

Water Workout Application Effects on the Body Composition and Motor Abilities of 13-Year-Old Female Adolescents

Efectos de la Aplicación de Entrenamiento Acuático sobre la Composición Corporal y las Habilidades Motoras de Adolescentes Mujeres de 13 Años de Edad

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SUMMARY: The aim of this research was to determine the water workout application effects on anthropometric characteristics, body composition and motor abilities of 13-year-old female adolescents. The research was conducted on the sample of 154 female adolescents from south-eastern Serbia, divided into experimental group (n= 82) and control group (n= 72). In the area of anthropometry, the following components were measured: body height, body mass, body mass index (BMI) and five skinfolds. In the area of body composition, the percentage of body fat and total muscle mass was measured. According to the Eurofit Manual, the standard tests recommended for testing school children were conducted, measuring the following variables in the motor area: plate tapping, sit-and-reach, standing broad jump, sit-ups in 30 seconds, bent-arm hang test, agility run 10 x 5 m, and 20 m shuttle-run. The three-times-a-week water training programme lasting for eight weeks was the experimental factor. ANOVA results indicate the statistically significant differences between the experimental and control groups in body mass, BMI, skin biceps brachi, skin suprailiac, skin medialis, skin triceps brachi and body composition variables ($p < 0.01$). There were statistically significant differences between the experimental and control groups ($p < 0.01$) in variables pertaining to the plate tapping, standing broad jump, sit-ups in 30 seconds, 20 m shuttle-run, and sit-and-reach and agility run 10 x 5 m ($p < 0.05$). Based on the obtained results, we can conclude that the water training programme affected the reduction of body composition, improvement of cardiorespiratory endurance, muscular force, muscular endurance and mobility in 13-year-old female adolescents. The given water training programme would be the means for obesity prevention in adolescents, which can be useful for the improvement of youth health and quality of life.

KEY WORDS: Morphologic characteristics; Physical activity; Body mass index (BMI).

INTRODUCTION

Obesity and physical inactivity are problems of the 21st century, jointly permanently affecting health and quality of life. In fact, the World Health Organization (WHO) identified the basic set of indicators determining the risk factors for development of chronic non-communicable diseases. Therefore, in adolescents, the dominant risk factors are obesity and physical inactivity (Patton *et al.*, 2011). The prevalence of overweight and obese younger adolescents in the world is increasing and obesity is becoming a pandemic. With regard to this, it is estimated that the percentage of obese and overweight children and adolescents in 2020 shall be about 9 % at the global level (WHO, 2009; Ogden *et al.*, 2014). It also supports the research results of the Ministry of Health of the Republic of Serbia from 2013 indicating that the number of obese and overweight adolescents in

Serbia is rising. In fact, in 2006, there were 8.5 % of them, and in 2013, 13.7 % (The Institute of Public Health of Serbia, 2013).

On the other hand, the WHO research from 2017 indicates that 81 % of adolescents at the global level are physically inactive and that physical inactivity represents the fourth mortality risk factor at the global level (WHO, 2017). Therefore, encouragement to a regular physical activity has for some time been one of the goals and tasks put forward by the developed and developing countries, which thus tries to mitigate adverse effects on health and quality of life of children and adolescents (Emeljanovas *et al.*, 2015). In order to improve health and increase motivation of adolescents for more frequent physical activity, water

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training programmes can be applied in practice influencing the reduction of body composition, transforming the anthropometric characteristics and improving motor abilities by means of their components and work methods. The research shows that water training has a high degree of correlation with the body mass reduction (Nagle *et al.*, 2007), development of cardiorespiratory endurance, muscle force and flexibility (Rica *et al.*, 2013), as well as the improvement of general health condition and quality of life (Raffaelli *et al.*, 2010). Based on the abovementioned, the topic of this research is the study of effects and contribution of water training application in 13-year-old female adolescents. The aim of this research is to identify the water training application effects on anthropometric characteristics, body composition and motor abilities in 13-year-old female adolescents.

MATERIAL AND METHOD

The experimental method was applied in the research, comprising initial and final measurements. The experimental programme lasting for eight weeks was implemented in the swimming pool at the “Dubocica” Sporting Recreational Centre in Leskovac (Serbia). In the given period, the experimental programme was realised three times a week, each lasting for 45 min.

Sample of respondents. The research was conducted on a sample of female adolescents from south-eastern Serbia ($n=154$) aged 13.05 ± 0.45 , divided by means of random sampling into two groups: experimental ($n=82$) and control ($n=72$) groups. Female respondents included in the experimental programme did not have any chronic diseases, deformities of spine and limbs or diseases for which physical activity was indicated. All female respondents included in the research participated voluntarily, with their parents' consent and were not part of some other training programme or sporting activity.

Sample of variables. Starting from the set subject matter and the aim of this research, variables in the area of: anthropometry, body composition and motor abilities were examined. In the area of anthropometry, the following components were examined: body height, body mass, body mass index (BMI), as well as five skinfolds: triceps brachi skinfold, biceps brachi skinfold, subscapularis skinfold, suprailiac skinfold and medial calf skinfold (Marfell-Jones *et al.*, 2006). Body height was measured with a stadiometer (Seca 220, UK), to the nearest 0.1 cm. Body weight was measured using InBody scale (InBody 230, model: MW 160, Biospace, Korea), to the nearest 0.1 kg. Body mass index

(BMI) was measured using InBody scale (InBody 230, model: MW 160, Biospace, Korea). Skinfold measurement was taken to the nearest 0.2 mm using a skinfold calliper (Holtain Ltd, Crymych, UK). In the area of body composition, the percentages of body fat and total muscle mass were examined, using InBody scale (InBody 230, model: MW 160, Biospace, Korea).

Variables in the area of motor abilities from the Eurofit Manual are the standard tests recommended for testing school age children and they included: Plate Tapping - tests speed of limb movement; Sit-and-Reach - flexibility test (using 15 cm at the level of the feet); Standing Broad Jump - measures explosive leg power; Sit-Ups in 30 seconds - measures trunk strength; Bent-Arm Hang Test - muscular endurance/functional strength; Agility Run 10 x 5 m - measures running speed and agility; and 20 m Shuttle-run - measures cardiorespiratory endurance (Council of Europe, Committee for the Development of Sport, 1993). Measurement was conducted at the Health Clinic in Leskovac – Sports Medicine Ward (Serbia).

Statistical data analysis. All data obtained in the course of the research were processed using descriptive and comparative statistical methods. In the area of descriptive statistics, the following was determined: arithmetic mean and standard deviation. For determining differences between measurements within groups and effects of experimental programme, multivariate analysis of variance (MANOVA) and univariate analysis of variance (ANOVA) were applied. The level of significance was set at ($p < 0.05$). The data were processed by the statistical package SPSS 19.0.

Experimental programme. Aiming to implement this research, we devised a group programme of water training to music which took place three times a week, with each session lasting for 45 min. The programme lasted for eight weeks in total. The music tempo varied between 122-132 bpm, while the music programme was different for each class. Exercises aiming to develop cardiorespiratory endurance, strength and mobility were prepared for each class and they were based on the water properties and Newtons law. Exercises were done in shallow chest-deep water, with average water temperature of 27.6 °C, and feet reaching the pool bottom. Each class was divided into initial, main and final segments. In the initial segment of the class, cyclic activities were performed (walking and running) as well as the exercise warming up all muscle groups. This class phase lasted between five and eight minutes. The main segment of the class comprised specific combinations of walking, running, rocking, kicking, jumping and scissors while standing and in motion. This class segment lasted for 20 min. Afterwards, they did specific exercises for

strengthening the muscles of arms and shoulder area, abdominal muscles, back muscles, muscles of gluteal areas and lower limbs in the period of 10 min. During one class, exercises strengthening the two antagonistic muscle groups were performed. In this class segment, props increasing the water resistance (swim paddles and noodle) were used once a week. Exercises were performed with a support on the bottom of the pool but also while floating. In the end they did the stretching exercises for 5 min.

RESULTS

Based on the MANOVA results (Table I), we detected statistically significant changes at the $p = .000$ c level in anthropometric characteristics and body composition after applying the experimental programme in the final measurement.

Table II shows the results of descriptive statistics and ANOVA results in the area of anthropometric characteristics and body composition. Statistically significant differences ($p < 0.01$) between initial and final measurements in the experimental group were detected in six variables: skin biceps brachi, skin subscapularis, skin suprailiaca, skin mediacalf, body fat and muscle mass. In skin triceps brachi variable, statistically significant difference was detected at the $p \leq 0.05$ level. In body height, body weight and BMI variables, no statistically significant differences were detected among

female respondents within the experimental group between measurements (Table II).

The ANOVA results (Table II) showed there were some statistically significant differences at the $p < 0.01$ level, among the female respondents of experimental and control groups after the experimental procedure in the following variables: body weight, BMI, skin triceps brachi, skin biceps brachi, skin suprailiaca, skin medicalf, body fat and muscle mass.

Based on the MANOVA results (Table III), we detected that after the application of experimental programme, there were some statistically significant changes at the $p = .000$ level in the final measurement in the area of motor abilities.

Table IV shows the results of descriptive statistics and ANOVA in the area of motor abilities. By comparing the obtained values between the initial and final measurements in female respondents of experimental group, we noticed some statistically significant differences ($p \leq 0.01$) in the following variables: plate tapping, stan broad jump, sit-ups in 30 s and 20 m Shuttle-Run. In agility run 10 x 5 m and sit-and-reach variables, statistically significant difference was detected at $p \leq 0.05$ level, while bent-arm hang test variable showed no statistically significant differences. In the control group, we only see statistically significant differences in 20 m Shuttle-Run variable ($p \leq 0.01$).

ANOVA results (Table IV) show that after the experimental treatment, there were statistically significant differences ($p < 0.01$) between experimental and control groups in the following variables: plate taping, stan broad jump, sit-ups in 30 s and 20 m shuttle-run. In sit-and-reach and agility run 10 x 5 variables, the statistically significant difference at $p < 0.05$ level was detected.

Table I. Multivariate differences between anthropometric characteristics and body composition of experimental and control groups in the final measurement.

Wilks' Lambda	F	Effect df	Error df	Sig.
0.514480	10.73	10	91	0.000

Table II. Descriptive statistics and ANOVA results pertaining to anthropometric characteristics and body composition of experimental and control groups in the initial and final measurements.

Variable	Experimental group (n= 82)		Control group (n= 72)		F	p
	M _I ±SD	M _F ±SD	M _I ±SD	M _F ±SD		
Body height (cm)	162.22±4.72	163.14±4.87	161.85±5.42	162.90±5.45	0.05	0.817
Body weight (kg)	56.16±9.44	54.12±6.18	56.51±9.37	58.21±9.08	7.08	0.009**
BMI (kg/m ²)	21.66±3.53	20.27±3.27	21.80±3.25	22.42±3.28	14.61	0.000**
SkinTriBrach (mm)	16.58±3.89	14.90±3.32*	16.87±5.92	17.96±3.26	21.62	0.000**
SkinBicBrach (mm)	15.12±4.84	12.28±2.17**	15.26±5.08	15.53±4.08	24.58	0.000**
SkinSubscap (mm)	16.58±5.61	13.44±3.42**	16.61±4.22	17.05±4.51	20.23	0.000**
SkinSuprailiac (mm)	18.40±7.73	14.86±5.42**	18.05±6.16	18.66±5.66	11.77	0.000**
SkinMediCalf (mm)	18.73±3.96	16.06±3.14**	18.92±4.33	19.62±3.30	30.50	0.000**
Body fat (%)	23.77±7.30	21.01±7.73**	25.79±6.70	26.48±6.72	13.96	0.000**
Muscle mass (kg)	21.62±4.21	22.24±4.27**	21.12±3.84	20.90±3.64	7.21	0.009**

Key: BMI-Body Mass Index; M-arithmetic mean; SD-standard deviation; F-variance value between groups; p-significance level; statistically significant difference at the level: * $p < 0.05$; ** $p < 0.01$

Table III. Multivariate differences between motor abilities of experimental and control groups in the final measurement.

Wilks' Lambda	F	Effect df	Error df	Sig.
0.693027	6.866	7	93	0.000

Table IV. Descriptive statistics and ANOVA results pertaining to motor abilities of experimental and control groups in the initial and final measurements.

Variable	Experimental group (n= 82)		Control group (n= 72)		F	p
	M _i ±SD	M _f ±SD	M _i ±SD	M _f ±SD		
Plate Tapping (s)	16.34±1.92	14.27±1.70**	16.49±2.36	16.41±2.20	29.56	0.000**
Sit-and-Reach (cm)	24.72±5.64	27.40±5.76*	24.52±6.17	24.90±6.12	4.41	0.038*
Stan Broad Jump (cm)	147.88±21.14	159.88±20.87**	146.84±18.89	146.24±20.76	14.58	0.000**
Sit-Ups in 30 s (count)	16.78±3.69	19.66±3.43**	16.86±3.16	17.12±3.48	13.50	0.000**
Bent-Arm Hang Test (s)	16.82±16.33	20.76±18.64	16.51±13.45	16.01±13.06	2.17	0.143
Agility Run 10 x 5 (s)	23.91±2.48	22.59±2.64*	24.17±2.69	23.87±2.94	5.26	0.023*
20 m Shuttle-Run	29.69±3.74	32.59±4.11**	26.26±2.31	28.03±4.17**	8.82	0.001**

Key: M-arithmetic mean; SD-standard deviation; F-variance value between groups; p-significance level; statistically significant difference at the level: * p < 0.05; ** p < 0.01

DISCUSSION

After analysing the research results, we concluded that there were neither statistically significant differences within groups in body height variable nor when comparing the results of experimental and control groups in the final measurement. In fact, during the period of eight weeks, female respondents grew, which is in compliance with the accepted, applicable standards for this age (Gajevic, 2009), although accelerative occurrences and effects of puberty were visible (Malina *et al.*, 2004; Grassi *et al.*, 2006). The obtained results regarding the body height of female respondents do not deviate from the research results obtained on the sample of 13-year-old female adolescents from Serbia, 162±5.2 cm (Mandaric, 2003), as well as those obtained a few years later 163.12±7.50 cm (Gajevic). We can conclude that water training contributed to the smooth growth and development of female respondents from the experimental group.

In the body mass variable, we notice that average values for the body mass of female respondents at the initial measurement deviate from the research results for the same sample in Serbia and European Union countries. In fact, compared to the research conducted by Mandaric female respondents have higher body mass values compared to the values of female respondents of the same age, respectively, the results for the experimental group were 5.61±6.21 kg and for the control group 5.95±6.14 kg. Higher values were also detected compared to the results obtained by Gajevic; results for the experimental group were higher by 2.02±3.02 kg, and for the control group by 2.37±2.95 kg respectively. Moreover, the research results indicate that compared to the female adolescents of the same age from the European Union, these female respondents have higher average body

mass values, the experimental group by 6.52±2.13 kg and the control group by 6.87±2.06 kg (Gajevic). The results of the initial measurement of the female adolescents from the south-eastern Serbia sample indicated the weight gain trend in the general population (WHO, 2009; The Institute of Public Health of Serbia). However, the final measurement results showed that, in body mass variable, three-times-a-week water training during the period of eight week statistically significantly (p < 0.01) influenced the body mass reduction. The obtained results may have arose from the cyclic and acyclic exercises performed in aerobic mode during each class, which is in compliance with the research of Nagle *et al.*, indicating that the combination of walking and running exercises in water affects the body mass reduction. Also, the obtained results for body mass variable may be contributed to the frequent physical activity in the form of classes of experimental programme.

The BMI results indicate that the female respondents of both groups had normal body mass according to the percentile ranks (P5-P85). However, by comparing the obtained BMI results and the research results of the Ministry of Health of the Republic of Serbia from 2013, we noticed the female respondents had higher BMI compared to the BMI of children and young people aged between 7 and 14 (BMI= 18.99). On the other hand, by comparing the obtained BMI results of experimental and control groups, we noticed that female respondents from the experimental group statistically significantly reduced the BMI values compared to the values of female respondents from the control group. According to the results of the final measurement of body mass and BMI variables, it should be emphasised that the reduction of body mass and BMI is in positive correlation with motor abilities, especially in the segment of hip muscle strength, mobility and cardiorespiratory endurance (Andreasi *et al.*, 2010).

After the experimental water training programme had been conducted, statistically significant differences at the $p < 0.01$ level were detected in the final measurement between the experimental and control groups in the following variables: five skinfolds, body fat and muscle mass. Values for skinfolds were statistically significantly reduced and at the same time, body fat was reduced and muscle mass increased. The obtained results may have arisen from the programme content which was performed in aerobic mode, then a combination of aerobic training and water resistance training because along with body fat reduction, we also strived towards the improvement of muscular force and muscle endurance. The research results are in compliance with the research results in which the water training programme lasting for eight weeks represents the time period necessary to obtain the statistically significant body fat reduction. Therefore, the research of Coleda *et al.* (2009), Hoeger *et al.* (1992), Michauda *et al.* (1995), body fat was reduced by 7.6 %, 2.7 %, 1.32 %.

The research results in the area of motor abilities indicate that after completed experimental water training programme, statistically significant progress in the plate tapping, stan broad jump, sit-ups in 30 s and agility run 10 x 5 variables was detected in experimental group compared to the control group. We can conclude that the programme content and the order of exercises based on polystructural cyclic activities in the water with and without props as well as the water resistance itself and laws of physics influenced the increase in the speed of alterative arm movements, explosive force of lower limbs muscles, repetitive strength of hip muscles and agility. The speed of performance of movements influenced the improvement of the result in stan broad jump and sit-ups in 30 s variables. In fact, with low movement speed, water resistance is determined by water density. As the movement speed picks up, water resistance is proportionally increased, that is, the muscle stress (Mayo, 2000), which results in the improvement of the muscle force. The strength of hip muscles is in direct correlation with the BMI and body fat (Andreasi *et al.*).

In addition to this, the research results indicate that the implemented water programme positively affected the 20 m shuttle-run variable results of female respondents from the experimental group compared to the female respondents of the control group at the significance level $p < 0.01$. In fact, application of experimental programme which comprised a combination of aerobic and resistance training, implemented three times a week in the duration of 45 minutes per class, is in compliance with conclusions of Mayo, stating that intensive water training two to three times a week maintains and increases the level of cardiorespiratory endurance. Also, programme implementation was in compliance with recommendations of the Garber *et al.* (2011), stating that

training session performed 3-5 times a week in the duration of 20-60 minutes in aerobic mode influences the improvement of cardiorespiratory endurance. Improvement of results in 20 m shuttle-run variable as a variable for assessing the cardiorespiratory endurance is in correlation with the lower value results for body mass and BMI (Andreasi *et al.*).

According to the obtained results, we can conclude that with their cyclic and acyclic movements and mobility of the entire body to the chosen music, exercises performed in the main part of the class influenced the improvement of results in the area of morphologic characteristics and motor abilities, mutually interactively related. Also, they statistically significantly improved the strength of hip muscles and cardiorespiratory endurance values while reducing body mass and BMI values, thus indicating that such training is a suitable means for improving the body composition but also for the prevention of obesity and excessive nutrition in 13-year-old female adolescents whose changes in body structure and the bone-skeletal system occur in a very prominent development phase.

Statistically significant improvement of results in sit-and-reach variable at the $p < 0.05$ significance level was detected in the final measurement in the experimental group. In addition to the stretching exercises performed in the final segment of the class, the low fat percentage in the body composition correlating with flexibility also affected the improvement of flexibility of female respondents participating in this research. Improvement of results in sit-and-reach variable is in compliance with the research results in this area (Bocalini *et al.*, 2008; Colado *et al.*, 2009), stating that stretching exercises in deep water influence the improvement of flexibility.

Generally speaking, we can conclude that there were statistically significant changes in anthropometric characteristics, body composition and motor abilities of 13-year-old female adolescents after applying the experimental water training programme lasting for eight weeks. Therefore, we can conclude that the water training programme can be applied in practice for the reduction of body composition, improvement of motor abilities and encouragement of female adolescents to frequent physical activity, which can be useful for improving health and quality of life in young people. In addition to this, this research provided certain information on water training application effects in female adolescents which may be applied in some further research.

MANDARIC, S. & SIBINOVIC, A. Efectos de la aplicación de entrenamiento acuático sobre la composición corporal y las habilidades motoras de adolescentes mujeres de 13 años de edad. *Int. J. Morphol.*, 36(2):629-634, 2018.

RESUMEN: El objetivo de esta investigación fue determinar los efectos de la aplicación de entrenamiento acuático en las características antropométricas, la composición corporal y las habilidades motoras de mujeres de 13 años. La investigación se realizó en una muestra de 154 mujeres adolescentes del sudeste de Serbia, divididas en dos grupos, experimental (n = 82) y control (n = 72). En el área de la antropometría, se midieron los siguientes componentes: Altura corporal, masa corporal, índice de masa corporal (IMC) y cinco pliegues cutáneos. En el área de composición corporal, se midió el porcentaje de grasa corporal y la masa muscular total. Según el Manual de Eurofit, se llevaron a cabo las pruebas estándar recomendadas para evaluar a escolares, midiendo las siguientes variables en el área motora: golpear las placas, sentado y alcance, salto de pie, sentadillas en 30 segundos, prueba de colgar el brazo doblado, agilidad de 10 x 5 m, y 20 m de carrera de lanzadera. El programa experimental de entrenamiento en agua tres veces por semana durante ocho semanas fue el factor experimental. Los resultados de ANOVA indican las diferencias estadísticamente significativas entre los grupos experimental y de control en masa corporal, IMC, pliegue braquico cutáneo, piel suprailíaca, tríceps y variables de composición corporal ($p < 0,01$). Hubo diferencias estadísticamente significativas entre los grupos experimental y control ($p < 0,01$) en las variables relacionadas con el golpe de placas, el salto de pie, las sentadillas en 30 segundos, la carrera de lanzadera de 20 m y la carrera de sentarse y alcanzar, y agilidad 10 x 5 m ($p < 0,05$). En base a los resultados obtenidos, podemos concluir que el programa de entrenamiento acuático provocó una reducción de la composición corporal, el mejoramiento de la resistencia cardiorrespiratoria, la fuerza muscular, la resistencia muscular y la movilidad en mujeres de 13 años. El programa de entrenamiento realizado en agua, sería el medio para la prevención de la obesidad en adolescentes, que puede ser útil para mejorar la salud y la calidad de vida de los jóvenes.

PALABRAS CLAVE: Características morfológicas; Actividad física; Índice de masa corporal (IMC).

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