after 6-week training program. First of all, height, weight and bioelectric impedance method was used for body fat rate, RAST test was done to measure agility by using electronic chronometer system with two-gated photocell having measurement in the sensitivity of 0.01, y-balance test battery was used to measure dynamic balance. Data was analyzed with SPSS 18. Collected data, pretest and posttest values of study and control group was analyzed with Wilcoxon test which was in 95 reliability range an significance level was accepted as $p<0.05$. When statistical data was examined, it was found that study group reported significant increments than control group in terms of anaerobic capacity, minimum power output, fatigue index, average power output and dynamic balance ($p<0.05$), while no significant differences were found in terms of other variables. Consequently, it was observed that exercises on instable ground developed dynamic balances of athletes.

It is thought that athletes use required muscle function for balance during movement in the lowest level and this retards fatigue by effecting power output positively.

Keywords: kick box, muay-thai, anaerobic, RAST

1. Introduction

The interest for martial arts such as kick box and muay thai have been increasingly growing recently because of their beneficial effects such as personal protection, developing muscle power and keeping the body in shape (Zazryn et al., 2003). Success of athletes depends on at least 5 factors in martial sports as it is in any sport branch. There are energy capacity, anaerobic and aerobic parts, tactic, technique and motivation. All these factors contain all functional systems occurred during competition and these interactions determine the quality of sport performance.

In fighting sports like kick box, besides technical and tactical trainings, it has been revealed that physical and physiological features such as aerobic and anaerobic power, speed, endurance, body fat, flexibility, coordination and skill are features affecting success (Zabukovec and Tiidus, 1995, Akgün, 1993) and that they require regular intensive exercises because fighting sports require activity in maximal and supramaximal intensity and short recovery during competitions (Crisafulli et al., 2009; Siegler JC and Hirscher K, 2010).

RAST test, which we used in our study, has been adapted from Wingate test measuring peak power, average power, fatigue index, anaerobic power and capacity (Zacharogiannis ve ark., 2004). RAST test includes 6 of 35 maximal sprints with 10-second time outs (Kalva-Filho et al., 2013, Zagatto et al., 2009). It is possible to determine effort power in each sprint with specifying the time of running and body weight (Anaerobic power=(Body weight X distance2) / time3). It is commonly used in practical applications because it is an easy-to-apply method.

Balance is a complex process which the interaction between emotional, visual, proprioceptive (deep feeling), muscle-skeletal and mental systems require (Çulhaoğlu, 2011). Balance, defined as a general concept referring dynamics which prevents body mass falling to ground, is keeping individual’s center of gravity when it varies and stabilizing and maintaining this condition (Zenbilici, 1995). Balance is an important feature to maintain body composition, which is necessary to reach high performance. Thereby, it constitutes the basics of dynamic sport branches including sudden changes in movement patter. All sports have balance factor in certain level (Altay, 2001). Exercises needed to develop proprioception and balance to increase life quality, prevent injuries and develop performance in certain age groups, vestibular system diseases in which balance problems occur, muscular-skeletal diseases and injuries and sport activities have been the research subjects recently (Okudur and Sanioğlu, 2012).

When studies are examined, instable grounds cause body oscillation, in other word, balance lost and muscle activity by restricting sensory and motor feedback loop. This requires an important change in received proprioceptive information capacity, in short, high-level control system (Anderson and Behm, 2005). In literature, it has been stated that prime mover muscles providing stabilization of the body by developing balance ability would decrease; accordingly, these muscles could have contribution as pushing power in activities such as jumping and running (Anderson and Behm, 2004).

With the light of this information, it was aimed in this study to measure both dynamic balance of elite martial arts athletes doing functional strength exercises on instable ground and the effects of circuit training program on their anaerobic capacities, and compare them with those following classical training program.

2. Material and Method

Athletes participated in our study were selected from students doing martial arts sports (kick box and muay-thai) in Faculty of Sport Sciences at Duzce University. . In the study conducted in 6 weeks with 24 sessions, while experimental group (EG) included 14 individuals (age: 19.78±1.36, height: 1.68±0.06) control group (CG) included 14 individuals (age: 19.92±2.09, height: 1.67±0.07) similar to those in experimental group. While athletes in EG followed circuit training program (Annex 1) including strength exercises on instable ground in 6 weeks with 24 sessions, those in CG followed classical training program. Pre- and posttests were applied before and after 6-week training program by the same team in Faculty of Spot Sciences.

First of all, height, weight and bioelectric impedance method was used for body fat rate measurement, and then standard warming procedure was applied (Annex 2), y-balance kit for dynamic balance measurement was used and RAST test (6x35 repeated sprint test) was done to measure agility by using electronic chronometer system with photocell. Blood lactate levels of athletes were measured before and just after RAST test. Data was analyzed with SPSS 18. Collected data, pretest and posttest values of study and control group was analyzed with Wilcoxon test which was in 95 reliability range an significance level was accepted as $p<0.05$.

3. Results

Table 1: Descriptive statistics of experimental and control group

Groups	Parameters	N	Mean	SD
Experimental group	Age (year)	14	19.78	1.36
	Height (m)	14	1.68	.06
Control group	Age (year)	14	19.92	2.09
	Height (m)	14	1.67	.07

N=Number of participants, SD=Standard Deviation

When table 1 is examined, it is seen that experimental group (EG) includes 14 individual (age:19.78±1.36, height: 1.68±0.06) while control group (CG) consists of 14 individuals (age:19.92±2.09, height: 1.67±0.07) similar to EG.

Table 2: Comparison of pre and posttest values of experimental group variables

Parameters	Tests	Mean	N	SD	Z	p
Weight (kg)	Pretest	64.76	14	8.85	-2.273	**.023****
	Post test	63.82	14	8.35		
Body fat (%)	Pretest	19.33	14	7.16	-3.078	**.002***
	Post test	17.68	14	6.43		
% Y Balance dominant	Pretest	76.43	14	14.92	-3.296	**.001***
	Post test	98.56	14	13.74		
% Y Balance non-dominant	Pretest	74.43	14	13.29	-3.296	**.001***
	Post test	96.03	14	10.38		
Anaerobic Capacity	Pretest	2125.11	14	763.28	-3.296	**.001***
	Post test	2236.41	14	798.02		
Maximal Power Output	Pretest	474.65	14	184.70	-.973	.331
	Post test	480.74	14	182.60		
Minimum Power Output	Pretest	249.71	14	81.10	-2.919	**.004***
	Post test	277.22	14	92.71		
Fatigue Index	Pretest	6.22	14	3.52	-2.605	**.009***
	Post test	5.77	14	3.29		
Lactate 1	Pretest	1.57	14	.34	-.771	.441
	Post test	1.54	14	.36		
Lactate 2	Pretest	8.99	14	2.71	-2.866	**.004***
	Post test	8.15	14	1.83		
Average Power Output	Pretest	354.18	14	127.21	-3.296	**.001***
	Post test	372.73	14	133.00		
Relative Peak Power	Pretest	7.22	14	2.25	-2.229	**.026****
	Post test	7.45	14	2.41		

N= Number of participants, SD=Standard Deviation, P=Significance level, * ($p<0.01$), ** ($p<0.05$).

When table 2 is examined, it is seen that no significant difference exists in terms of other variables (p>0.05) while significant differences have been found pretest and posttest scores of experimental group in terms of weight, body fat, y balance dominant leg, y balance non-dominant leg, anaerobic capacity, minimum power output, fatigue index, lactate 2, average power output, relative peak power (p<0.05).

Table 3: Comparison of pretest and posttest values of control group variables

Parameters	Tests	Mean	N	SD	Z	p
Weight (kg)	Pretest	65.21	14	8.47	-.734	.463
	Post test	65.05	14	8.82		
Body fat (%)	Pretest	19.65	14	8.51	-.421	.674
	Post test	19.53	14	8.17		
% Y Balance dominant leg	Pretest	78.90	14	13.27	-2.919	.004*
	Post test	87.08	14	9.75		
% Y Balance non-dominant leg	Pretest	77.78	14	14.60	-2.291	**.022****
	Post test	86.46	14	8.43		
Anaerobic Capacity	Pretest	1957.18	14	852.38	-.408	.683
	Post test	1961.34	14	849.23		
Maximal Power Output	Pretest	432.91	14	169.15	-.157	.875
	Post test	439.83	14	186.38		
Minimum Power Output	Pretest	232.13	14	117.62	-.910	.363
	Post test	232.59	14	115.07		
Fatigue Index	Pretest	5.30	14	2.43	-.910	.363
	Post test	5.51	14	2.75		
Lactate 1	Pretest	1.40	14	.37	-1.031	.303
	Post test	1.46	14	.28		
Lactate 2	Pretest	7.95	14	1.52	-1.226	.220
	Post test	8.20	14	1.32		
Average Power Output	Pretest	326.19	14	142.06	-.408[c]	.683
	Post test	326.89	14	141.53		
Relative Peak Power	Pretest	6.50	14	1.98	-1.083	.279
	Post test	6.59	14	2.11		

N= Number of participants, SD=Standard Deviation, P=Significance level, * (p<0.01), ** (p<0.05).

In table 3, it is seen that no significant difference exists in terms of other variables (p>0.05) while significant differences have been found between pretest and posttest scores of control group in terms of y balance dominant leg and y balance non-dominant leg (p<0.05).

Table 4: Comparison of pretest and posttest differences of experimental and control group

Parameters	Groups	N	X	SD	Z	P	Cd	ES
Weight (kg)	Experimental	14	-.94	1.44	-1.104	.285	0.59	0.28
	Control	14	-.16	1.16				
Body fat (%)	Experimental	14	-1.65	1.82	-2.372	**.016***	1.08	0.47
	Control	14	-.12	.81				
% Y Balance dominant leg	Experimental	14	22.13	10.04	-3.170	**.001***	1.53	0.60
	Control	14	8.18	8.08				
% Y Balance non-dominant leg	Experimental	14	21.60	9.34	-2.711	**.006***	1.29	0.54
	Control	14	8.67	10.53				
Anaerobic Capacity	Experimental	14	111.29	69.20	.2.527	**.011***	0.96	0.43
	Control	14	4.15	140.81				
Maximal Power Output	Experimental	14	6.08	21.16	-.322	.769	0.028	0.014
	Control	14	6.91	36.03				
Minimum Power Output	Experimental	14	27.50	26.26	-2.481	**.012***	0.99	0.44
	Control	14	.45	28.14				
Fatigue Index	Experimental	14	-.45	.62	-2.757	**0.05***	0.37	0.18
	Control	14	.21	.67				
Lactate 1	Experimental	14	7.41	2.86	-.644	.541	0.37	0.18
	Control	14	6.54	1.64				
Lactate 2	Experimental	14	6.61	1.98	-.276	.804	0.076	0.038
	Control	14	6.74	1.37				
Average Power Output	Experimental	14	18.54	11.53	-2.527	**.011***	0.96	0.43
	Control	14	.69	23.46				
Relative Peak Power	Experimental	14	.23	.33	-1.332	.194	0.39	0.19
	Control	14	.09	.37				

N= Number of participants, SD=Standard Deviation, P=Significance level, Cd= Cohen's d, ES= Effects Size
* ($p<0.01$), **($p<0.05$).

In table 4, significant differences have been found between experimental and control groups in terms of body fat, y balance dominant leg, y balance non-dominant leg, anaerobic capacity, minimum power output, fatigue index average power output ($p<0.05$).

4. Discussion and Conclusion

Although there are limited studies related to kick box in literature, shape of applied movement and activities are supported by balance exercises with full body. Besides quick and interactive movements of body and body parts, it includes intensive exercises, activities forcing visual and emotional systems (Whipple, 1997). The other potential benefits of kick box contain enhancing aerobic and anaerobic energy systems and handle deficit of muscle power (Chung et al. 2008; Crisafulli, 2009).

When pretests and posttests are evaluated, athletes have reported statistically significant increments in terms of anaerobic capacity, minimum power output, fatigue index, average power output and dynamic balance scores when compared to those in control group ($p<0.05$).

Collecting data of test results has become commonly used method by athletes and coaches to understand what level athletes should and can reach (Zorba, 1999). It was found that athletes exercised on instable grounds reported better development than control group in terms of dynamic balance of dominant and non-dominant leg although pretest and posttest results in dynamic balance scores of athletes in control group displayed statistically significant differences in our study. In a related study, Jackson et al. (2012) increased the effects of kick box training on balance and mobility impairments and showed that kick box branch was an applicable activity to remedy balance and mobility impairments of individuals.

In another supportive study, Filipa et al. (2010) suggested that the development, observed in both legs after neuromuscular trainings, was statistically significant. In one of the similar studies, Holm et al. (2004) conducted a study, in which 35 elite handball players having age mean of 23 years old and they followed a 5-session training program applied 3 days for 7 weeks in preseason, then 1 day in a week during the season from easy to difficult, used balance mat and board in addition to training they did in normal ground. As a result of measurement done before participating neuromuscular training program, after 8 weeks and a year, researchers observed significant development in dynamic balances abilities of handball players. According to results, while an increment of 15.8% was observed in dynamic balance of experimental group after 8 week, another increment of 6.3% was observed after a year with the learning effect continued. The results of Holm et al. (2004) support our findings. In another study, Myer et al. (2004) suggest that development in balance ability increases stability, functional and sport performance. In contrast with these studies, according to Willardson (2004), any materials such as stability ball, foam roll or balance board exterior to accustomed movements can discompose neuromuscular processing and this can result in negative transfer and reduction in performance. Similarly, according to Kibele and Behm (2009), typical static equipment (i.e. Swedish ball, balance boards) cannot match to training dynamics, especially to sport performance.

In literature, anaerobic metabolisms of elite kick boxers have been examined in limited studies. Like Muay Thai and boxing, because kick box is a sport which requires activity in maximal and supramaximal intensity and short recovery during competitions, it has physical demand containing regular intensive exercises (Crisafulli et al. 2009; Siegler JC and Hirscher K. 2010). Kick box competitions require agility, speed and strength. Additionally, kick box athletes use various jump techniques that is characterized with plyometric drills including anaerobic power to hit the opponent and move (Allen et al., 2008).

Wingate test, which is used to confirm validities of test applied to measure sport-related anaerobic power and capacity (Queiroga et al., 2013, Zagatto et al., 2009), RAST test, which has significant high-level relationship with Wingate, have been used (Adamczyk, 2011, Zagatto et al., 2009) in our study.

Without additional resistance training, by itself, development in balance ability may enhance performance in activities, require explosive power. Despite of this, followed training programs focus on developing explosive power vertically and horizontally, limited studies in literature examine falling techniques to take a powerful balance position to make the next move (Chaouachi 2014). It was stated that fighting sport athletes had high anaerobic power and capacity, medium aerobic capacity and good knee extension strength in literature (Zabukovec ve Tiidus, 1995). Functional awareness based on support is needed to redress the balance, accordingly adaptation is provided to changing gravity center (Yaggie and Campbell 2006). The purpose of balance training is to ease neuromuscular ability, preparation and reaction by developing balance in the situation of impaired muscular-skeletal system (Laskowski et al., 1997).

With the results of RAST test in our study, it was found that experimental group who followed training program forcing neuromuscular system thorough neuromuscular exercises on instable ground reported significant development than control group in terms of anaerobic capacity, minimum power output, fatigue index, average power output.

Ouergui et al. (2014) found that significant increments in estimated compulsion, blood lactate level and heart rate after a kick box competition, and they showed that even a kick box competition was efficiency to push anaerobic metabolism. Thus, they stated that training programs should be designed to work anaerobic energy systems for lower and upper extremity and revealed that important development occurred in aerobic capacity, anaerobic fitness and agility performance after 5-week kick box trainings.

In a similar study, Crisafulli et al. (2009) evaluated the aerobic and anaerobic metabolism changing during a fighting simulation. Authors stated that Muay Thai branch had aerobic and anaerobic effects in high level according to CO2 carbon dioxide production, O2 consumption and heart rate after competition.

Consequently, it has been found that exercises done on instable ground had impact on dynamic balances of athletes. In this condition, it is thought that athletes' features such as agility and power output are affected positively and these exercises help athletes to use their power more economically in fighting sports requiring intensive effort.

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Appendix 1

Table 5: Training Program

	1week	**2week**	**3week**	**4week**	**5week**	**6week**
Punch the boxing hand target pad on the bosu	20 sec	20 sec	20 sec			
Kick the boxing hand target pad on the bosu	20 sec	20 sec	20 sec			
Trampoline jumps	20 sec	20 sec	20 sec			
Squat on bosu	20 sec	20 sec	20 sec			
Y-balance single leg reaching on gym mat	20 sec	20 sec	20 sec	30 sec	30 sec	30 sec
Agility ladder running on gym mat	20 sec	20 sec	20 sec	30 sec	30 sec	30 sec
Spin movement with bulgarian-bag on bosuball	20 sec	20 sec	20 sec	30 sec	30 sec	30 sec
Battle ropes training on bosuball	20 sec	20 sec	20 sec	30 sec	30 sec	30 sec
Push up on gym mat				30 sec	30 sec	30 sec
Throw a medicine ball on gym mat				30 sec	30 sec	30 sec
High knee pull on bosuball				30 sec	30 sec	30 sec
Single leg jumps on four directions on bosuball (Forward-backward-left-right)				30 sec	30 sec	30 sec