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THE INFLUENCE OF PHYSICAL EXERCISES CARRIED OUT IN THE AQUATIC ENVIRONMENT ON PHYSIOLOGICAL PARAMETERS FOR 10 – 12 YEAR TENNIS PLAYERS

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ABSTRACT. The objective of this study is to highlight the effect of physical exercises specific to the game of tennis, carried out in the aquatic environment to optimize the effort capacity of the players practicing this sport on the physiological parameters of the players in this sport. The impact of such an intervention program in the aquatic environment is a multilateral one, having benefits on optimizing performance capacity, maintaining an optimal state of health and opening new horizons for children practicing the game of tennis. A novelty element of this experimental research is represented by the implementation in the training program of tennis players in the aquatic environment and exercises from other sports branches such as swimming, gymnastics and athletics. The intervention program is a bold attempt to weave and combine exercises from different sports, in a non-specific and totally different environment, in order to improve performances and results, looking at the perspective, without necessarily aiming at great current performances, in the short term, which could bring disappointments, create certain barriers or even lead to the abandonment of sports activities.

Keywords: *tennis, performance, aerobic capabilities, unconventional training*

REZUMAT. ***Influența exercițiilor fizice effectuate în mediul acvatic asupra parametrilor fiziologici la jucătorii de tenis de 10 -12 ani*.** Această lucrare își propune să evidențieze efectul exercițiilor fizice specifice jocului de tenis, desfășurate în mediul acvatic asupra parametrilor fiziologici ai jucătorilor din acest sport. Tenisul modern se caracterizează prin restructurarea conținutului

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pregătirii, în contextul amplificării spectacolului sportiv. Azi, tenisul presupune un fond specific de aptitudini ale jucătorilor, care include în primul rând o pregătire polivalentă, manifestarea unei mari libertăţi de creaţie, de inventivitate tactică, ce nu poate fi exprimată decât de indivizii care au atins un înalt nivel de măiestrie tehnică, fizică si psihologică. Sportivii de tenis de performanţă au nevoie de un amestec de abilităţi anaerobe, cum ar fi viteza, agilitatea şi puterea, combinate cu capacităţi aerobe mari. (Kovacs et al., 2007). Frecvenţa cardiacă este un aspect esenţial pentru un antrenor, deoarece oferă informaţii despre intensitatea efortului fizic în raport cu capacităţile fiecărui individ (Cumming, 2017). Însemnătatea pregătirii fizice este unanim recunoscută, deoarece constituie suportul activităţii jucătorilor care astfel îşi pot valorifica posibilităţile tehnico-tactice si psihologice. În aceste condiţii, necesitatea aplicării unor mijloace şi metode de pregătire inedite, "neconvenţionale" adecvate influenţării pozitive a capacităţii de performanţă, reprezintă din punctul nostru de vedere o preocupare esenţială a specialistului din domeniul motricităţii. În timpul alergării prin apă, consumul de oxigen este de 3 ori mai mare, la o viteză de 50m/min, această valoare se poate obţine la o viteză considerabil mai mică decât la o alergare pe uscat (Brinks et al., 2009).

Cuvinte cheie: *tenis, performanţă, capacităţi aerobe, antrenament neconvenţional*

INTRODUCTION

Tennis is the sport in which elegance, dynamism and emotional many states combine harmoniously, contributing considerably to the development and maturation of man on a sporting and social level. It is considered one of the most complex sports and at the same time the most demanding. It requires balance control, eye-brain-limb coordination, quickness, speed of thought, speed of reaction and movement, endurance, and a strange combination of caution and abandon that we name courage.

The theoretical-practical knowledge related to the game of tennis demonstrates the fact that this sport has evolved significantly in terms of the effort it involves and therefore I consider it imperative to improve and develop the effort capacity, the physiological parameters as well as the motor qualities, speed in all its forms of manifestation, strength and resistance.

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During running through water, oxygen consumption is 3 times higher at a speed of 50m/min, this value can be achieved at a considerably lower speed than running on land (Brinks et al., 2009).

Competitive tennis athletes need a mixture of anaerobic skills, such as speed, agility and power, combined with high aerobic capabilities (Kovacs et al., 2007).

Heart rate is an essential aspect for a trainer, as it provides information about the intensity of physical effort in relation to the capabilities of each individual (Cumming, 2017).

The judicious intercession of conventional means with the "unconventional" adapted (in which practical executions are doubled by the permanent cerebral demand, where the intervention of some new stimuli requires the ability of attention forcing the player to overachiever thus inducing adaptations of performance capacity) must be an essential requirement of current preparation and an essential concern of the specialist in the motor field.

From a biological point of view, physical and especially sports effort is an appropriate biological (exciting) stimulus that forces the body to respond through electrical, mechanical, thermal manifestations (Monea, 2010).

In the specialized literature, there are scientific articles that demonstrate the fact that an aquatic gymnastics program that includes aerobic exercises, running, specific jumps and different distances covered by swimming procedures, significantly improves blood oxygen intake, heart rate and muscle strength, so these programs are also recommended for people who want to get in the best possible physical condition (Villacis, 2017; Ivanova, 2019; Pieniązek et al., 2021).

MATERIAL AND METHODS

Purpose of research

Monitoring training programs in the aquatic environment in order to identify the most relevant aspects that can contribute to the optimization of effort capacity and their subsequent implementation in long-term planning in the tennis game.

The selection of some means and the development of an unconventional methodical line (carried out in the aquatic environment) dedicated to optimizing the physiological profile, respectively increasing the effort capacity imposed by current tennis.

The comparative analysis of the recorded values, their interpretation and the statement of conclusions that reveal the efficiency (inefficiency) of the integration of the previously mentioned means in the sports training of children and juniors in the game of tennis.

Hypotheses of the research

The starting point in the proposed practical-methodical approach has as its starting point the following remark: if the situations in which the athlete is transposed in the preparation process are diversified and the executions have an appropriate dosage (volume, intensity, complexity) the motor accumulations obtained through the specific exercise can be effectively transferred to current court tennis (positive transfer).

Considering that the optimization of sports training in current field tennis is conditioned by the level of effort capacity, we will organize (carry out) an experimental study that will confirm/invalidate the hypothesis according to which the integration in training of tennis-specific motor structures adapted (held) in the aquatic environment will had the effect of optimizing the effort capacity of 10-12 year old tennis players and will induce increases in physiological parameters as expected.

Procedures and methods of research

Bibliographic Bibliographic study, organizing-conducting the experimental study, graphical analysis, statistical relevance (arithmetic mean, median, standard deviation, coefficient of variation, amplitude);

Procedure

This research used the Cosmed K5 spirometer, wich is a portable device used to assess lung function during exercise. This is a useful method to assess lung capacity, tidal volume and airflow under exercise to assess respiratory function and fitness in athletes. This spirometer provides data such as tidal volume, vital capacity, maximum expiratory flow rate, inspired and expired oxygen and many other parameters that can be used to monitor and optimize training. The K5 also allows the evaluation of a number of cardiovascular parameters such as heart rate, blood pressure and oxygen saturation, thus enabling the overall assessment of sports and fitness performance. The device was used to monitor vital capacity.

Applied test

The VAMEVAL test being the means of evaluation for this physiological parameter.

The field test consists in two chalenges of a progressive run between two lines drawn at a distance of 20 meters from each other. The pace of the run is dictated by a CD-player that emits audible beeps, the player must cover the distance between the two lines in the interval between the beeps. The player will aim to move at a running speed so that they reach the line and turn at the beep.

Participants and experiment development

The subjects of the experiment in number 20 organized in the two conventional experimental groups (experimental and control) are engaged in performance activity with numerous participations in field tennis competitions.

While the control group performed a standard training programme according to the conventional training plan, the experimental group took part in adapted training stages (where the actuators are adapted to the aquatic environment), traineeships inserted in conventional annual plan. The means and methods applied under the adapted, unconventional program refer synthetically to: displacement in water, water games (volleyball, polo, badminton, exercises imitative forehand and backhand strokes using mis stringless racquets). All these means and methods are carried out in swimming pools, where athletes have evolved into water with increased progressive depth (knee level, coxofemurale joints, elbow, scapular-humerale joints).

The introduction in the training program of swimming exercises (free style) over a distance of 100-125m can have a significant contribution to the improvement of physiological parameters of junior tennis players.

The short-term cold water program increases the output of striated muscles, so fatigue sets in later (Knechtle et al., 2020). Increases cardiopulmonary endurance - swimming trains and strengthens the cardiovascular system, increasing the ability of the heart and lungs to deliver oxygen to the muscles and remove carbon dioxide (Muniz-Pardos et al., 2022). The tennis players of the experimental group who took part in the research carried out physical exercises in the aquatic environment with an average of 7.5 hours during one month. Thanks to a systematic physical effort, dosed and adapted to the particularities and needs of each individual, the nervous system, which coordinates the entire activity, undergoes a series of positive changes (Görner, 2020; Turdaliyevich & Pulatovna, 2020; Yapici-Öksüzoğlu, 2020).

The introduction in the training program of swimming exercises (free style) over a distance of 100-125m can have a significant contribution to the improvement of physiological parameters of junior tennis players.

Table 1.
Initial evaluation
Systolic and diastolic blood pressure and vital capacity
Experimental Group

No.	Name	Systolic and diastolic blood pressure	Vital capacity
1	M.C	115-70	3348.5
2	F.I.	120-70	3480
3	A.M.	120-75	3650
4	F.S.	110-65	3285.5
5	S.C.	100-60	3860
6	F.A.	115-75	3530
7	S.D.	115-75	3115.5
8	P.M.	100-55	3360
9	P.A.	100-75	3575
10	S.A.	115-70	3060.5

Table 2.
Initial evaluation
Systolic and diastolic blood pressure and vital capacity
Control Group

No.	Name	Systolic and diastolic blood pressure	Vital capacity
1	S.R.	120-70	2755
2	O.K.	110-65	3435
3	L.C.	120-70	3320.5
4	H.E.	125-75	3800
5	R.G.	100-55	3000
6	M.S.	125-80	3220
7	T.D.	110-60	3475.5
8	M.R.	105-65	2985.5
9	N.S.	105-60	3100
10	R.A.	120-70	3635

Table 3.
Final evaluation
Systolic and diastolic blood pressure and vital capacity
Experimental Group

No.	Name	Systolic and diastolic blood pressure	Vital capacity
1	M.C	120-70	3590.5
2	F.I.	125-75	3710
3	A.M.	125-80	3840.5
4	F.S.	115-70	3500
5	S.C.	110-70	4025.5
6	F.A.	120-75	3795
7	S.D.	120-70	3325
8	P.M.	110-70	3545.5
9	P.A.	115-80	3690.5
10	S.A.	120-80	3220

Table 4.
Final evaluation
Systolic and diastolic blood pressure and vital capacity
Control Group

No.	Name	Systolic and diastolic blood pressure	Vital capacity
1	S.R.	120-70	2865
2	O.K.	115-70	3530
3	L.C.	125-75	3420.5
4	H.E.	130-75	3870.5
5	R.G.	110-65	3115
6	M.S.	130-85	3295
7	T.D.	115-60	3580
8	M.R.	105-70	3100.5
9	N.S.	110-65	3195.5
10	R.A.	120-70	3755

RESULTS AND DISCUSSIONS

In the experiment aimed at optimizing the physiological parameters, the results with reference to the systolic pressure indicate a statistically insignificant difference, therefore the hypothesis is rejected.

In the experiment aimed at optimizing the physiological parameters, the results with reference to the diastolic pressure indicate a statistically insignificant difference, therefore the hypothesis is rejected.

In the experiment aimed at optimizing the physiological parameters, the results with reference to the vital capacity indicate a statistically insignificant difference, therefore the hypothesis is rejected.

Regarding the hypothesis according to which the integration into the sports training of some motor structures specific to tennis carried out in the aquatic environment can have a positive effect on the effort capacity of 10-11-year-old tennis players and can induce increases in physiological parameters, the results of the experiments from hypothesis perspective are still uncertain and requires more research on this. However, preliminary data show that water training may be beneficial for developing exercise capacity and improving performance in tennis athletes.

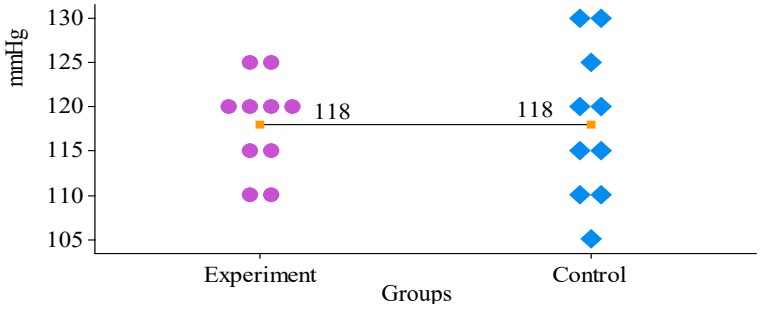
Table 5. *Systolic Blood pressure Test/Statistics*

Statistical indicators	Experiment	Control	Statistical indicators	Experiment-Control	
Average	118	118	Average difference		0.00
Median	120.0	117.5	Average difference (%)		0.00%
Std. deviation	5.37	8.56	The non-parametric test Mann-Whitney	Z	p
Minimum	110	105		-0.077	0.938
Maximum	125	130	Effect size		0.02
Amplitude	15	25			
Coef. variability	4.6%	7.3%			

The mean systolic blood pressure has a value of 118 mmHg in both the experiment and the control. In the case of both groups the dispersion of the results is homogeneous. The size of the effect is very small, almost non-existent. The Mann-Whitney test indicates a statistically significant difference between the two groups, the significance threshold $P = 0.938 > 0.05$, for $Z = -0077$.

Synthesis

Mean difference	Effect size	The difference between the groups is	Null hypothesis
0.00(0%)	Very low	statistically insignificant	Is accepted



Graph 1. *Diastolic blood pressure/ average representation*

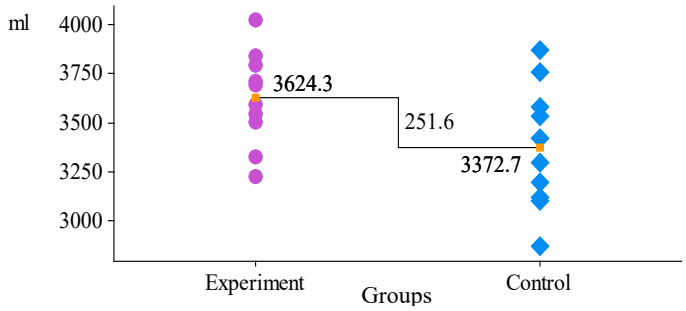
Table 6. *Diastolic Blood pressure Test/Statistics*

Statistical indicators	**Experiment**	**Control**	**Statistical indicators**	**Experiment-Control**	
Average	74.0	70.5	Average difference		3.5
Median	72.5	70.0	Average difference (%)		4.73%
Std. deviation.	4.59	6.85	The non-parametric test Mann-Whitney	Z	p
Minimum	70	60		--1.435	0.151
Maximum	80	85	Effect size		0.32
Amplitude	10	25			
Coef. variability	6.2%	9.7%			

The diastolic blood pressure is higher in the experiment Group on average with 3.5 mmHg (4.73%). The results are homogeneously dispersed for both groups. The size of the effect is medium. The results of the Mann-Whitney test indicate a statistically significant difference between the two groups, the significance threshold P = 0.151 > 0.05, for Z =-1,435.

Synthesis

Mean difference	Effect size	The difference between the groups is	Null hypothesis
3.5 (4.73%)	medium	statistically significant	Is accepted



Graph 2. *Diastolic blood pressure/ average representation*

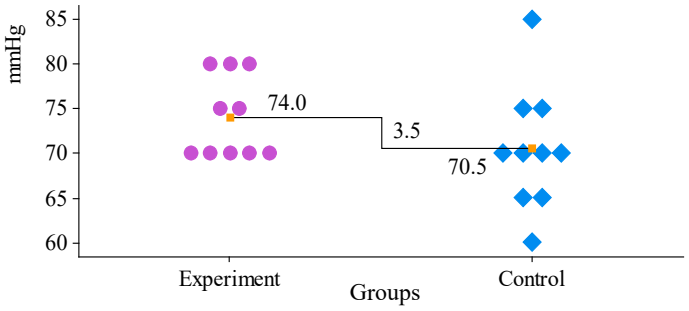
Table 7. *Vital Capacity Test/Statistics*

Statistical indicators	Experiment	Control	Statistical indicators	Experiment-Control	
Average	3624.3	3372.7	Average difference		251.6
Median	3640.50	3357.75	Average difference (%)		6.94%
Std. deviation.	241.39	316.17	The non-parametric test Mann-Whitney	Z	p
Minimum	3220	2865		-1.814	0.070
Maximum	4026	3871	Effect size		0.41
Amplitude	806	1006			
Coef. variability	6.7%	9.4%			

The average value for vital capacity is higher in the experiment Group with 251.6 ml (6.94%). The results are homogeneously dispersed for both groups. The size of the effect is medium to sea. The results obtained by the athletes of the two groups are not significantly different, according to the Mann-Whitney test. Significance threshold P = 0.070 > 0.05, for Z = - 1.814.

Synthesis

Mean difference	Effect size	The difference between the groups is	Null hypothesis
251.6 (6.94%)	Medium to high	statistically insignificant	Is accepted



Graph 3. *Vital capacity/ average representation*

DISCUSSIONS

Regarding the physiological parameters Igarashi & Nogami (2018) after conducting a study stated that exercise on land, aquatic exercise should have a beneficial effect by lowering blood pressure. In addition, aquatic exercise should lower the blood pressure of subjects with hypertension, and other forms of aquatic exercise besides swimming should also lower blood pressure.

According to a study carried out by Shei (2018), by practicing physical exercises and swimming in the aquatic environment, the functional capacity of the respiratory system (total lung capacity, expiratory reserve volume and inspiratory reserve volume) improves, as well as that of maximal oxygen absorption and consumption during exertion (Shei, 2018).

Another study conducted by Yardley et al. attests to the fact that physical exercise in the aquatic environment contributes to maintaining stable blood pressure – by improving circulation and cardiovascular health (Yardley et al., 2012).

Following an experiment carried out in the aquatic environment, Mooventhan & Nivethitha (2014) concluded that Aerobic exercise is specific to these physical activities, programmed systematically, continuously and gradually, with intensity and volume adapted to the objectives pursued, significantly improves cardiovascular resistance.

Kwok et al. (2022) concluded that running in the aquatic environment and variation in water temperature have a positive influence on maximal oxygen volume and physiological parameters but at the same time recommend in-depth studies on this aspect.

CONCLUSIONS

The body's ability to adapt to effort is improved due to the versatility of the exercises applied in difficult conditions.

The hypothesis according to which the integration in the sports training of certain motor structures specific to tennis carried out in the aquatic environment can have a positive effect on the effort capacity the results of the experiments are still uncertain.

The coordinative and physical capacities of the aquatic environment (repetitions characterized by superior concentration parameters – request of Nas and skeletal muscle) produce positive accumulations on the tenismanilor's capacity of effort.

It is observed an improvement in the practical way of addressing unpredictable situations in training and in competition;

Even the progress of the experimental group was noticable higher than the control group, the obtained **results do not validate the research hypothesis**. Nevertheless we recomand the implementation of such program wich has beneficial effects that are found in the performances of 10-12-year-olds.

The small number of subjects negatively influences the research results.

The first limitation of our study derives from the small sample of participants.

This aspect is related to the difficulties in identifying children who will accept belonging to an experiment involving physical exercise in a non-specific environment, as well as their willingness to engage in intervention programs, despite the fact that they can produce positive changes on sports training.

We recommend the use of these programs and in early stages as the engine profile of children involved in the sports performance of the formation during this period, and the uniquely diversified, adapted means (which manage to capture the interest) must be integrated into the conventional sports training programme.

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