EVALUATION OF ANAEROBIC CAPACITY IN STUDENTS ACCORDING TO GENDER BY IMPLEMENTING A FUNCTIONAL TRAINING PROGRAM WITH AQUA FITNESS EQUIPMENT

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Abstract: *Background:* Optimizing anaerobic capacity is an important factor in the physical condition of students. *Aims:* To evaluate the impact of improving aerobic capacity of students by gender, by implementing a 14-week functional training program using aqua fitness equipment.
Methods: The study sample consisted of 40 of subjects (20 males and 20 females), students of general medicine specialization. The samples practiced functional training, carried out for 14 weeks, with two weekly sessions. Within these trainings high intensity and short duration exercises performed with Aqua fitness equipment were included. The study included an anaerobic exercise test performed on a treadmill, evaluating the parameters: volume of oxygen consumed per minute (VO_2 L/min), volume of oxygen consumed per minute per kilogram of body mass (VO_2 ml/min/kg), the respiratory exchange rate between O_2 and CO_2 (RER), respiratory rate (BF - cycles/minute), total amount of air breathed in one minute (VE/L/min) , percentage of normal volume of oxygen consumed (normal VO_2 %), percentage of maximum volume of oxygen consumed (VO_2 peak %) and ventilator equivalent for oxygen and carbon dioxide (VE-VO_2 ;VE-VCO_2). *Results:* The progress between the initial and final testing in both groups, for all parameters of the anaerobic test were statistically significant, for $p<0.05$. The greatest progress in the male group between the initial and final testing was in the parameter VE (L/min) with a value of 5.205, followed by VO_2 peak% with a value of 4.993. The parameter VO_2 normal% had a value of 4.016 and VO_2 (ml/min/kg) recorded a value of 2.294. In the female group, the greatest progress between the initial and final testing was recorded in the VO_2 parameter (ml/min/kg) with a value of 3.281, followed by the value of 2.951 in BF (cycles/minute), 2.387 in VE-VO_2 (L/min) and 2.382 in VO_2peak. *Conclusion:* The relevant results of the study highlight that the male group recorded higher values compared to the female group, in all parameters of anaerobic exercise capacity investigated in the study.
Keywords: anaerobic capacity, functional training, fitness, anaerobic exercises, Aqua fitness equipment.

Introduction

Anaerobic capacity is the body's ability to produce energy in the absence of oxygen, and is found in high-intensity, short-duration activities such as weightlifting. This effort capacity plays a significant role in the development of motor qualities such as strength, speed, and power (Kenney et al., 2015). Anaerobic capacity is directly proportional to the rate at which adenosine triphosphate is released through anaerobic metabolic pathways from fast-twitch muscle fibers. Anaerobic glucose and macroergic phosphate compounds are the systems that support anaerobic effort (Ionescu & Caramoci, 2017). The distribution of fast-twitch muscle fibers in the muscles (type II), phosphocreatine and glucose levels, muscle mass, and the type of physical activity are factors that can influence anaerobic capacity (Stone et al., 2007; Powers & Howley, 2017).
High-intensity training, intermittent speed running or high-intensity functional training effectively contribute to improving anaerobic capacity because they cause metabolic and structural changes in muscle tissue. At the same time, they favor enzymatic and energetic adaptations (Ross & Leveritt, 2001). In addition, functional exercises promote the development of short-term endurance and coordination, essential components of everyday life and various sports (Stone et al., 2007). Anaerobic exercises contribute to maintaining an optimal state of health by increasing bone density, improving metabolism, and body composition.
In assessing students' anaerobic capacity, we used a series of parameters to monitor physiological adaptations to high-intensity, short-duration exercise. The parameters used were: oxygen consumption expressed in liters per minute (VO_2 L/min), volume of oxygen consumed per minute per kilogram of body mass (VO_2 ml/min/kg), respiratory rate BF (cycles/minute), ventilator equivalent for O_2 and CO_2 (VE-VO_2 ,VE-VCO_2 L/min, percentage of normal volume of oxygen

consumed (VO_2 normal %), percentage of maximum volume of oxygen consumed (VO_2 peak %) and total amount of air breathed in one minute (VE L/min). These parameters provide information about energy efficiency, resistance to exercise as well as metabolic changes induced by anaerobic exercise. An important parameter is VO_2 peak %, which represents the maximum oxygen consumption the body can achieve during intense exercise. (McArdle et al., 2010).

A modern approach to fitness is functional training, aimed at improving the individual's ability to effectively perform movement's specific to everyday life. (D 'elia, 2013; Clark et al., 2015). Researchers Andradeas & Saldanha (2012) consider functional training an innovative method for optimizing functional capacity through varied, dynamic movements. This type of training targets the components of physical fitness such as muscular force, cardiovascular endurance, mobility, and coordination (Xiao et al., 2021). Functional training stimulates physiological adaptations that optimize the efficiency of the anaerobic system, due to the complex, multiplanar movements it integrates (Bolye, 2016; Liu et al., 2014). Thus, functional training that integrates exercises performed with your own body weight, traditional or innovative fitness equipment, and performed at high intensity with short recovery breaks, causes the body to predominantly use anaerobic energy (Kraemer & Ratamess, 2004).

The Aqua fitness equipment, consisting of a bag, ball, kettlebell, and dumbbells, is the new element in this study. This equipment is an innovative adaptation of traditional gym materials. In our opinion, these materials are more effective because water generates instability during physical exercises. This aspect significantly increases exercise intensity and allows progressive adaptation of effort, thereby improving anaerobic capacity.

The purpose of the study: optimizing the anaerobic capacity of the two groups of academic students, as a result of the implementation of an experimental functional training program using Aqua fitness equipment for 14 weeks during physical education lessons.

Hypothesis: By implementing a 14-week functional training program using Aqua fitness equipment, the anaerobic capacity of gender-differentiated students will significantly improve.

Materials and methods

Period and place of the study

The study was conducted over 16 weeks and included an initial assessment (IF), a final assessment (FT), and implementation of a functional training program using Aqua fitness equipment over 14 weeks. It is worth mentioning that for the anaerobic exercise test to be carried out in the Functional Explorations Laboratory, part of the Center for Advanced Medical and Pharmaceutical Research, UMFST "G.E. Palade" from Târgu Mureș, we received the agreement from the Ethics and Scientific Research Committee of the UMFST "G.E. Palade" in Târgu Mureș (no. 3169 of 27.05.2024). The study was conducted in accordance with the Code of Ethics of the Declaration of Helsinki. All participants included in the study provided informed consent.

Participants

The study involved a female group of 20 subjects aged 20.3 ± 1 years, with a mean weight of 61.2 ± 3.1, a mean height of 1.69 ± 0.018 cm, and a mean BMI of 21 ± 1.17. The male group of 20 subjects aged 22.75 ± 1.37 years, with a weight of 75.05 ± 2.74 kg, a height of 1.79 ± 0.022 cm, and a BMI of 23.42 ± 1.03. The participants are students at the University of Medicine, Pharmacy, Sciences and Technology "G.E. Palade" in Târgu Mureș, specializing in general medicine.

c) Assessment tools and testing protocol

General anthropometric measurements were performed to characterize the subjects. These included determining body weight and height, using the Tanita DC-240MA scale and a stadiometer. Heart rate measurement was performed by attaching a belt with a textile surface and a rubber portion. Its positioning was performed at the chest level using a fixed clamping system. Data transmission was performed via a wireless system, with the data being transmitted in real time to the PC. The subjects performed the warm-up to prepare their bodies for the effort and prevent injuries. The warm-up lasted approximately 5 minutes and included joint mobility exercises. After the warm-up, the subjects were attached to a respiratory mask that covered the mouth and nose to objectively measure respiratory gases. The mask was connected to the Cortex Metalyzer 3 B ergonomic portable spirometry system, after which the subjects ran for 3 minutes. Then, the treadmill was inclined to 10%, and the participants ran for 30 seconds at the maximum speed recorded in the aerobic exercise test. Post-exercise recovery was performed on an incline of 6.5 km/h for 1 minute and 2 minutes at an incline of 4.5 km/h.

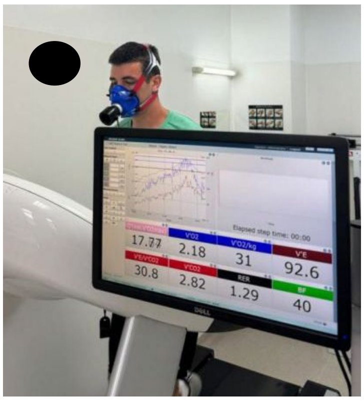

Figure 1. Image of performing the anaerobic exercise test

Functional training program using Aqua fitness equipment

The functional training program was implemented for 14 weeks, with two sessions per week, each lasting 60 minutes. The program structure was designed to integrate high-intensity exercises, performed in short intervals, with recovery periods adapted to the subjects' particularities, with the objective of optimizing anaerobic capacity. Each lesson was structured into a general warm-up, a specific Aqua fitness exercise segment, and a post-workout recovery segment.

e) Statistical analysis

SPSS 24 software was used to analyze the results of this study, calculating the following parameters: mean, standard deviation (SD), minimum, maximum, variation, and coefficient of variation (CV). To identify the differences between the means of the two tests, we calculated the paired T-Test and Cohen's d, which quantifies the effect size. Interpretation of the effect size: <0.3 small effect, between 0.3 and 0.5 medium effect, between 0.5 and 0.8 large effect,>0.8 very large effect. The significance threshold was set at $p < 0.05$. At the same time, we applied an independent t-test between male and female subjects to highlight significant differences in anaerobic capacity.

Results

In Table I, we presented the descriptive results of the female group in the anaerobic test. Analyzing the results, we find that the mean values increased compared to the initial testing for all test parameters, indicating the evolution of the group of participants. The coefficient of variability falls between 10-20% and decreased during the final testing, indicating that the subjects' results are close and the group is homogeneous.

Table I. Descriptive statistics for the anaerobic test of the female group

Parameters	Testing	Mean	SD	Min.	Max.	Variances	CV (%)
VO_2 (L / min)	IT	2,481	0.290	2.05	3.12	0.084	11,688
	FT	2,745	0.186	2.51	3.22	0.035	6,775
VO_2 (ml/min/kg)	IT	40,305	2,887	33.14	46.02	8,338	7,162
	FT	43,587	1,469	42.08	47.10	2,159	3,370
VE (L /min)	IT	95,033	3,000	89.60	99.70	9,001	3,156
	FT	97,115	2,433	92.34	101.20	5,921	2,505
VE-VO $_2$ (L/min)	IT	35,739	2,381	31.44	39.70	5,672	6,662
	FT	33,352	2,117	30.10	37.50	4,485	6,347
VE- V CO $_2$ (L/min)	IT	32,690	2,597	29.74	37.78	6,749	7,944
	FT	30,753	2,147	27.60	34.60	4,610	6,981
BF (cycles/min)	IT	51,859	5,632	41.20	65.78	31,723	10,860
	FT	48,907	4,162	40.10	56.40	17,324	8,510
RER	IT	1,211	0.044	1.10	1.28	0.002	3,633
	FT	1,240	0.032	1.18	1.30	0.001	2,580
Normal VO_2 %	IT	101,567	1,062	100.20	103.50	1,128	1,045
	FT	103,506	0.885	102.34	105,506	0.784	0.855
VO_2 peak %	IT	96,938	1,076	95.12	98.60	1,159	1,109
	FT	99,320	0.985	98.12	101.20	0.971	0.991

IT-initial test; FT – final test, Mean-Media; SD-standard deviation; Min-minimum, Max-maximum; CV%-coefficient of variability; VO_2 (L/min)-volume of oxygen consumed per minute; VO2/kg (ml/min/kg)-volume of oxygen consumed per minute per kilogram of body mass; VE (L/min)-total amount of air breathed in one minute expressed in liters/minute; VE-VO_2 (L/min) ventilator equivalent for O2, expressed in liters/minute, VE/VCO_2 - ventilator equivalent for CO_2; RER-respiratory exchange rate between O_2 and CO_2; BF (cycles/minute)-respiratory frequency, VE (L/min)-total amount of air breathed in one minute; VO_2 normal%-percentage of normal volume of oxygen consumed; VO_2 peak% - percentage of maximum volume of oxygen consumed.

Paired Student T-test interpretation highlights that for all parameters of the anaerobic test between the initial and final testing it was statistically significant, for $p<0.05$ (Table II). Analyzing the results in Table 2, we find that the greatest improvement between the initial and final tests was in the VO_2 parameter (ml/min/kg), with a value of 3.281, followed by BF (cycles/min) at 2.951. The ventilator equivalent for oxygen (VE-VO_2 L/min) recorded a value of 2.387, and the VO_2 peak% was 2.382. The total amount of air breathed (VE l/min) in one minute was 2.082 and the percentage of the normal volume of oxygen (VO_2 normal %) was 1.939. The lowest results were recorded for the respiratory exchange rate (RER) and the volume of oxygen consumed /minute (VO2 L/min), with a value of 0.264. Cohen's da values were > 0.8 for the parameters VO_2 (L /min); VO_2 (ml/min/kg); VE-VO_2 (L/min), VE- V CO_2 (L/min), VO_2 normal% and VO_2 peak%, which reflects a very large effect size. For the parameters BF (cycles/min) and RER, the effect size value was large. These aspects highlight the efficiency of the experimental program, achieved through innovative equipment.

Table II. Paired samples T and Cohen's d for the anaerobic test of the female group

Parameters	Diff (XFT-XIT)	SD	95% CI		t	p	Cohen's
			Lower	Upper			
VO_2 (L/min)	0.264	0.176	0.181	0.346	6,679	0	1,083
VO_2 (ml/min/kg)	3,281	2,518	2,102	4,460	5,827	0	1,432
VE (L/min)	2,082	0.924	1,649	2,514	10,074	0	0.762
VE-VO2 (L/min)	2,387	1,077	2,891	1,882	9,911	0	1,059
VE- V CO_2 (L/min)	1,937	0.810	2,316	1,557	10,690	0	0.812
BF	2,951	2,088	3,929	1,973	6,319	0	0.600
RER	0.029	0.022	0.018	0.039	5,837	0	0.753
Normal VO_2 %	1,939	0.877	1,528	2,349	9,883	0	1,985
VO_2 peak %	2,382	0.803	2,006	2,758	13,256	0	2,309

Dif (XFT-XIT)-difference of the mean, SD – standard deviation, SEM - Standard Error of the Mean , CI – confidence coefficient, t – Student T value, p – level of statistical significance; Cohen's d- Effect for the paired mean difference.

In table III, we presented the descriptive results of the male group in the anaerobic test. Analyzing the results, we found that the mean values increased compared to the initial testing for all test parameters, indicating the evolution of the female group. The coefficient of variability is below 10% and decreased in the final testing, highlighting the fact that the results are very close, and the group is very homogeneous.

Table III. Descriptive statistics for the anaerobic test of the male group

Parameters	Testing	Mean	SD	Min.	Max.	Variances	CV (%)
VO_2 (L/min)	IT	3,525	0.318	3.09	3.98	0.101	9,021
	FT	3,790	0.181	3.45	4.05	0.033	4,775
VO_2 (ml /min/kg)	IT	47,825	1,785	44.40	50.10	3,188	3,732
	FT	50,119	1,102	48.30	52.35	1,216	2,198
VE (L/min)	IT	112,247	3,687	104.55	119.46	13,598	3,284
	FT	117,453	2,007	114.56	121.35	4,029	1,078
VE-VO_2 (L/min)	IT	34,214	2,280	30.95	37.77	5,200	6,663
	FT	31,661	1,075	29.78	33.20	1,156	3,395
VE-VCO_2 (L/min)	IT	28,623	2,962	23.50	36.53	8,779	10,348
	FT	26,342	2,370	22.60	30.50	5,620	8,997
BF (cycles/min)	IT	52,496	1,849	50.20	57.22	3,422	5,537
	FT	50,941	1,694	48.82	55.78	2,872	2,243
RER	IT	1,198	0.044	1.12	1.29	0.005	3,672
	FT	1,246	0.031	1.19	1.29	0.001	2,487
Normal VO_2 %	IT	104,333	1,658	100.30	106.50	2,751	1,589
	FT	108,349	1,352	105.40	110.23	1,831	1,247
VO_2 peak%	IT	100,887	1,261	98.23	102.91	1,592	1,249
	FT	105,880	1,173	103.89	107.90	1,377	1,107

IT-initial test; FT – final test, Mean-Media; SD-standard deviation; Min-minimum, Max-maximum; CV%-coefficient of variability; VO_2 (L/min)-volume of oxygen consumed per minute; VO2/kg(ml/min/kg)-volume of oxygen consumed per minute per kilogram of body mass; VE(L/min)-total amount of air breathed in one minute expressed in liters/minute; VE-VO_2 (L/min) ventilator equivalent for O2, expressed in liters/minute, VE/VCO_2 - ventilator equivalent for CO_2; RER-respiratory exchange rate between O_2 and CO_2; BF(cycles/minute)-respiratory frequency, VE (L/min)-total amount of air breathed in one minute; VO_2 normal%-percentage of normal volume of oxygen consumed; VO_2 peak% -percentage of maximum volume of oxygen consumed

Paired Student T-test interpretation indicates that, for all anaerobic test parameters, the difference between the initial and final tests was statistically significant at $p < 0.05$ (Table IV). Analyzing the results in Table IV, we find that the greatest progress between the initial and final testing was in the VE (L/min) parameter, with a value of 5.205, followed by VO_2 peak %, with a value of 4.993. The VO_2 normal % parameter had a value of 4.016, and VO_2 (ml/min/kg) recorded a value of 2.294. The oxygen and carbon dioxide equivalents (VE-VO_2 and VE-VCO_2) were similar, at 2.553 and 2.280, respectively. At the same time, the respiratory frequency (BF cycles/minute) was 1.555. The lowest results were recorded at RER of 0.048 and oxygen consumption per minute of 0.265. Cohen's values were >0.8 for all parameters, indicating a very large effect size and demonstrating the effectiveness of the experimental program using innovative equipment.

Table I V. Paired samples T and Cohen's size la anaerobic test of the male group

Parameters	Diff (XFT-XIT)	SD	95% CI		t	p	Cohen's
			Lower	Upper			
VO_2 (L / min)	0.265	0.182	0.180	0.350	6,512	<0.001	1,024
VO_2 (ml/min/ kg)	2,294	1,527	1,578	3,009	6,714	<0.001	1,546
VE (L /min)	5,205	2,813	3,888	6,521	8,274	<0.001	1,753
VE-VO $_2$ (L/min)	2,553	1,830	3,410	1,696	6,240	<0.001	1,433
VE-CO_2 (L/min)	2,280	1,664	3,059	1,501	6,126	<0.001	0.850
BF	1,555	1,132	2,085	1,024	5,483	<0.001	0.876
RER	0.048	0.039	0.029	0.066	6,138	<0.001	1,261
Normal VO_2 %	4,016	1,674	3,232	4,799	10,724	<0.001	2,654
VO_2 peak %	4,993	1,456	4,311	5,674	15,333	<0.001	4,100

Dif (XFT-XIT)-difference of the mean, SD – standard deviation, SEM - Standard Error of the Mean, CI – confidence coefficient, t – Student T value, p – level of statistical significance; Cohen's d- Effect for the paired mean difference.

According to Table V, at the initial testing, the comparative analysis of the two groups revealed statistically significant differences for the parameters VE (L/min) = 17.214; VO_2 (ml/min/kg) = 7.520, VE–VCO_2 = 4.067, and VO_2 peak (%) = 3.949. The effect size, expressed by Cohen's coefficient, had a very large effect of 3.43 for VO2 (L /min); 3.13 for VO_2 ml /min/kg); 5.12 for VE (L/min); 1.46 for VE-VCO_2 (L/min), 2 for VO_2 normal % and 3.37 for VO_2 peak %. Regarding the parameter BF (cycles/minute), a small effect of 0.15 was recorded, and for RER, the value was 0.27. Small differences between the two groups were observed in the case of normal VO_2 (%) = 2.766, VE–VO_2 = 1.525; VO_2 (L/min) = 1.043, BF (cycles/min = 0.637, and RER = 0.012. At the final testing, the comparative analysis revealed statistically significant differences for the parameters VE (L/min) = 20.338; VO_2 peak (%) = 6.560; VO_2 (ml/min/kg) = 6.532; VE–VCO_2 = 4.410, and normal VO_2 (%) = 4.843. Small differences between the two groups were observed in the case of BF (cycles/min) = 2.034, VE–VO_2 = 1.691, VO_2 (L/min) = 1.043, and RER = 0.006. Size The effect, expressed by the Cohen 's coefficient, had a very large effect, of 5.68 at VO_2 (L /min) ; 5.12 at VO_2 (ml/min/kg); 9.12 at VE(L/min); 1.95 at VE-VCO_2 (L/min); 4.24 at VO_2 normal % and 6.06 at VO_2 peak. In parallel, a moderate effect was observed for the BF parameter (cycles/minute), with a value of 0.64, and for RER, 0.19. The comparative effect between the two groups was high at the initial testing for most parameters and at the final testing an additional improvement of the value was observed, reflecting the efficiency of the implemented program. At the same time, the results of the comparative analysis reflect the fact that the group of male participants recorded higher values than the group of female participants, both at the initial testing and at the final testing for all test parameters. This difference is due to physiological factors such as muscle mass percentage, body composition and cardiorespiratory capacity. These aspects are consistent with the literature, which demonstrates that male subjects register higher values of anaerobic and aerobic capacity.

Table V. Independent Sample T-test for male and female group

Test	Testing	Levene's Test		t	p	Diff (XFT-XIT)	95%CI		Cohen 's d
		F	p				Lower	Upper	
VO₂ (L/min)	IT	1,665	0.205	10,823	<0.001	1,043	1,238	0.848	3.43
	FT	0.289	0.594	17,989	<0.001	1,045	1,162	0.927	5.68
VO₂(ml/min/kg)	IT	1,956	0.170	9,906	<0.001	7,520	9,056	5,938	3.13
	FT	2,159	0.150	15,902	<0.001	6,532	7,364	5.70	5.03
VE (L /min)	IT	0.218	0.643	16,195	<0.001	17,214	19,366	15,062	5.12
	FT	0.276	0.603	28,834	<0.001	20,338	21,765	18.91	9.12
VE-VO₂ (L/min)	IT	0.008	0.931	2,068	<0.001	1,525	0.032	3,017	0.65
	FT	8,365	0.006	3,185	<0.001	1,691	0.616	2,766	1.01
VE-VCO₂ (L/min)	IT	0.039	0.845	4,616	<0.001	4,067	2,283	5.85	1.46
	FT	0.437	0.513	6,167	<0.001	4,410	2,962	5,858	1.95
BF	IT	10,798	0.002	0.481	<0.001	0.637	3,321	2,046	0.15
	FT	9,060	0.005	2,024	<0.001	2,034	4,068	0.000	0.64
RER	IT	0.183	0.671	0.884	<0.001	0.012	0.016	0.041	0.27
	FT	0.070	0.793	0.641	<0.001	0.006	0.027	0.014	0.19
VO₂ normal %	IT	5,283	0.027	6,282	<0.001	2,766	3,658	1,874	2.00
	FT	3,349	0.075	13,397	<0.001	4,843	5,575	4,111	4.24
VO₂ peak%	IT	0.238	0.629	0.650	<0.001	3,949	4,700	3,198	3.37
	FT	0.370	0.545	19,146	<0.001	6,560	7,253	5,866	6.06

F-statistic from Levene's Test for Equality of Variances; Sig.- Significance (p-value) of Levene's Test; t- t -statistic from the independent samples t-test; Sig. (2-tailed)- Two-tailed p-value for the t-test; Mean Difference (MD) - difference between the means of the two groups; Std. Error Difference (SE)- Standard error of the mean difference; 95% CI Lower / Upper- Lower and upper bounds of the 95% confidence interval for the mean difference; Cohen's d- Effect size for the mean difference.

Discussions

In this study, the optimization of anaerobic capacity of two groups of students was investigated by implementing a functional training program using Aqua fitness equipment. The results obtained highlight the fact that the application of the training program led to significant improvements in anaerobic capacity, the progress recorded at the final testing being superior to those found at the initial testing. At the same time, the present study makes a relevant contribution to deepening knowledge in the field of fitness and functional training, the results being consistent with scientific approaches in the specialized literature regarding the efficiency of similar interventions.

A study by Ma and Thongdecharoen (2023) examined the effects of a functional training program on muscle strength, agility, power, and anaerobic capacity in 30 amateur boxers. The training program was implemented for 8 weeks, with 3 sessions/week. The results revealed significant improvements in anaerobic capacity and other parameters in the experimental group compared to the control group. According to Eken et al., (2022) high-intensity functional training contributes to significant improvements in anaerobic capacity parameters. The study was conducted on a group of 15 kickboxers aged 18-25. Erol et al. (2022), investigated the effects of functional training on anaerobic capacity. The program was implemented for 6 weeks, with 2 weekly sessions on a group of 22 soccer players. The results showed that functional training improved specific parameters of anaerobic capacity.

Functional training is an effective method for optimizing anaerobic capacity through physiological adaptations that support intense and short-term effort. Complex exercises target multiple muscle groups and stimulate anaerobic metabolism. Thus, regular practice of functional exercises provides benefits in both high-intensity physical activities and sports performance. Studies suggest that high-intensity functional training contributes to improving anaerobic, aerobic capacity and musculoskeletal fitness (Mcweeny et al., 2020). In addition to the beneficial effects on anaerobic capacity, functional training improves dynamic balance by stimulating neuromuscular coordination and postural control during the execution of complex movements (Caglayan & Ozbar, 2022). Improving physical fitness should be approached in an interdisciplinary manner to determine the impact and relationship of essential factors and determined according to the characteristics of the content and the particularities of the subjects (Badau et al, 2015, Badau et al., 2018, Badau et al. 2021; Badau et al., 2023; Morina et al., 2021).

Limitations of the study

The present study is subject to several limitations that should be acknowledged when interpreting the findings. First, the relatively modest sample sizes in both groups, combined with the restriction of participant eligibility to students aged 19-25 years, may limit the generalizability of the results to broader populations. Second, the 14-week intervention period, while sufficient to observe measurable adaptations, may not capture the full spectrum of long-term physiological changes associated with aquatic functional training. Third, the exclusion of other age categories and diverse population groups represents a further constraint, as the observed effects may differ considerably across varying developmental and fitness profiles. Finally, the absence of a comparative analysis between the Aqua fitness equipment-based experimental program implemented in the present study and alternative functional training modalities constitutes an additional limitation, as it precludes definitive conclusions regarding the relative efficacy of this approach within the broader landscape of functional training interventions.

Practical implications of the study

Based on the results, functional training programs using innovative Aqua fitness equipment significantly contribute to optimizing anaerobic capacity. We believe that it is necessary to introduce this equipment into training programs to stimulate active participation and motivation of the subjects. Furthermore, integrating aquatic functional training into periodized programs may offer a complementary approach to traditional land-based methods, enhancing overall athletic performance while reducing the risk of musculoskeletal injury. Future research should explore the long-term effects of such programs across diverse athletic populations to establish standardized protocols and evidence-based guidelines for their implementation in competitive sports settings.

Conclusions

The findings derived from the Anaerobic Exercise Test provide compelling evidence for the effectiveness of the functional training program incorporating Aqua fitness equipment. Among all measured parameters, the most substantial improvements were recorded in ventilator equivalent (VE) and peak oxygen uptake percentage (VO_2 peak %), suggesting that aquatic functional training elicits significant adaptations in both ventilator efficiency and maximal aerobic power output. The individualized design of the functional training program, tailored to participants' specific physiological and performance characteristics, proved instrumental in optimizing anaerobic capacity throughout the study period. The comparative analysis between groups revealed that male participants consistently recorded higher values than their female counterparts across all assessed parameters at both the initial and final testing points. These observed inter-sex differences are attributable to well-established physiological determinants, including differences in skeletal muscle mass percentage, body composition profiles, and cardiorespiratory capacity, all of which are known to confer a significant advantage in anaerobic performance among male students.

Conflict of interest

There is nothing to declare.

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There is nothing to declare.

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