

## THE EFFECTS OF RECREATIONAL ACTIVITIES WITH VOLLEYBALL AND SWIMMING CONTENTS ON THE ANTHROPOMETRIC CHARACTERISTICS AND FUNCTIONAL ABILITIES OF STUDENTS

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The basic aim of this experimental research was to study the effectiveness of recreational programs with volleyball and swimming contents. It was carried out on a sample of 368 male students of the University of Niš, which were divided into 3 sub-samples; 115 subjects were part of an experimental group which trained volleyball contents, 126 made up the experimental group which trained swimming contents and 127 were part of the control group.

By using two different programs of recreational exercise in the training of the experimental groups, an increase in their functional abilities occurred, especially in the case of the experimental group which trained using recreational contents from volleyball. A more significant increase in maximal anaerobic ability and relative and absolute maximal oxygen uptake was determined for the experimental group which trained using contents from volleyball; therefore, the use of this type of exercise in the training aimed at their development is justified. In the case of the other experimental group, a significant increase in vital lung capacity was noted.

When it comes to circular measurements of the body and fatty tissue, a difference was noted in the decrease of fatty tissue and body weight for the experimental group in relation to the control one, and a simultaneous increase in circular measurements, which is the consequence of an increase in muscle tissue at the expense of fatty tissue. For the control group, an increase in circular measurements was noted, at the expense of fatty tissue.

*Keywords: Recreational programs, experiment, functional abilities, anthropometric measurements, male students.*

### INTRODUCTION

Today, under the conditions of modern living and work, static work loads dominate, along with a very small engagement of the locomotor apparatus, which is why negative influences on the human body occur. The human body represents a uniquely organized whole, comprised of a row of dimensions of the psychosomatic status. That both the positive and negative changes to these dimensions are influenced by a large number of factors has been proven by Radovanović (1981) and Mikić (1991). Numerous analyses and much research show that people have really become addicted to the modern way of life and that they participate in physical activities to a very small extent, even less than is their natural need, which inevitably leads to "modern age" disease, as the consequence of an inadequate level of functional abilities.

The experience gained by working with the student population imposes a solution in the direction of a compensation for the negative influences of the modern way of life, by using well organized and expertly programmed physical activities. All the mentioned activities should

be an everyday necessity due to the adaptation of the body to new living conditions, the influence on one's health status (James, 1982; Simić et al., 1984; Ivković-Lazar, 1992), bringing abilities for work to a higher level or even for the purpose of an active holiday and the entertainment of younger generations. Daily walking and running over a period of 8–10 weeks can increase cardiovascular abilities by 20–25% (Balke, 1972).

Recreational exercise requires regular use of the model, adequate dosing of activity and regular monitoring and checking of the exercise effects. If children and students get used to everyday physical exercise and if it becomes a necessary element of their life regime and lifestyle, they could continue with it until late in life (Aleksandrov, 1978; Aslan, 1988).

Practice and the results obtained by working with the student population (Živković, 2005) indicate that various physical activities in their extent and content, cannot have an effect in regards to overall development, unless they are implemented over adequate and correct time spans. The reasons, which have so far been cited, along with the fact that physical education classes are, for the time being, not performed in an organized manner as

part of the curriculums of the Universities of Serbia, must inevitably lead to a stagnation of anthropological dimensions among the student population, considering the fact that a break occurs in systematic exercise after the completion of high school, a fact that was indicated by Nikolić (2003). In order to prevent the inadequate development of anthropological dimensions among the student population, a fact that many authors have indicted in the past (Đurašković, Mihajlović, & Nikolić, 1984; Radovanović & Božić, 1990; Mitić, 1990; Ilić, 1991), it is necessary to organize programmed recreational exercise (Blagajac, 1987), in order to directly affect the effectiveness of the transformation process. It has been proven in practice that each student has special characteristics and development dynamics.

Planned and programmed recreational exercise, apart from affecting the development and stabilization of anthropological dimensions, as proven by a number of authors (Bjorntorp, 1974; Todorovski, 1979; Mokeev et al., 1994; Štrbac, 1997; Nikolić, 2003) and being a preventive and corrective function, is part of the easier and more adequate completion of the obligations that students have within their study regime, which in the overall context means a preparation for the challenges which their future vocation, for the purpose of survival in modern society, places before them.

The problem of our research was to check the effects of various recreational activity programs (volleyball and swimming) on the morphological characteristics and functional abilities of students. The subject matter of our research were the morphological characteristics and functional abilities and their adaptation to work loads which are caused by the contents of these programs.

The basic aim of this experimental research was to examine the effectiveness of recreational programs with volleyball and swimming contents.

In regards to the set goals, the basic supposition was that the experimental groups, which as part of their exercise use recreational program contents, would achieve a significant decrease in measurements of circular dimensionality and fatty tissue in comparison to the control group which did not exercise. Another hypothesis was that the experimental group could achieve a statistically significant increase in functional abilities in relation to the control group.

## METHOD

### The sample of subjects

The population from which the sample was extracted for the purposes of this research is defined as a male student population, whose subjects are aged from 19 to 26, are clinically healthy and without any bodily aberrations. One of the more important criteria for choosing

the sample was that the students, during the course of the 2001/2002 school year, attend classes on a regular basis, along with voluntarily choosing to participate in the experimental group for Volleyball (E1), the experimental group for Swimming (E2) or the control group (KO).

The first experimental group (E1) was made up of students of the University of Niš, who of their own free will chose that they would, in the form of a recreational activity, only play volleyball according to a previously determined plan and program, three times a week at regular intervals. The subjects from this group were divided into three sub-groups and each numbered 35 students, so 115 students actively participated in these classes.

The members of the other experimental group (E2) were students who of their own accord decided that they would, in the form of a recreational activity, only swim according to a previously determined plan and program, three times a week at regular intervals. This group was divided into four sub-groups, each consisting of 30–35 students, so 126 students actively participated in these classes.

The control group was formed using 127 students of the University of Niš. The subjects of this group (KO) did not have regular or organized recreational physical activities, so the overall data that was included in the study consisted of only what was obtained from those students who were measured and tested at the beginning and end of the experiment, over regular intervals. For practical reasons most of the students from this group were students of the Faculty of Medicine.

### The sample of variables

The research included those variables that best represent manifest and latent dimensions, and at the same time have metric characteristics which were determined in earlier research (correctness, reliability and objectivity).

All the measurements of anthropological variables were carried out by means of the International Biological Program (IBP) (Weiner & Lourie, 1969).

The research encompassed nine measurements of the morphological area which cover a three-dimensional hypothetical area, and the measurements for the evaluation of a rectilinear dimensionality were left out. This choice was motivated by the character of the research, including: body mass (ABDMS), average thorax volume (ATHVL), abdominal volume (ADVL), extended forearm volume (AFAVL), thigh volume (ATHVL), skin creases of the forearm triceps (ASCFT), back skin creases (ABCSC), abdominal skin creases (AADSC) and thigh skin creases (ATHSC).

In order to define the functional area, five tests were conducted, including: vital lung capacity (FVLCP), resting heart rate frequency (FRHRF), absolute maximal

uptake of  $O_2$  (FAMOU), relative maximal uptake of  $O_2$  (FRMOU) and a test for maximal anaerobic abilities according to Astrand (FMAAA).

In choosing the variables, the experience gathered from the research conducted so far on the student population was used, and what was also taken into consideration was the fact that the choice had to include the necessary metric characteristics (correctness, reliability and objectivity).

### A description of the research

The experimental programs consisted of the realization of technical/tactical elements of volleyball and swimming by means of the interval method, and which were realized starting from 1. 10. 2001 with the start of the new school year at the University of Niš and lasted continuously until 15. 1. 2002, or to be more precise, for one semester or 45 classes (the duration of one class was 60 minutes). This period of time was judged to be the most suitable for the functioning of the changes to the studied values in a qualitative sense, considering the summer holidays and the initial state of the subjects' abilities.

At the beginning of the experimental program, an initial as well as a final measurement as part of all the tests used in the research was conducted, with the aim of determining the variability of the results from the initial and final states in the morphological development and the functional abilities of the students of the control and experimental groups.

With the purpose of a better adaptability of physiological functions and their being taken to a higher level, at certain points during the experiment the values and dynamics of heart rate when the subject is in motion and the frequency of breathing were checked. Registering the changes that took place in the course of the work had a direct impact on the further progressive increase of the intensity of the activities.

### Methods of data analysis

In order to efficiently solve the problem of the effect of the experimental program on the somatic status of the subjects, it was necessary to determine whether there were any differences among the subjects of the experimental and control groups at the initial measuring, or whether while choosing the sample of subjects, a homogenizing of the groups occurred before the onset of the experimental treatment.

In order to determine the differences between the subjects of the experimental and control groups in regards to somatic status at the multivariate level, the multivariate analysis of the variance was used (MANOVA), and in order to obtain the data regarding in which of the

variables differences do occur, the univariate analysis of the variance was used (ANOVA).

After we had determined that there were differences at the initial state among the groups, it was necessary to determine the extent of the progress that each of the groups had made in the studied areas, during the period between the initial and final measuring. For that purpose, at the multivariate level, the multivariate analysis of the variance was used (MANOVA – repeated measures), while at the univariate level, the univariate analysis of the variance was used (ANOVA – repeated measures).

On the basis of the determined inter-group differences at the initial measuring among the experimental and control groups in the anthropometric and functional space, with the aim of determining the effectiveness of the applied experimental programs, an analysis of any possible inter-group differences at the final measuring in the studied areas was conducted, by means of the multivariate analysis of the covariance (MANCOVA), while the individual univariate differences among the groups in regards to certain variables were determined at the univariate level by means of the univariate analysis of the covariance (ANCOVA). In fact, by means of this analysis the noted differences at the initial measurings among the groups was neutralized, and the determination of the differences was done via partialized adjusted middle values at the final measurement.

### Legend

Wilks' Lambda – value of Wilks' Lambda test;

Rao's R – value of Rao's test;

df1, df2 – degree of freedom;

Q – statistical pregnancy?, significance? of the value of Rao's test;

Mean – arithmetical middle value;

Std. dev. – standard deviation of the mean;

Var. – variable;

Adj. mean – adjusted mean;

F – value of the F-test;

p – statistical pregnancy?, significance? of the F-test.

## THE RESULTS AND THE DISCUSSION

By inspecting TABLE 1–4 of the multivariate and the univariate analysis of the variance of the applied anthropometric measures and functional tests among the subjects of the experimental and control groups in their initial state, it can be concluded that a statistically significant inter-group difference is present at the .00 level ( $Q = .000$ ). The noted difference most probably presents itself as the fact that the sample of subjects of the experimental groups is defined as a stratified sample

of subjects with affinities for sport, which most likely on its part draws the distinctions both in the anthropometric and functional structures of the subjects.

**TABLE 1**

The multivariate analysis of the variance among the subject groups within the anthropometric area at the initial measuring

Wilks' Lambda	Rao's R	df 1	df 2	Q
0.536	14.50	18	714	.000

**TABLE 2**

The univariate analysis of the variance among the subject groups within the anthropometric area at the initial measuring

Var.	Mean			Mean sqr effect	Mean sqr error	F(2.365)	p
	E1	E2	KO				
ABDMS	76.6	74.7	76.3	33945.1	93.0	1.40	.248
ATHVL	93.8	93.3	89.2	13590.7	37.2	21.45	.000
ADVL	78.9	79.6	79.1	15834.7	43.4	0.36	.697
AFAVL	28.0	28.2	27.8	2972.6	8.1	0.68	.506
ATHVL	55.0	54.6	53.3	7831.8	21.5	4.66	.010
ASCFT	10.2	10.0	14.4	8777.8	24.0	32.55	.000
ABCSC	10.7	11.6	12.9	7602.6	20.8	7.32	.001
AADSC	13.8	14.7	14.6	18479.3	50.6	0.61	.544
ATHSC	14.7	13.7	16.7	11860.6	32.5	9.19	.000

**TABLE 3**

The multivariate analysis of the variance among the subject groups within the functional area at the initial measuring

Wilks' Lambda	Rao's R	df 1	df 2	Q
0.840	6.57	10	722	.000

**TABLE 4**

The univariate analysis of the variance among the subject groups within the functional area at the initial measuring

Var.	Mean			Mean sqr effect	Mean sqr error	F(2.365)	p
	E1	E2	KO				
FVLCP	4476.52	4318.25	4748.82	139051947	380964.2	15.74	.000
FRHRF	79.51	81.83	82.96	22780	62.4	5.91	.003
FAMOU	3.13	3.09	2.92	167	0.5	3.43	.034
FRMOU	40.71	41.15	37.99	18315	50.2	7.32	.001
FMAAA	43.51	42.74	43.43	20038	54.9	0.41	.666

The results of the analyses of the differences between the initial and final measuring (TABLE 5–16) indicate that in the case of the experimental groups, a significant increase in all the functional abilities occurred, with the exception of the maximal anaerobic ability (FMAAA) of the swimmers, where no significant improvement was noted. In the case of the control group, the improvement in the results is evident in the case of absolute maximal oxygen uptake – FAMOU, and a decrease was noted in

the resting heart rate frequency – FRHRF and in the maximal anaerobic ability – FMAAA.

In the anthropometric area the decrease in body weight and fatty tissue located under the skin is evident, along with an increase in the circular measurements of swimmers (with the exception of the abdominal volume, which decreased) at the expense of the muscle tissue, while for the control group an increase in circular measurements was noted, but at the expense of an increase in fatty tissue under the skin.

**TABLE 5**

The multivariate analysis of the variance (repeated measures) between the initial and final measurements in the anthropometric area of the E1 group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.149	67.14	9	106	0.00

**TABLE 6**

The univariate analysis of the variance (repeated measures) between the initial and final measurements in the anthropometric area of the E1 group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.114)	p
	Initial	Final				
ABDMS	76.61	75.62	57.00	.13	429.66	.000
ATHVL	93.84	93.91	.30	1.44	.21	.649
ADVL	78.86	78.51	6.89	3.89	1.77	.186
AFAVL	27.98	28.10	.90	.76	1.19	.277
ATHVL	55.00	55.02	.03	.46	.06	.800
ASCFT	10.21	9.67	16.28	.23	71.09	.000
ABCSC	10.68	10.20	13.15	.21	64.00	.000
AADSC	13.76	13.51	3.71	2.59	1.43	.234
ATHSC	14.73	14.18	17.15	.43	39.72	.000

**TABLE 7**

The multivariate analysis of the variance (repeated measures) between the initial and final measurements in the anthropometric area of the E2 group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.122	93.31	9	117	0.00

**TABLE 8**

The univariate analysis of the variance (repeated measures) between the initial and final measurements in the anthropometric area of the E2 group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.125)	p
	Initial	Final				
ABDMS	74.71	73.93	38.50	.77	49.68	.000
ATHVL	93.33	93.94	23.16	.21	112.06	.000
ADVL	79.56	78.76	40.32	.91	44.08	.000
AFAVL	28.23	28.71	14.05	.53	26.33	.000
ATHVL	54.59	55.37	37.41	.86	43.56	.000
ASCFT	9.98	9.12	45.94	.35	132.92	.000
ABCSC	11.60	10.47	79.54	.14	558.43	.000
AADSC	14.67	13.63	68.83	.35	199.18	.000
ATHSC	13.66	12.41	98.81	1.08	91.11	.000

**TABLE 9**

The multivariate analysis of the variance (repeated measures) between the initial and final measurements in the anthropometric area of the KO group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.777	3.72	9	118	.000

**TABLE 10**

The univariate analysis of the variance (repeated measures) between the initial and final measurings in the anthropometric area of the KO group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.125)	p
	Initial	Final				
ABDMS	76.24	77.22	60.52	25.68	2.36	.127
ATHVL	89.16	90.00	44.17	9.13	4.84	.030
ADVL	79.06	80.06	63.00	16.00	3.94	.049
AFAVL	27.78	28.56	38.89	2.32	16.79	.000
ATHVL	53.25	54.43	88.10	7.92	11.12	.001
ASCFT	14.44	15.38	55.70	16.25	3.43	.066
ABCSC	12.87	13.20	7.07	8.75	.81	.371
AADSC	14.60	15.02	11.40	15.22	.75	.388
ATHSC	16.70	17.83	80.02	16.98	4.71	.032

**TABLE 11**

The multivariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the E1 group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.153	121.81	5	110	0.00

**TABLE 12**

The univariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the E1 group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.114)	p
	Initial	Final				
FVLCP	4476.52	4623.48	1241783.0	2484.4	499.84	.000
FRHRF	79.51	77.30	280.5	3.3	84.71	.000
FAMOU	3.13	3.27	1.2	.0	37.18	.000
FRMOU	40.71	43.06	316.5	5.0	63.20	.000
FMAAA	43.51	45.92	335.4	4.9	68.70	.000

**TABLE 13**

The multivariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the E2 group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.142	146.01	5	121	0.00

**TABLE 14**

The univariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the E2 group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.125)	p
	Initial	Final				
FVLCP	4318.25	4526.98	2744802.0	4241.6	647.12	.000
FRHRF	81.83	79.87	240.1	5.4	44.28	.000
FAMOU	3.09	3.18	.5	.0	41.15	.000
FRMOU	41.15	43.00	216.3	2.5	88.22	.000
FMAAA	42.74	42.95	2.8	3.6	.77	.381

**TABLE 15**

The multivariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the KO group

Wilks' Lambda	Rao's R	df 1	df 2	Q
.749	8.17	5	122	.000

**TABLE 16**

The univariate analysis of the variance (repeated measures) between the initial and final measurings in the functional area of the KO group

Var.	Mean		Mean sqr effect	Mean sqr error	F(1.126)	p
	Initial	Final				
FVLCP	4748.82	4745.67	629.9	76661.7	.01	.928
FRHRF	82.96	84.35	122.0	8.9	13.65	.000
FAMOU	2.92	2.96	.1	.0	4.40	.038
FRMOU	37.99	37.89	.7	5.1	.14	.711
FMAAA	43.43	42.29	83.1	11.5	7.23	.008

By inspecting TABLE 17, where the multivariate covariance analysis of the applied anthropometric variables among the subjects of the experimental and control groups at the final measuring with the partialization and neutralization of the noted differences at the initial measuring is shown, it can be concluded that a statistically significant inter-group difference exists at

the .00 level ( $Q = .000$ ). The noted difference occurs under the influence of the applied experimental factors, by means of which a conclusion can be drawn that the applied experimental programs of recreational physical activities had a positive affect on the transformation of the anthropometric characteristics of the subjects of the experimental groups.

**TABLE 17**

The multivariate analysis of the covariance among the subject groups within the anthropometric area at the final measuring

Wilks' Lambda	Rao's R	df 1	df 2	Q
.768	5.46	18	696	.000

TABLE 18 shows the univariate differences of certain anthropometric tests among the experimental and control groups at the final state with the neutralization and partialization of the differences in anthropometric area at the initial measuring, where a significant inter-group difference in all the variables at the .05 level ( $p < .05$ ) is evident, with the exception of the variable for the middle thorax volume (AMTHVL) and thigh volume (ATHVL). Body mass, abdominal volume and the fatty tissue under the skin were significantly reduced among the swimmers and volleyball players in comparison with the members of the control group, who regis-

tered an increase in body mass and fatty tissue during the experimental period.

From the obtained results the conclusion can be drawn that the experimental programs of the E1 and E2 groups gave good results when it comes to changes in anthropometric measurements, and especially when it comes to reducing fatty tissue under the skin and reducing body weight. What is also noticeable is the decrease in the circular dimensionality in the case of both of the experimental groups in relation to the control one, as a consequence of the decrease in fatty tissue under the skin, or the increase of the same among the members of the control group.

**TABLE 18**

The univariate covariance analysis among the subject groups in the anthropometric area at the final measuring

Var.	Adj. mean			Mean sqr effect	Mean sqr error	F(2.356)	p
	E1	E2	KO				
ABDMS	74.82	74.98	77.09	116.64	17.09	6.83	.001
ATHVL	92.16	92.71	93.02	16.18	6.92	2.34	.098
ADVL	78.69	78.53	80.15	58.82	11.54	5.10	.007
AFAVL	28.04	28.51	28.86	14.08	2.25	6.25	.002
ATHVL	54.46	55.11	55.27	16.85	5.60	3.01	.051
ASCFT	10.59	10.25	13.31	206.21	10.14	20.33	.000
ABCSC	10.83	10.39	12.70	112.67	5.20	21.66	.000
AADSC	13.85	13.11	15.22	89.88	11.17	8.05	.000
ATHSC	14.44	13.40	16.56	201.23	11.04	18.22	.000

By inspecting TABLE 19, where the multivariant covariance analysis of the applied functional tests among the subjects of the experimental and control groups at the final measuring with the partialization and neutralization of the noted differences at the initial measuring is shown, it can be concluded that a statistically significant inter-group difference exists at the .00 level ( $Q = .000$ ).

The noted difference occurs under the influence of the applied experimental factors, according to which a conclusion can be drawn that the applied experimental programs of recreational physical activities had a positive affect on the transformation of the functional abilities of the subjects of the experimental groups.

**TABLE 19**

The multivariate covariance analysis among the subject groups in the functional area at the final measuring

Wilks' Lambda	Rao's R	df 1	df 2	Q
.517	27.81	10	712	.000

TABLE 20 shows the univariate differences of certain functional tests among the experimental and control groups at the final state with the neutralization and partialization of the differences in the functional area at the initial measuring, where a significant inter-group difference in all the tests at the .05 level ( $p < .05$ ) is

evident. The volleyball players had the best results for the resting heart rate frequency – FRHRF, absolute maximal oxygen uptake – FAMOU, relative maximal oxygen uptake – FRMOU and maximal anaerobic ability – FMAAA, while the swimmers achieved the best results for the increase in vital lung capacity – FVLCP.

**TABLE 20**

The univariate covariance analysis among the subject groups in the functional area at the final measuring

Var.	Adj. mean			Mean sqr effect	Mean sqr error	F(2.360)	p
	E1	E2	KO				
FVLCP	4649.20	4702.66	4544.28	707892.1	53465.6	13.24	.000
FRHRF	78.84	79.50	83.18	587.7	9.6	61.15	.000
FAMOU	3.20	3.15	3.07	.4	.0	9.92	.000
FRMOU	42.40	42.02	39.53	261.1	7.2	36.45	.000
FMAAA	45.57	43.48	42.11	335.7	11.8	28.53	.000

In the discussion of the statistical analysis, what is emphasized is the fact that by using various programs of recreational exercise within the experimental group, an increase in functional abilities occurred, especially in the case of the experimental group which trained using recreational contents from volleyball. A more significant increase in the maximal anaerobic and relative and absolute maximal oxygen uptake was determined for the

experimental group which used volleyball contents in its training, and it was therefore justified that this type of exercise be used in the training for the development of these abilities. The E1 experimental group reached an increase in absolute maximal oxygen uptake from 3.13 and 3.27. The resting heart rate frequency (average value) for the students of the E1 experimental group was 77.3 beats per minute. These values are somewhat

greater in comparison to the average values of athletes (soccer players and handball players), and somewhat smaller in comparison to the values of men who do not participate in sport activities (Đurašković, 2002). This can be explained by the fact that the subjects were not, during the course of their exercise, burdened with the limits of submaximal and maximal work loads, which would lead to the prevailing influence of the parasympathetic nerves (n. vagus) over the sympathetic ones. In addition, it is well known that the programmed and correctly distributed physical activity leads to bradycardia (Đurđević, 1981), and this fact can be used to explain the lower heart rate frequency of our subjects in relation to men who do not actively participate in physical activities. Similar results were obtained in the research conducted by Đurđević (1981), Đurašković (2002) and Živanić (2004). The swimming program had a significant effect on the vital lung capacity. It was manifested in a value from 4318 ml at the initial up to 4527 ml at the final measuring.

When it comes to the circular measurements of the body and fatty tissue, the difference in the reduced amount of the fatty tissue and body weight can clearly be seen in the experimental groups in relation to the control one, and at the same time an increase in circular measurements, which can be explained by an increase in muscle mass at the expense of fatty tissue. In the case of the control group, an increase in is evident, but with an increase in fatty tissue.

## CONCLUSION

On the basis of the analysis of the results obtained during the course of this research, it can be concluded that the experimental programs of recreational physical activities with contents from volleyball and swimming did make a significant contribution to the decrease in body weight and fatty tissue under the skin. The program of recreational physical activities with contents from volleyball gave the best results for the improvement of the maximal anaerobic abilities and maximal absolute and relative oxygen uptake, not to mention that it decreased the resting heart rate frequency, while the program of physical activities with swimming contents gave the best results for the increase of vital lung capacity.

On the basis of these research results it could generally be concluded that the applied experimental programs in volleyball and swimming had positive effects on the improvement of the anthropometric characteristics and functional abilities of the male student population.

The application of regular forms found in recreational activities is mostly of significance for the preservation of good health and the improvement of the functions of the respiratory and cardiovascular systems. This kind

of research could have multiple scientific and practical implications:

- the research results could relatively easily be applied in practice, as they give an insight into the verified programs of regular recreational activities;
- the results of this research could also have a positive affect on the motivation of the subjects for a systematic completion of recreational activities, considering the fact that hypokinesia is to a great extent present in people this age;
- the direct results and the applied programs of recreational activities enable a scientific validation of the set of variables by means of which it is possible to later track the effects of the programmed recreational activities on the somatic status of the subjects;
- the obtained research results enable the scientifically verified programs of recreational activities to receive more frequent application, to spread in everyday use and among people of various age groups;
- the direct results of the effects of recreational activities on the change in the status of the anthropometric and functional areas could be applied in the building of a system of programmed recreational activities and the methodological tracking of these effects on the overall anthropological status of the subjects from the student population.

Naturally, many questions are left open and in need of an answer. One of these questions is how to determine which exercises have significantly contributed to the determined differences among the experimental and control groups. The second question refers to the part played by the other leisure activities of the subjects, which to a great extent can influence the positive or negative reactions of the body, and which were not under our control. What remains is for upcoming similar research to follow a larger number of measuring instruments and keep under control as many factors which influence the changes in the studied dimensions as possible.

Finally, the fact that this research and other research similar to it will open other questions must not be excluded. These might be questions to which we cannot give a proper answer at this point, but which, in any case will be a motivation for further expert and scientific verification of such research.

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#### ÚČINKY REKREAČNÍCH AKTIVIT S VOLEJBALOVOU A PLAVECKOU NÁPLNÍ NA ANTROPOMETRICKÉ CHARAKTERISTIKY A FUNKČNÍ SCHOPNOSTI STUDENTŮ

(Souhrn anglického textu)

Základním cílem tohoto experimentálního výzkumu bylo zkoumat účinnost rekreačních programů s volejbalovou a plaveckou náplní. Byl prováděn na vzorku 368 studentů mužského pohlaví z Univerzity v Niš, kteří byli rozděleni do 3 podskupin. 115 účastníků bylo přiřazeno do experimentální skupiny, která se věnovala volejbalu, 126 tvořilo experimentální skupinu, která se věnovala plavání a 127 představovalo kontrolní skupinu.

Při použití dvou různých programů rekreačního cvičení došlo v průběhu tréninku experimentálních skupin ke zvýšení funkčních schopností, zvláště v případě experimentální skupiny, která se věnovala rekreační volejbalové náplni. U experimentální skupiny, která se věnovala volejbalu, byl stanoven významnější nárůst maximální anaerobní schopnosti a relativního i absolutního maximálního příjmu kyslíku. Využití tohoto typu cvičení při tréninku zaměřeném na jejich vývoj se proto jeví jako opodstatněné. V případě zbývajících dvou experimentálních skupin byl pozorován významný nárůst vitální kapacity plic.

Pokud jde o obvodová měření těla a tukové tkáně, byl u experimentální skupiny vůči kontrolní skupině zaznamenán rozdíl ve snížení tukové tkáně a tělesné hmotnosti a zároveň nárůst hodnot při obvodovém měření, což byl důsledek nárůstu svalové tkáně na úkor tukové. U kontrolní skupiny byl při obvodovém měření zaznamenán nárůst hodnot, a to na úkor tukové tkáně.

*Klíčová slova: rekreační programy, experiment, funkční schopnosti, antropometrická měření, studenti mužského pohlaví.*

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