GLOBAL QUANTITATIVE DIFFERENCES OF MOTOR ABILITIES BETWEEN TWO GROUPS OF STUDENTS AFTER 12-WEEK FITNESS PROGRAM

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Abstract
The aim of the study was to find out global quantitative differences of motor abilities between two groups, an experimental group that have done 12 weeks fitness program and a control group that finished one semester of regular faculty program without any extra physical activity. All participants were health sport faculty male students with ages 19 ± 1. The experimental program included a three times work out per week, two times resistance, weight training and once a week plyometrics training). In order to detect potential differences between the groups we conducted two discriminant analyses; one on data we got from the first assessment and the other on data we got from the second examination. The obtained results show that there were not any significant differences between the groups at the initial assessment, but there were significant differences at the final assessment. One statistically significant discriminant function has been obtained at the final assessment. The values of canonical correlation are pretty high, which is to say that eighteen motor tests make very good difference between two groups. The tests of hands segmental speed, repetitive strength of a trunk, static strength of hands and legs and explosive power of lower limbs are variables that make the most significant difference between the groups. We can say that 12 weeks fitness program, a combination of resistance and plyometric training, has made a positive transformation of motor abilities of the experimental group participants so that made statistically significant differences between the groups. We think that this kind of fitness program should be a part of regular faculty program, so it would increase students' motor capacities and help them to easily pass through all faculty tasks.

Key words: *motor abilities, weight and plyometric training, canonical discriminant analysis*

Introduction

A purpose of exercise training is an adaptation, so a body can handle it easily next time when the same exercise is applied. An exercise is a stress that body needs to deal with. As long as the stress is sufficient, what means higher / stronger than previous one, an adaptation will occur, but also if the stress is physically powerful; we can expect injury or over-training. So it is very important to optimize and rationalize our training programs in order to achieve the best results in shorter time, but to avoid unwanted effects. The exercise's volume and intensity level have to be adjusted according to an individual needs and established on initial assessment we have done before. Also, an appropriate choice of exercise will contribute better results. We always choose exercises according to sport or activity specificity. According to previous research carried out by (Ford et al., 1983; Blakey & Southard, 1987; Adams et al., 1992; Anderst et al., 1994; Robinson et al., 1995; Lyttle et al., 1996; Đug, 2005; Mujezinović, 2008), who investigated effects of different types of strength training (weight training, resistance training and isometric training) on power, speed and strength enhancement, we conducted this study trying to check effects of our program that have been designed as combination of two work regimes, resistance training with weights and plyometric training. „When we mix weight training and plyometrics the purpose is the enhancement of speed - strength. We are concerned not just with the application of force, but the rate of force development. Speed strength deals with the "amount of internal strength which the neuro-muscular (the body's electrical system) is able to mobilize per unit of time". Hartmann and Tunnemann's definition of strength training it is defined as "a person's capacity to use muscular activity (enhanced by the use of weights) to exert resistance on external forces in order to overcome these forces. Weight training has become an irreplaceable part of each strength training and it is included in programs of many sports, especially in sports where strength and power are dominant factors for achieving good results. Weight training is the best way to enhance strength and muscular hypertrophy. It is very important to know what intensity, number of repetitions and series are suitable for development of different types of strength and suitable for different kind of population. This research was conducted on novices who weren't familiar with the realized program, so we adjusted the training program to their fitness level.

"Training loads characterized by one to three series, with eight to twelve repetitions, intensities of 70 to 85% of 1MR and pauses between one and two minutes, correspond to the recommendations for muscular hypertrophy training with amateur / intermediate individuals". The other part of the program we applied had been designed to be performed in plyometrics regime that refers to human movement that involves an eccentric muscle contraction immediately and rapidly followed by a concentric contraction. Plyometrics is a type of exercise training designed to produce fast, powerful movements (jumps, sprints, throws...), and improve the functions of the nervous system. Applying the program we tried to compare two groups, an experimental that accomplished the 12-week program and a control that did just regular faculty program.

Methods

Seventy two actually healthy college male students with ages 19 ± 1 year participated in this study. They were divided in two groups; an experimental group with 36 entities and a control group which also included 36 entities. Conducting a survey of participants' off campus physical activities, we didn't detect any activity (like jogging, hiking, cycling, skating etc.) that can be a reason of variability. All of them had shorter or longer history of physical activity participation, but during the study, probably because of their college duties, they were not included in any organised sport activity except those related with the research. Only participants who had hundred percent of training session attendance have been considered in examination. Also, according to the survey it wasn't possible to register any specific nutrition habits, but those that are usual for cultural milieu. The both groups were tested two times, once at an initial testing session and the other time 12 weeks after the first assessment at a final testing. We tested both group by eighteen motor tests. The tests were chosen in that way to cover six hypothetical motor ability dimensions. Each area was covered by three tests: segmental speed: (MBFTAPF - arm plate tapping, MBFTANF – a foot plate tapping , and MBFTAZF – a foot tapping on a wall), flexibility (MFLBOSF – a side leg stretch , MFLISKF – a stick inversion, and MFLPRKF – a sit and reach), explosive power: (MFESSVMF – a vertical jump, MFETROF – a triple jump, and MFEBMLF – a medicine ball toss), repetitive strength: (MRESKLF – press ups, MREPTLF – sit ups, and MRCZTLF – a back extension), static strength (MSLIZPF –a squat position maintenance, MSAVIS – a bent-arm hang, and MSCHILF – a horizontal maintenance) and agility and total body coordination: (MAGKUSF - 4 meters shuffle steps, MAGTUPF –a zig-zag test, and MAGOSSF – a bending down eight figure running).

Experimental program

The control group participated only in a regular faculty program during one university semester, which include practical parts of sport subjects as (handball, athletics and football), while the experimental group participated in a regular physical exercise program and an extra fitness program which included a three times work out per week (two times resistance, weight training and once per week plyometric training). The experimental group participants were also tested in a gym in order to get their the 1RM - 1 maximum repetition in 16 exercises (bench press, squat, hang clean, leg press, step ups, leg extension, leg curl, leg adduction and abduction, back extension, sit ups, sitting military press, triceps press downs, lat pull-downs, barbell upright row, standing curl bar curls.). Before every training session they had 15 minutes warm up. Based on 1RM of tested exercises we designed a weight training program and determined a training load. Because the most participants were not familiar with weight training we used training principles for beginners. As we can see from the table 1 that training load were linearly increased from week to week as the participants improved their strength. First two weeks was anatomy adaptation of musculoskeletal system to weight training. During that period participants were learning weight training techniques and principles. Next four weeks they worked on muscular endurance and hypertrophy. The rest of weight program was designed to develop muscular hypertrophy and maximal power.

The plyometric training was realised in a sport hall of the faculty. It is used to develop maximal power. The first two weeks was adaptation to this kind of a high intensity activity. It included twenty minutes of warm up and several of low-intensity plyometric exercises as double-leg jumps in place, running in place, skipping rope and side to side jumps over a small barrier. As the program was approaching to the end, exercises were shorter, but more intense. We used different height depth jumps and different weight medical balls in order to control the exercise intensity.

Results

To find out possible differences (what was actually a goal of the study) between the groups after 12-week fitness program we conducted canonical discriminant analysis on data we have got on final testing.

Table 1. Program parameters

SERIE NUMBER	REPETITION / LOAD %	I-II WEEK	III-IV WEEK	V-VI WEEK	VII-VIII WEEK	IX-X WEEK	XI-XII WEEK
SERIE I	REPETITION	14-16	14	14	14	12	12
	LOAD %	40-50 %	50%	50%	50%	60%	60%
SERIE II	REPETITION	14-16	10-12	10-12	10-12	8-10	8-10
	LOAD %	40-50 %	60 %	60 %	60 %	70%	70%
SERIE III	REPETITION	10-12	10-12	10-12	10-12	8-10	4-5
	LOAD %	60%	60 %	60 %	60 %	70%	80-90%
SERIE IV	REPETITION		8-10	8-10	8-10	4-5	4-5
	LOAD %		70%	70%	70%	80-90%	80-90%
SERIE V	REPETITION			8-10	8-10	4-5	2-3
	LOAD %			70%	70%	80-90%	90-95%
SERIE VI	REPETITION				4-5	2-3	2-3
	LOAD %				80-90%	90-95%	90-95%

The analysis is usually used to investigate differences between groups and to determine the most parsimonious way to distinguish between groups, as well as to discard variables which are little related to group distinctions. It is more superior then some other analyses because it doesn't have any limitations regarding number of variables and groups, and also it deals with global differences (all variables) and in same time takes care of variables' inter correlations. To be sure that there hadn't been any significant differences (in tested motor variables) between the groups at the initial testing we also used canonical discriminant analysis. The results from tables 2 and 3 shows that there hasn't been obtained a statistically significant (.085) discriminant function on initial assessment, but there was one statistically significant (.019) discriminant function obtained on final testing. The value of the canonical correlation of the second analysis is pretty high, so we can say that, based on eighteen motor tests we used in this research, we can discriminate the groups. The canonical correlation value is 0.647 so that 0.647 x 0.647 x 100 = 41.86% of the variance in the discriminant function scores can be explained by groups' differences.

Table 2. Eigenvalues

Function	Eigenv	Canonical
INITIAL	.523[a]	.586
FINAL	.719[a]	**.647**

Table 3. Significance

Wilks' Lambda

Measur.	Wilks' L	Chi-2	df	Sig.
INITIAL	.657	25.449	17	**.085**
FINAL	.582	32.488	18	**.019**

The results from table 3 show the position of group centroids at the function of eighteen motor tests. The positive pole is represented by the experimental group and negative pole by the control group.

Table 4. Group centroids

Functions at Group Centroids

GROUP	Function 1
1 (control group)	-.847
2 (exp. group)	.824

The positive pole is defined by variables for segmental speed (MBFTAPF, MBFTANF), explosive power (MFETROF), repetitive strength (MREPTLF) and static strength (MSLIZPF, MSAVIS) estimation, while negative pole is defined by variables for agility estimation (MAGKUSF, MAGTUPF, MAGOSSF).

Table 5. Structure matrix

THE STRUCTURE MATRIX
(THE FINAL ASSESSMENT)

GROUP	VARIABLES	FUNCTION 1
EXPERIMENTAL GROUP	MBFTAPF	**.512**
	MSAVISF	**.463**
	MSLIZPF	**.397**
	MREPTLF	**.309**
	MFETROF	**.269**
	MBFTANF	**.206**
	MRESKLF	.198
	MFESSVMF	.172
	MFEBMLF	.160
	MFLBOSF	.098
	MBFTAZF	.097
	MFLPRKF	.056
	MFLISKF	.030
	MSCHILF	.023
CONTROL GROUP	MAGKUSF	**-.245**
	MAGOSSF	**-.234**
	MAGTUPF	-.134
	MRCZTLF	-.067

Discussion

We tested the hypothesis that 12-week combined resistance and plyometric training would create differences between tested groups, respectively, greater improvements in motor abilities in the experimental group, than in the control group, that have done only regular faculty programme.

The hypothesis is confirmed, what is obvious according to the obtained results. In point of fact, there are significant differences between the groups, which weren't a case at baseline. The revealed differences can be attributed to the applied fitness program, because the both groups had a same, controlled environment, what is comprehensible from the participants' survey report. As we mentioned, we set up our study based on previous research conducted by Adams et al., 1992; Ford et al., 1983; Blakey et al., 1987. They all reported about 15 % improvement in lower limbs power, tested by vertical jump, speed and acceleration ability improvement per 3-4%, in group that carried out the combined training. After the inspection of obtained results it is obvious that the experimental group shows more superior values in all tested variables. Although, control group is represented by negative pole that does not mean that control group is better in the negative pole variables, because the variables are characterized by time, so that means the lower values mean better results. We can say that applied fitness programme has made significant differences between examined groups. The highest difference between the groups corresponds to variable for upper limbs speed estimation (MBFTAPF – arm plate tapping). We think that a hand's strength enhancement has contributed upper limbs' speed improvement. The other two motor abilities that have been affected by the programme are static and repetitive strength assessed by variables: MSAVISF, MSLIZPF, and MREPTLF. Although these abilities are predisposed to be transformed because of their low hereditary, they are changed for the reason that the weight training design, especially its first part when participants had to deal with smaller loads and big number of exercise's series and number of repetitions. Also, variables MFETROF (triple jump), MAGKUSF (4 meters shuffle steps), MAGOSSF (eight figure running with bending down), for explosive power of lower limbs and agility assessment, have contributed to group discrimination. According to previous research mixing weight training and plyometrics enhances speed and strength. That is obvious in our case where participants improved their legs' explosive power and functional coordination of whole body and agility.

There are no any significant differences in flexibility tests between groups, most likely, because the groups prior to training sessions performed static stretching, so this kind of warm up probably increased flexibility in both groups, and made no differences at final testing. Although, a traditional opinion is that weight training products a loss of flexibility, results from our research do not suggest that, for the reason that there are not differences between groups.

Conclusion

As we assumed, the obtained results shows differences in motor capacity between the groups after the 12-week fitness program have been realised. The biggest differences are made in variables for estimation of segmental speed, explosive power, as well as agility, repetitive and static strength. Mixing the two programs produced significant enhancement in different realisation of strength and power. As it expected, the applied programme highly affected those abilities that are low genetically conditioned; static and repetitive strength. According to initial testing, we fixed the program intensity and extensity. Individualizing the program to student's needs we followed some of basics fitness conditioning principles. As it evident, conducting this research we confirmed some previous investigations on same topic. Combining the different fitness programs we succeeded in motor capacity transformation. This kind of programme is not hard to realise and its effects are respectable. We think the program we applied on experimental group should be an irreplaceable part of regular program for first year students of sport faculty. This program can definitely help them to improve their motor capacities and consequently to easily pass all, not so effortless, faculty tasks. It would be excellent if we had opportunity to extend the program through all faculty years with appropriate progression in order to "fabricate" mentally and physically prepared men for future work and life. In addition, there is a lot of space for future researchers to conduct similar investigations, but with more experimental groups that would perform different types of fitness programs, in order to find out which of accomplished programs is more effective.

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GLOBALNE KVANTITATIVNE RAZLIKE MOTORIČKIH SPOSOBNOSTI DVIJU GRUPA STUDENATA NAKON 12-TJEDNOG FITNESS PROGRAMA

Sažetak

Cilj ovog rada je bio utvrđivanje globalne kvantitativne razlike između dvije grupe ispitanika; eksperimentalne grupe koja je realizirala dvanaestotjedni fitness program i kontrolne grupe koja je participirala samo u redovitom fakultetskom programu bez dodatnih tjelesnih aktivnosti. Ispitanici su bili zdravi studenti muškog spola starosti 19±1 g. Eksperimentalni program je uključivao dva treninga snage sa utezima i jedan pliometrijski trening tjedno. Kanonička diskriminativna analiza je korištena na podacima iz inicijalnog i finalnog mjerenja. Dobiveni podaci pokazuju da inicijalno nije bilo statistički značajnih razlika, dok je finalno dobivena jedna statistički značajna diskriminativna funkcija. Kanonička korelacija je visoka, što upućuje na to da je moguća distinkcija među grupama temeljem motoričkih testova. Testovi segmentarne brzine ruku, repetitivne snage trupa, te statičke i eksplozivne snage gornjih i donjih ekstremiteta su varijable koje statistički najviše doprinose razlikovanju grupa u korist eksperimentalne grupe. Prema tome, možemo reći da je primjenjeni tromjesečni program proizveo pozitivne transformacije motoričkih kapaciteta kod entiteta eksperimentalne grupe. Za pretpostaviti je da bi ovakva vrsta fitness programa trebala postati sastavni dio redovitog programa nastave na Fakultetu za tjelesni odgoj i sport kako bi povećao motoričke kapacitete studenata te im olakšao ispunjavanje fakultetskih zadataka i obaveza.

Ključne riječi: *motoričke sposobnosti, fitness program, kanonička diskriminativna analiza*

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