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EFFORT CAPACITY AND MOVEMENT SPEED DEVELOPMENT USING AQUATIC EXERCISE IN 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 and motor qualities in children and juniors. As all good players know, it doesn't matter how good the player can hit the ball if he cannot get to it. Correct movement skills are vitally important for success on the tennis court. Tennis requires quick movement in all directions. Performance speed: This refers to the time it takes from initiation until the completion of an action/stroke. In the example, this speed refers to the time it takes you to move to the ball, get set up to hit the ball, and to recover for the next shot. 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. Twenty 10-12-year-old tennis players were involved in the training program, who took an initial and a final evaluation, with the aim of identifying the advantages of the means used. Exercises for the development of movement speed and acceleration should be planned and performed during the general training periods and during the development periods for children and juniors.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.

Key words: effort capacity, speed, tennis, aquatic environment

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INTRODUCTION

The theoretical-practical knowledge in relation to the game of tennis proves that this sport has evolved significantly in terms of the effort and speed of the technical-tactical actions it involves, and therefore I consider it imperative to improve and develop the effort capacity and movement speed.

The player may have to sprint forward to reach a drop shot, back up for an overhead, or move from side to side to reach wide forehands and backhands

The player doesn't overlook the importance of working on his movement on the court although it is essential to work on grooving the player's.

Efficient movement of tennis players on the tennis court doesn't only depend on speed and agility, but also quickness.

Initial acceleration can also be associated with the first 10 m of a sprint, while agility is seen as the capacity of easiness in changing directions, and quickness in starting and stopping (

On average, a sprint distance performed during a point is between 4 to 7 m, and an average of 4 to 7 changes of direction.

Based on these statistics and facts, tennis players need to have remarkable dynamism in multidirectional movements during matches and explosive, short movements over the court (Elliott, 2006).

Speed or velocity defined by) as it describes the rate at which a player moves from one location to another. state that it is the capability to cover a distance quickly.

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 (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 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.

Freelap is a high-performance timing system designed to measure and analyze runners' times during training and competition. This system uses wireless technology and precise timing sensors that fit easily into a belt or wristband to measure the runner's time with an accuracy of 1/1000 of a second. Freelap can be used to measure running times, acceleration, top speed, pace and many other important metrics to analyze and improve runner performance. The system is easy to use and can be configured in different ways to meet the specific needs of each coach or athlete. Freelap is considered one of the most accurate and reliable timing systems on the market and is commonly used by high performance coaches and athletes around the world.

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.

Physical running tests: 6x20m, 5m, 10m and shuffle test.

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 tennis competitions.

The duration of the experimental approach was 12 months. The experimental and control groups were monitored throughout this interval (taking data to allow the interpretation of the adaptation to the specific effort, respectively to allow the validation of the effectiveness of the proposed training means. Data were taken that reveal the specific evolution of the following physiological parameters: frequency respiration at rest and during exertion.

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)

RESULTS AND DISCUSSIONS

In the experimental study carried out, aimed at optimizing the effort capacity and physiological parameters, the results with reference to the respiratory frequency at rest indicate a statistically significant difference, therefore the hypothesis is confirmed.

In the experimental study carried out, aiming at the optimization of the physiological parameters, the results with reference to the respiratory frequency during the effort indicate a statistically insignificant difference, consequently the hypothesis is rejected.

In conclusion, the hypothesis according to which the integration in 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 are partially confirmed and require more research on this. However, preliminary data show that water training may be beneficial for developing exercise capacity and improving the performance of athletes in the game of tennis.

In conclusion, the hypothesis according to which the integration in 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 are partially confirmed and require more research on this. However, preliminary data show that water training may be beneficial for developing exercise capacity and improving the performance of athletes in the game of tennis.

Table 1. Respiratory rate at rest

Statistical indicators	Experiment	Control	Statistical indicators	Experiment-Control	
Average	16.10	17.60	**Average difference**		-1.50
Median	16.00	18.00	**Average difference (%)**		9.32%
Abaterea std.	0.99	1.58	**The non-parametric test Mann-Whitney**	Z	p
Minimum	15	15		-0.549	0.030
Maximum	18	20	**Effect size**		0.48
Amplitude	3	5			
Coef. variability	6.2%	9.0%			

The respiratory frequency at rest is lower in the experimental group, on average, by 1.50 resp/min (9.32%). The dispersion of the results shows a homogeneous structure in the case of both groups. The effect size is large. The results obtained by the athletes of the two groups are significantly different, according to the Mann-Whitney test, the significance threshold p=0.030 < 0.05, for Z = -2.166**.**

Synthesis

Mean difference	Effect size	The difference between the groups is	Null hypothesis
-1.50 (9.32%)	high	statistically significant	Is rejected

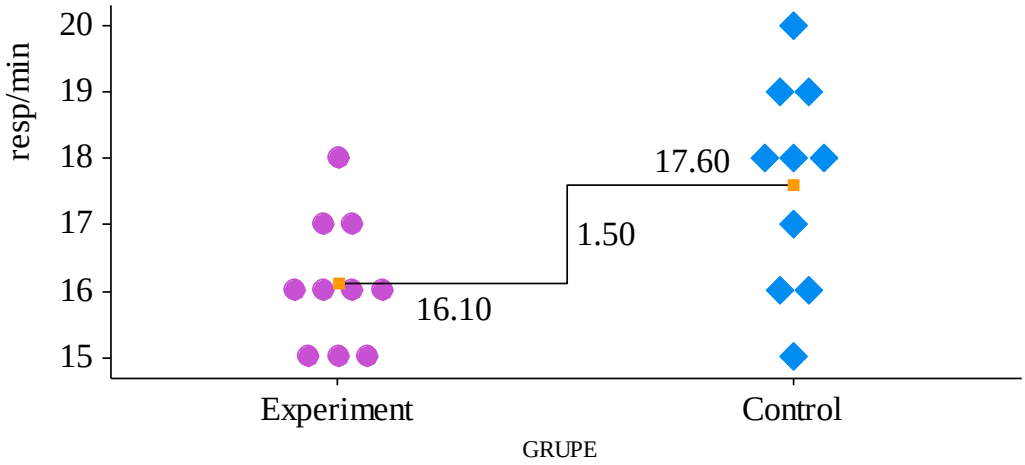

Figure 1. Respiratory rate at rest

Table 2. Respiratory rate during exertion

Statistical indicators	Experiment	Control	Statistical indicators	Experiment-Control	
Average	31.80	32.10	**Average difference**		-0.30
Median	32.00	32.00	**Average difference (%)**		0.94%
Abaterea std.	1.23	1.37	**The non-parametric test Mann-Whitney**	**Z**	p
Minimum	30	29		-**0.549**	0.583
Maximum	33	34	**Effect size**		0.12
Amplitude	3	5			
Coef. variability	3.9%	4.3%			

The respiratory frequency during effort is lower in the experimental group, on average, by 0.30 resp/min (0.94%). In the case of both groups, the dispersion of the results is homogeneous. The effect size is small. The results of the Mann-Whitney test indicate a statistically insignificant difference between the two groups, the significance threshold p=0.583 > 0.05, for Z = -0.549. In fig. the averages, their difference and the individual results obtained by the athletes are presented in graphic form.

Synthesis

Mean difference	Effect size	The difference between the groups is	Null hypothesis
-0.30 (0.94%)	low	statistically insignificant	Is accepted

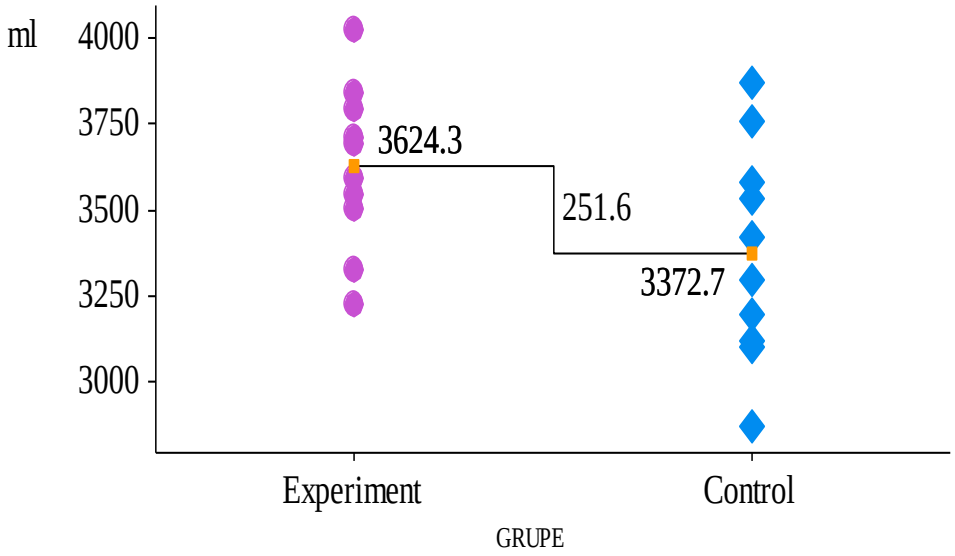

Figure 2. Respiratory rate during exertion

RUNNING 6 x 20 m

Table 3. The values of the motor quality test speed "running 6 x 20 m"

Statistical indicators	T.I.	T.F.	Statistical indicators	T.F.-T.I.	
Mediate	4.62	4.49	**Average difference**		-0.13
Median	4.67	4.51	**Progress**		2.8%
std deviation	0.19	0.17	**95% C.I.**	(-0.17 ; -0.08)	
Minimum	4.3	4.2	**Standard deviation**		0.06
Maximum	4.9	4.7	**The non-parametric test Wilcoxon**	Z	p
Amplitude	1	1		-2.803	0.005
Coef. variability	4.1%	3.7%	**Effect size**		0.63

The average time in the 6x20 m run decreased at the final testing of the experimental group by 0.13 sec. The progress achieved in the development of movement speed and agility in order to optimize the tennis game is 2.8%. The difference of means is in the range (-0.17; -0.08), in 95% of cases. The results are homogeneously dispersed in the case of both tests. The size of the effect is large to very large and statistically significant, p=0.005<0.05, for Z = -2.80.

Sintesys

Diff. averages	Effect size	The difference between the groups is	Null hypothesis
-0.06 (1.36%)	Very small	statistically significant	accepted

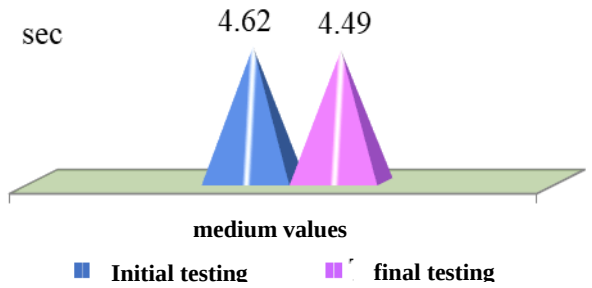

Fig.3 Synthesis of the results of the assessment of motor quality speed "running 6 x 20 m"

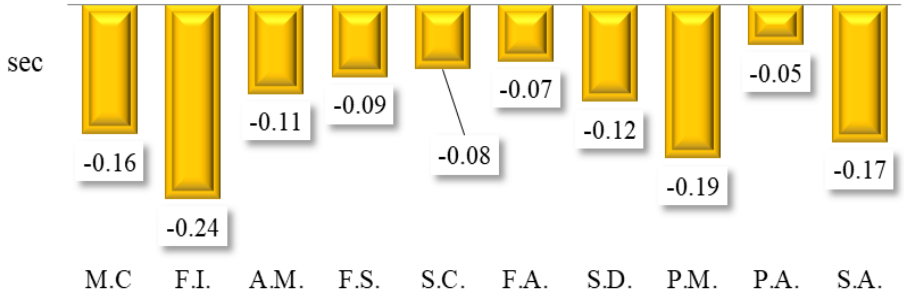

Fig.4 Representation of individual progress of motor quality speed

SHUFFLE TEST

Table 4. The values of the evaluation in the shuffle test

Statistical indicators	T.I.	T.F.	Statistical indicators	T.F.-T.I.	
Mediate	8.62	8.11	**Average difference**		-0.51
Median	8.68	8.00	**Progress**		6.0%
std deviation	0.32	0.39	**95% C.I.**	(-0.72 ; -0.30)	
Minimum	8.0	7.5	**Standard deviation**		0.29
Maximum	9.0	8.8	**The non-parametric test Wilcoxon**	Z	p
Amplitude	1	1		-2.705	0.007
Coef. variability	3.7%	4.8%	**Effect size**		0.60

In the shuffle test test, the time is shorter in the experimental group, on average, by 0.45 sec (5.56%). In the case of both groups, the dispersion of the results is homogeneous. The effect size is large. The results obtained by the athletes of the two groups are significantly different, according to the Mann-Whitney test, the significance threshold p=0.026 < 0.05, for Z = -2.232. In the figure, the averages, their difference and the individual results obtained by the athletes are presented in graphic form.

Sintesys

Diff. averages	Effect size	The difference between the groups is	Null hypothesis
-0.45 (5.56%)	high	statistically significant	Is rejected

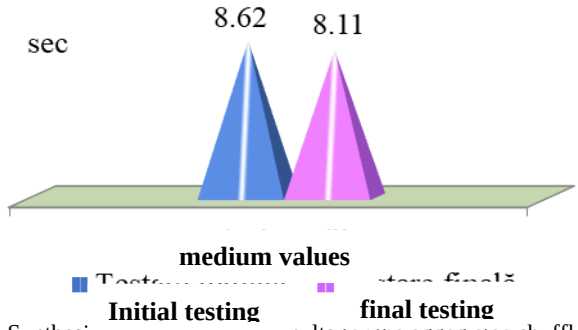

Fig.5 Synthesis of the evaluation results for the added step shuffle test

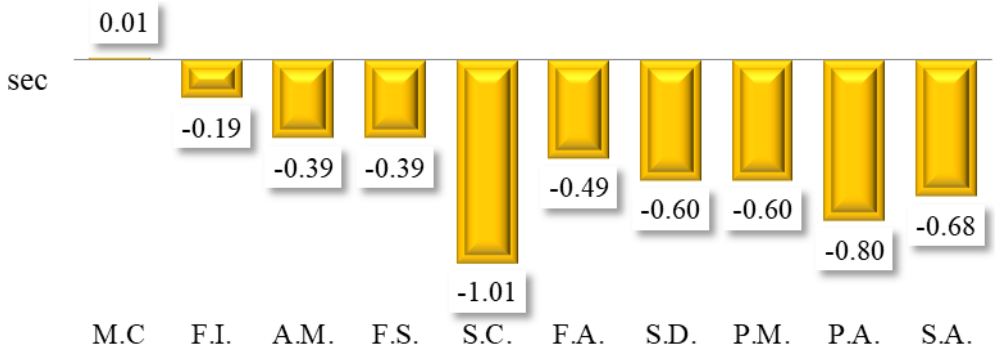

Fig.6 Representation of individual progress of motor quality speed

DISCUSSIONS

Aquatic training programs involving running, strength and endurance exercises have a positive impact on the sports performance of children and junior tennis players under competitive and adverse conditions.

Following some studies in 2002, Bethany Diamond, master trainer for Nautilus Institute, at the Sports Medicine Center in Seattle, Washington state concluded the following:

The muscular force necessary to overcome water resistance to achieve speed in water translates into swifter movement on land. Speed training on land is achieved by sprints. For example, suicide drills (running to cones spaced incrementally farther apart and returning to the starting line after touching each) develop both speed and quickness. However, although effective, such land drills have an inherent risk of injury to the ankles and knees. Water's buoyant support negates much of that risk.

Agility drills in water improve a player's ability to change direction and regain balance quickly. When a client moves through water, a current moving in the same direction is created. When cued to change direction, the athlete is forced to move against this strong current, which can be difficult to overcome. Such rapid directional changes in the water challenge and develop balance and foot speed.

According to a study carried out by Shei (2014), 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.

In 2002, in the study regarding the effect of aquatic and non aquatic training on speed and agility among male volleyball players M.Gokul Raj & M. Senthil Kumar evaluated twenty adults (ten male and ten female) by running at two levels of immersion (hip and chest) and two speed conditions (slow and fast). Data were collected using an underwater force platform. The following variables were analyzed: vertical force peak (*Fy*), loading rate (*LR*) and anterior force peak (*Fx anterior*). Three-factor mixed ANOVA was used to analyze data.

The results of the study had shown there was a significant difference between aquatic training, non-aquatic training and control group on speed and agility. Further the results of the study showed that there was a significant increase on speed and agility after twelve weeks of aquatic training and non-aquatic training. However the improvement was in favour of experimental groups. There was a significant difference was occurred between aquatic training, non-aquatic training and control group after eight weeks of specific training programme. Aquatic training programme have better improvement in speed and agility compared with other groups.

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.

Another study conducted by Yardley et al. attests to the fact that physical exercise in the aquatic environment contributes to maintaining a 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 more 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 and speed movement, even 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 partialy validates 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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