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EFFECTS OF AQUA AEROBICS ON BODY COMPOSITION, BODY MASS, LIPID PROFILE, AND BLOOD COUNT IN MIDDLE-AGED SEDENTARY WOMEN

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ABSTRACT
Purpose. The aim of the present investigations was to determine the effects of aqua aerobics on body weight and composition, lipid profile, and selected blood count parameters in middle-aged sedentary females. **Methods.** Twenty-one women were randomly assigned to an experimental group (age 56.20 ± 2.57 years, height 162.80 ± 4.76 cm, weight 74.03 ± 3.84 kg) that participated in aqua aerobics classes three times a week for three months and a control group (mean age 56.44 ± 3.28 years, height 165.00 ± 3.91 cm, weight 70.01 ± 11.36 kg) not involved in any kind of targeted exercise. The aqua aerobics classes were tailored to suit the age and abilities of the participants, with workout intensity controlled and maintained at approximately 128–137 bpm. **Results.** Significant differences between the experimental and control groups were found for body weight, total body water, fat-free mass, and skeletal muscle mass. A significant increase in post-intervention hemoglobin and erythrocyte counts was observed in the experimental group. **Conclusions.** Future studies should determine the intensity of physical activity with the most beneficial effect on blood variables in middle-aged and older individuals.

Key words: body composition, lipid profile, blood count parameters, aqua aerobics, middle-aged female

Introduction

Today, apart from typical aerobics classes carried out in a gym, there is a wide range of water-based activities that provide an alternative to traditional fitness-based workouts [1]. Water-based exercises have several important physical, mental, and social benefits. While exercising in water is popular among both healthy and disabled people, water exercises are mostly recommended to obese, middle-aged, or elderly individuals [1] as well as pregnant women [2]. Aquatic exercises are safer than land-based exercises for these populations, where the absence of load-bearing compression on the joint reduces the risk of injury to the musculoskeletal system. Traditional gym classes can be too difficult to perform and, especially in the case of the elderly, be less effective than expected.

When immersed in water, the body can weigh up to 90% less than on land. This loss of weight removes load on the joints and spine and allows movement amplitude to increase compared with normal conditions. In addition, overcoming water resistance (with or without aquatic equipment) causes a substantial increase in energy expenditure. As a result, the effects of water-based exercises, such as an increase in muscle strength, may be greater than the effects similar exercises performed on land [3]. Studies have also found that, depending on the depth of immersion and water temperature, heart rate may be slower by 10–15 beats per minute (bpm) compared with similar exercises conducted on land [4].

Aqua aerobics, or 'waterobics', is a form of aerobic activity involving long dynamic exercises performed at moderate intensity. A wide range of targeted workouts are offered, such as aqua fat burner, aqua step, aqua senior, aqua dance, aqua yoga, and aqua for pregnant women, all adjusted to the age, health condition, needs, and preferences of participants. Numerous researchers have investigated different aspects of such water exercises. Hoeger et al. [5] compared the training response to water aerobics and low impact aerobic dance. Kravitz and Mayo [6] reviewed the physiological effects of aquatic exercise while Kaneda et al. [7] and Simmons and Hansen [8] evaluated the impact of water exercise on balance ability and postural mobility. However, the impact of water-based exercise on body composition and blood count has not been fully investigated so far. Therefore, the aim of the present investigations was to determine the effects of aqua aerobics on body composition, lipid profile, and selected blood count parameters in middle-aged sedentary females.

Material and methods

Approval for the study protocol was obtained from the Bioethics Committee of the Academy of Physical Education in Katowice. Twenty-eight women aged 50–60 years volunteered to participate in the study, of which 21 were selected. Inclusion criterion was being at the postmenopausal stage while the exclusion criterion was contraindications for water exercise. The participants were randomly assigned to experimental (n = 10) and control (n = 11) groups. Mean age, height, weight, and

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BMI values were 56.20 ± 2.57 years, 162.80 ± 4.76 cm, 74.03 ± 3.84 kg, and BMI 27.86 ± 1.74 for the experimental group and 56.44 ± 3.28 years, 165.00 ± 3.91 cm, 70.01 ± 11.36 kg, and 25.87 ± 3.64 for the control group, respectively. All participants were diagnosed as overweight or obese, with body weight approximately 20% over normal range.

The members of the experimental group were to attend a 45-min aqua aerobics class three times a week for 14 weeks (42 training sessions total). Each participant attended an average of 40 sessions. The control group was not involved in any kind of targeted exercise.

The aqua aerobics classes were conducted in a swimming pool with a depth 60–160 cm and water temperature 26–28°C. The exercises were tailored to suit the age and abilities of the participants. Exercise intensity was continually registered, controlled, and maintained at approximately 128–137 bpm (Polar S810i, Polar Electro, Finland). Each class consisted of three parts. The first, a warm-up, lasted 10 to 15 min and comprised running and arm exercises in different planes and directions eliciting a heart rate of approximately 128 ± 5 bpm. The main part lasted 25–30 min and consisted of full body aqua aerobics workout with a wide range of flotation devices (aqua disc, pool noodle, swimming board). Exercise intensity was higher compared with the warm-up, eliciting a heart rate of approximately 132 ± 5 bpm. The last part lasted 5 min and involved muscle stretching and a cool-down to slow-rhythm music, with heart rate maintained at approximately 120 bpm.

The impact of water-based exercises on body weight, body composition, lipid profile, and blood count parameters were assessed pre- and post-intervention 1 day before the experimental group began aqua aerobics classes and 1 day after the end of training (3-month interval). The participants did not exercise or take any medication prior to taking measurements. Resting blood samples were drawn before breakfast from the antecubical vein and examined with a hematology analyzer (Advia 2120i, Siemens, Germany). Body composition was estimated using an 8-electrode bioelectrical impedance analyzer (InBody 220, Inbody, Korea). Measurements were taken by a certified representative of MEDfitness, the exclusive distributor of InBody equipment in Poland. Body composition and body weight was measured in the morning (09:00–10:00 h) at an ambient air temperature of 21°C, 2 h after breakfast and after using the toilet. Interclass correlation coefficients for the body composition measures varied from 0.88 to 0.99.

Body composition, blood count, and lipid profile variables selected for analysis included: body weight (BW), body height (BH), body mass index (BMI), total body water (TBW), fat-free mass (FFM), body fat mass (BFM), skeletal muscle mass (SMM), and percent body fat (PBF); counts of white blood cells (WBC), red blood cells (RBC), hemoglobin (HGB), and hematocrit (HCT); and total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG) counts.

The means and standard deviations were calculated for all variables. Student's *t* test for independent samples was used to identify any significant differences between the experimental and control groups. Student's *t* test for dependent samples was used to identify significant differences between the results obtained pre- and post-intervention. The level of significance was adopted at 5%. All statistical procedures were performed with Statistica ver. 9.0 (Statsoft, USA).

Results

Analysis of body composition in the experimental group revealed significant differences between the baseline and final values for body weight ($p = 0.04$), total body water ($p = 0.008$), fat-free mass ($p = 0.01$), skeletal muscle mass ($p = 0.009$), and percent body fat ($p = 0.04$). The only significant difference in body composition between the experimental and control groups was in percent body fat, and only at baseline ($p = 0.03$) (Table 1).

Analysis of blood count variables in the experimental group revealed significant differences between the baseline and final values for red blood cell ($p = 0.04$) and hemoglobin ($p = 0.004$) counts. Significant differences in baseline and final counts of hemoglobin were observed in the control group ($p = 0.04$). The only significant differences among the selected blood count variables between the experimental and control groups was for white blood cells, and only at baseline ($p = 0.03$) (Table 2).

No significant intra- or inter-group differences were observed among the lipid profile variables (Table 3).

Discussion

Post-intervention measurements of the sample of middle-aged women participating in aqua aerobics classes revealed significant changes in body weight ($p = 0.04$), fat-free mass ($p = 0.01$), total body water ($p = 0.008$), and skeletal muscle mass ($p = 0.009$) when compared with baseline values that were not observed in the control. Similar results were obtained by Sonati et al. [9], who observed that regular physical exercise performed by older women helped reduce body fat content and increase fat-free mass. The beneficial effects of water exercises on body composition were also confirmed by Bergamin et al. [10], Takeshima et al. [11], Kim [12], and Fernández-Lao et al. [13]. However, contrary observations were published by Speakmen and Westerterp [14], who concluded that greater physical activity was not associated with higher fat-free mass in the elderly. The results of Hollmann et al. [15] indicated that the participation of older individuals in structured physical activity helps prevent muscle atrophy. Our results are consistent

Table 1. Body composition variables

	Experimental group		Control group		*t* test for independent variables	
	Mean	*SD*	Mean	*SD*	*t*	*p*
Age (years)	56.20	2.57	56.44	3.28	–0.18	0.86
BH (cm)	162.80	4.76	165.00	3.91	–1.09	0.29
BW_baseline (kg)	74.03	3.84	70.01	11.36	0.72	0.48
BW_final (kg)	73.46	4.67	70.73	11.86	0.89	0.38
t test for dependent variables	**$t = -2.37$**	**$p = 0.04$**	$t = -1.33$	$p = 0.21$		
TBW_baseline (l)	35.47	2.04	34.64	4.64	–0.54	0.60
TBW_final (l)	33.76	2.28	34.36	5.53	0.60	0.56
t test for dependent variables	**$t = -3.34$**	**$p = 0.008$**	$t = 0.84$	$p = 0.42$		
FFM_baseline (kg)	46.74	2.74	47.08	6.33	–0.51	0.62
FFM_final (kg)	47.93	3.09	46.76	7.59	0.54	0.59
t test for dependent variables	**$t = -3.37$**	**$p = 0.01$**	$t = 0.67$	$p = 0.52$		
BFM_baseline (kg)	27.26	3.97	22.88	5.55	1.79	0.09
BFM_final (kg)	25.48	4.53	23.98	5.53	0.92	0.37
t test for dependent variables	$t = 1.4$	$p = 0.19$	$t = -1.85$	$p = 0.1$		
SMM_baseline (kg)	25.08	1.75	25.81	3.85	–0.53	0.60
SMM_final (kg)	26.48	1.88	25.61	4.56	0.56	0.58
t test for dependent variables	**$t = -3.30$**	**$p = 0.009$**	$t = 0.73$	$p = 0.48$		
BMI_baseline (kg/m^2)	27.86	1.74	25.87	3.64	1.27	0.22
BMI_final (kg/m^2)	27.55	2.01	26.07	3.36	1.49	0.16
t test for dependent variables	$t = -1.44$	$p = 0.18$	$t = -0.67$	$p = 0.51$		
PBF_baseline (%)	36.91	4.57	32.44	3.46	**2.38**	**0.03**
PBF_final (%)	34.93	4.15	33.86	4.05	0.57	0.58
t test for dependent variables	**$t = 2.38$**	**$p = 0.04$**	$t = -1.81$	$p = 0.1$		

BH – body height, BW body weight, TBW – total body water, FFM – fat-free mass, BFM – body fat mass, SMM – skeletal muscle mass, BMI – body mass index, PBF – percent body fat; results in bold indicate statistical significance at $p < 0.05$

Table 2. Blood count variables

	Experimental group		Control group		*t* test for independent variables	
	Mean	*SD*	Mean	*SD*	*t*	*p*
WBC_baseline (10^3/µl)	5.54	1.19	7.26	1.91	**–2.38**	**0.03**
WBC_final (10^3/µl)	5.87	1.63	6.41	1.05	–0.85	0.41
t test for dependent variables	$t = -1.12$	$p = 0.28$	$t = 1.69$	$p = 0.12$		
RBC_baseline (10^6/µl)	4.63	0.34	4.81	0.32	–1.17	0.26
RBC_final (10^6/µl)	4.75	0.30	4.79	0.31	–0.33	0.74
t test for dependent variables	**$t = -2.39$**	**$p = 0.04$**	$t = 0.42$	$p = 0.68$		
HGB_baseline (g/dl)	13.71	0.60	14.06	1.21	–0.80	0.43
HGB_final (g/dl)	14.13	0.37	14.34	1.08	–0.59	0.56
t test for dependent variables	**$t = -3.78$**	**$p = 0.004$**	**$t = -2.44$**	**$t = 0.04$**		
HCT_baseline (%)	40.02	1.96	41.01	3.07	–0.85	0.41
HCT_final (%)	37.81	1.11	40.79	3.26	–0.78	0.45
t test for dependent variables	$t = 0.73$	$p = 0.48$	$t = 0.64$	$p = 0.53$		

WBC – white blood cells, RBC – red blood cells, HGB – hemoglobin, HCT – hematocrit; results in bold indicate statistical significance at $p < 0.05$

Table 3. Lipid profile variables

	Experimental group		Control group		*t* test for independent variables	
	Mean	*SD*	Mean	*SD*	*t*	*p*
TC_baseline (mmol/l)	6.13	1.22	5.63	0.75	1.08	0.30
TC_ final (mmol/l)	5.90	1.08	5.95	0.65	–0.11	0.92
t test for dependent variables	*t* = 0.91	*p* = 0.38	*t* = –3.19	*p* = 0.01		
HDL-C_baseline (mmol/l)	1.81	0.25	1.60	0.38	1.45	0.17
HDL-C _final (mmol/l)	1.94	0.42	1.64	0.28	1.83	0.08
t test for dependent variables	*t* = –1.84	*p* = 0.09	*t* = 0.62	*p* = 0.54		
LDL-C_baseline (mmol/l)	3.76	1.01	3.71	0.67	1.00	0.33
LDL-C_final (mmol/l)	3.60	0.91	3.80	0.60	–0.56	0.58
t test for dependent variables	*t* = 0.72	*p* = 0.48	*t* = –3.91	*p* = 0.94		
TG_baseline (mmol/l)	0.99	0.46	1.45	0.67	–1.75	0.10
TG_final (mmol/l)	0.86	0.41	1.41	0.54	–1.29	0.22
t test for dependent variables	*t* = 1.93	*p* = 0.08	*t* = 2.49	*p* = 0.87		

TC – total cholesterol, HDL-C – high-density lipoprotein cholesterol, LDL-C – low-density lipoprotein cholesterol, TG – triglycerides

with this finding, where participation in the 3-month aqua aerobics program resulted in increased skeletal muscle mass ($p = 0.009$).

The literature provides abundant evidence on the beneficial effects of water-based exercises on the human body, especially on body mass, body composition, and muscle strength [16], flexibility [17], and oxygen uptake efficiency (VO_2max) [18, 4]. Apart from an overall increase in physical fitness, other benefits of aqua aerobics are related to the physical, thermal, chemical, and mechanical properties of water. Pool water temperature is frequently lower than human body temperature and can help fortify the body and strengthen the immune system. Metabolic rate also increases in order to compensate for the drop in body temperature. The flow of water over the skin from arm and leg movements strengthens blood vessels and nerve endings, facilitating blood flow and improving nervous system function. In addition, the movement of particular body parts against water has an effect similar to that of a full-body massage and may accelerate blood flow. This results in increased cell oxygen levels and the quicker removal of post-exercise metabolic waste [16].

The absence of significant intergroup differences for BMI might have resulted from the fact that the applied aqua aerobics program was tailored for the elderly female participants. The aim of such exercises was to strengthen and condition particular muscle groups and increase joint flexibility. As such, this was not a typical cardio workout for younger women who wish to lose body fat. There is also some evidence that a higher BMI in the elderly can be beneficial and associated with higher survival rates. Lee et al. [19] studied the relationship between mortality rates and overall adiposity, measured by whole body fat (%), and abdominal adiposity, measured by waist circumference, waist–hip ratio, and relative abdominal fat, in sample of 3975 elderly Chinese (age ≥ 65 years). They found that higher whole body fat (%) as well as a higher proportion of abdominal fat was associated with lower all-cause mortality in men but not women, concluding that "overall adiposity might be protective in old age, but central fat might offset that benefit and remain harmful as in the middle-aged". Such data should be taken into consideration by instructors and trainers when devising health-related training programs for middle-aged and older individuals.

Of the various components of blood, white blood cells (WBC) are responsible for the immune response. Numerous authors have emphasized the association between elevated WBC count and increased incidence of cardiovascular disease [20, 21]. An investigation by Johannsen et al. on sedentary postmenopausal women enrolled in exercise programs revealed a significant decrease in total WBC count [22]. Our experimental group showed an increase in total WBC count when compared with the control group; this difference, however, was not statistically significant ($p = 0.28$). The cause of this inconsistency may have been due to the relatively short experiment duration (3 months) when compared with Johannsen et al. (6 months).

The literature on the effects of physical activity on the number of red blood cells (RBC) in the blood is mostly focused on blood doping [23, 24], recombinant human erythropoietin for enhancing exercise performance [24], and altitude training [25]. There are no data regarding the influence of physical activity on RBC count in elderly individuals. Our investigation revealed a significant RBC increase in the experimental group ($p = 0.04$).

A slight decrease (3.75%) and slight increase (5.38%) in total cholesterol (TC) was observed in the experimental and control groups, respectively. This is important as a high cholesterol level is one of the main risk factors for cardiovascular disease. The risk score among individuals with a cholesterol level ≥ 268 mg/dl is 2.4 fold higher than in those with a total cholesterol < 218 mg/dl [26]. Several authors have also emphasized the role of various cholesterol fractions – high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) [27]. The American College of Sports Medicine [28] defines a HDL-C reading of 60 mg/dL as high enough to protect against heart disease. Furthermore, the occurrence of metabolic syndrome, a group of risk factors that, when occurring together, increases the risk for coronary artery disease, stroke, and type 2 diabetes, is also associated with low HDL-C or high triglyceride level (TG). An individual who meets three of the following five criteria is diagnosed as having the syndrome [29]: abdominal obesity, hypertriglyceridemia ≥ 150 mg/dl, low HDL-C defined as < 40 mg/dl in men and < 50 mg/dl in women, high blood pressure, or high fasting blood glucose. A cross-sectional study [29] found that physically active older individuals have higher HDL-C, lower LDL-C, and lower TG compared with their sedentary counterparts. Following a 1-year experiment on a group of 60 older adults aged 66.75 ± 4.47 years, who exercised three times a week for 60 to 90 min, Van Roie et al. [30] observed an improvement in TC (6.0% decrease), LDL-C (7.6% decrease), HDL-C (2.0% increase), and TG (3.5% decrease). These results are similar to ours (TC: 3.75%, LDL-C: 4.26%, HDL-C: 6.7%, TG: 13.13%). However, all of the abovementioned researchers as well as King et al. [31] concluded that, although older adults can benefit from a regular regimen of moderate-intensity exercise in terms of improved fitness levels and minor improvements in HDL-C levels, physical exercise has limited influence on the risk factors of cardiovascular disease.

Our study showed some differences between the experimental and control groups; in the case of HDL-C, these intergroup differences reached $p = 0.08$. Galán et al. [32] examined 320 participants aged 58–86 years divided into two groups. The first group (EXER) exercised 3 times a week under the supervision of a physiotherapist. The other (EXERAT) followed a similar exercise regime but additionally received a nutritional antioxidant treatment. Ten months of sustained exercise significantly increased ($p = 0.05$) HDL-C by 12.7% and 11.4% in the EXER and EXERAT groups, respectively. Opposite to our results, the researchers also found a significant increase (1.9%) in TG and an unexpected, although insignificant, increase (0.7%) in LDL-C (EXER). The other group (EXERAT) demonstrated a significant reduction of LDL-C by 3.4%. There was also an insignificant increase of TG by 1.6% while EXER participants showed a 14.7% decrease in TG (again comparable to our results). Kamijo and Murakami [33] also found that regular physical exercise significantly lowered TG levels in elderly women. Considering the discrepancies between results reported by different authors, we believe caution must be taken in drawing ultimate conclusions. However, our results are in accordance with those of Tran and Weltman [34], who, based on a meta-analysis of 95 studies conducted between September 1955 and October 1983, found that regular exercise resulted in a 6.3% and 10.1% decrease in TC and LDL-C, respectively, while HDL-C levels, on the other hand, increased by 5%. Our results show that, following the 3-month aqua aerobics program, cholesterol level was within the normal range for four participants while another five exhibited normal LDL-C concentrations ($n = 10$). Nonetheless, one limitation to our study was the lack of diet monitoring, which could have influenced lipid profile values.

Conclusions

1. The experimental group showed a significant decrease in fat-free mass, skeletal muscle mass, percent body fat.
2. The 14-week aqua aerobics program resulted in statistically significant differences between baseline and final red blood cell and hemoglobin counts.
3. Future studies should determine the intensity of physical activity with the most beneficial effect on blood variables in middle-aged and older individuals.

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