**STATE UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS
OF THE REPUBLIC OF MOLDOVA**

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REGULATION OF PHYSICAL EFFORT PARAMETERS IN 6 - 8-YEAR-OLD FOOTBALL PLAYERS BASED ON CARDIOVASCULAR INDICES

Specialty 533.04. Physical education, sports, kinesiotherapy and recreation

Summary of the doctoral thesis in education sciences

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Composition of the Commission for public defense of the doctoral thesis:

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CONCEPTUAL BENCHMARKS OF THE RESEARCH

Topicality of the theme and importance of the issue addressed. Football is one of the most practiced sports in the world. As a performance sport, football currently reached a special development regarding the game itself, the competition and the training process as well. Considered a complex sport, football depends on a series of factors, such as: physical condition, psychological factors, technique of the player and tactics of the team [1, 2, 3, 10, 19, 25, 28].

In modern football, it is impossible to achieve top results without a quality training of the young players. The studies of several specialists [2, 3, 5, 13, 17, 19, 21] in the field of football focus more on the training of juniors and less on the children. The success of any team, including the youth teams, is defined by three key factors: technique of the player, tactics and general state of each player (physical, moral, psychological state etc.). The specific characteristics of football game require the evaluation from the point of view of the technical and tactical content, a prerequisite of motor activity. The success of the team in a game depends on how the players master different techniques, both from the perspective of biomechanics and the precision and speed of the game actions [4, 7, 8, 9].

Researchers in the field suggested that the development of physical (namely the aerobic and anaerobic endurance), neuromuscular (strength, speed, dexterity), anthropometric and body composition capabilities are essential aspects for an optimal development that would allow athletes to perform at a higher level. These data prove that the applied training programs should be individualized in this regard, as it is already done with the goalkeepers [6, 12, 16, 22, 23].

Physiological and hematological changes in athletes after training sessions and competitions were always of interest to sports scientists. Moreover, the intensity, duration and type of exercise are factors that influence performance, along with the physiological and hematological changes in athletes. In football, as in other sports, the level of achievement of sports performance is associated with certain morphofunctional changes. It should be noted that some morphofunctional indicators can be both hereditary and acquired. Football is an intense endurance sport that has a positive relation with reduced levels of iron, ferritin and red blood cells [7, 8, 14, 20, 25].

Examining the activity profile and physiological demands of football game, there are studies showing that small surface games elucidate the high heart rate for all groups of players, the difference between the heart rate responses and the technical activities of the performance players, the potential impact of variation on growth and biological maturity state. Several studies have highlighted the existence of an association between the group of cardiovascular diseases risk factors and the physical inactivity [15, 18, 26, 27]. Other studies compare the HR-V_O2 relation determined on the playing field during football-specific efforts, at different intensities, with the relation identified in the laboratory. Heart rate responses in and between the methods of controlled and integrated physical training in the elite football players were also compared. A positive result would support the feasability of introducing the non-invasive assessment of cardiovascular regulation as a method of monitoring the beneficial effects of physical

exercises [10, 20]. An effective strategy to develop physiological markers for team sports appears to be the use of repeated sprints with changes of direction [16].

In fact, these addressed issues became the subject of our research, contributing to the improvement of the regulation of physical effort parameters in football players aged 6-8 years, on the basis of the cardiovascular indices.

Description of the situation in the research field and identification of the research issues

In the view of the Romanian Football Federation, the process of becoming a football player goes through several preparation periods, from childhood, corresponding to the first „steps" in football, up to the level of professional or amateur player. The predominantly formative zone (5 to 8 years old) refers to the period when competitive results are not of major importance, but the pleasure of children and their opportunity to express themselves as freely as possible in the game. At this stage of the training process corresponding to the age of 5 to 8 years, also called „discovery", different forms of the game are presented, namely: at the age of 5-6 years, 3-a-side football is played (without goalkeepers, with small size goalposts) while at the age of 7-8 years it is the 5-a-side football (street football, where all positions are played) [16].

In this regard, the development of the training process of 6-8-year-old children in football game is a complex activity, which requires finding training solutions based both on methodological and scientific arguments, but which also has a series of characteristics, mainly related to the particularities of age.

Most of the publications [18, 20, 31], especially those aiming at the training of children and juniors, deal with the topic of physical effort parameters regulation in the most general way, without taking into account the individual particularities of the players. Also, there is not sufficient methodological information related to the training of the children aged 6-8 years in football game, in particular on the planning of the specific means and the management of effort according to age particularities, as well as of the action systems. In order to study the scientific issue regarding the regulation of physical effort parameters throughout the training, the recommendations of FIFA, UEFA and FRF were approached and, in terms of model of player, the suggestions of Moritz Zierlein, 2023 were used [24].

The purpose of the research consists in studying the effectiveness of regulating the physical effort parameters within the football training sessions in 6-8-year-old children based on the change in cardiovascular indices.

Objectives of the research: 1. Studying the conceptual benchmarks regarding the sports training of footballers at the initial stage of preparation. 2. Determining the physical effort parameters on the basis of cardiovascular indices in 6 - 8 year -old football players. 3. Analysis of the opinions of specialists regarding the regulation of physical effort parameters in children who play football at the initial stage of training. 4. Development of the experimental program on the regulation of physical effort parameters based on cardiovascular indices within the training sessions with 6- 8-year-old football players.

5. Experimental validation of the effectiveness of physical effort parameters regulation based on cardiovascular indices in the training of footballers aged 6-8 years.

Hypothesis of the work. It was assumed that the regulation of physical effort parameters on the basis of cardiovascular indices change during training sessions will lead to the improvement of the parameters of the effort zones submitted to stress and, consequently, will increase the level of sports training of 6-8-year-old football players.

The important scientific issue solved in this field refers to the regulation of physical effort parameters in 6-8-year-old footballers by developing and implementing an experimental program centered around the modification of cardiovascular indices. This program will influence the optimization of effort zones in the training lessons and, consequently, will lead to the improvement of their functional capacity.

The novelty and scientific originality of the paper consists in the fact that an experimental program focused on the regulation of the physical effort parameters in 6-8-year-old football players, based on cardiovascular indices, was developed and implemented. The parameters of effort zones within the training sessions were determined on the basis of cardiovascular indices. It was also carried out a correlation analysis regarding the influence of the somatic-functional and cardiovascular indices on the effort zones parameters during the training lessons.

The theoretical importance of the paper derives from the fact that methodological benchmarks regarding the regulation of the physical effort parameters in football players aged 6-8 years, based on cardiovascular indices, were established after analyzing the specialized literature and the opinions of the specialists in the field cited during the research. These benchmarks, in turn, contribute to the completion of the existing conceptions in the field of theory and methodology of football sports training, especially at the stage of initial preparation.

The applicative value of the work offers the possibility of implementing the experimental program and the methodological benchmarks at the initial training stage, developed on the basis of cardiovascular indices. The results can be used as a methodological guide by coaches of the football sports schools and also by students in higher education institutions of physical education and sport specializing in "football".

Implementation of scientific results. The results of the research were implemented in the sports training of beginner football players within the Romanian Sports Clubs: CS Chiajna, CSM Otopeni, CS FC Argeș Pitești, CSȘ 1 Pajura Bucharest.

Theses proposed for defense

1. The optimization of the training process of novice athletes, in any sport, including the football game, was and still is one of the most important issues. Specialists are always looking for new solutions, both pedagogical and physiological ones. Very few works in the specialized literature deal with the physical effort regulation of beginner athletes based on cardiovascular indices. Exactly this aspect, in

our opinion, is not sufficiently elucidated in the specialized literature, with reference to the football game at beginner level.

2. The analysis of the opinions expressed by football specialists, regarding beginner level, complements several aspects of sports training of beginner footballers, a process focused on the regulation of physical effort parameters based on cardiovascular indices.

3. The important scientific issue solved in this field is related to a new view on the training of the beginner footballers, focused on the regulation of physical effort parameters in the 6-8-year-old players, through the development and implementation of an experimental program using the cardiovascular indices.

4. Adjusting the physical effort parameters on the basis of cardiovascular indices during the training of the football players aged 6-8 years will create premises for improving the training process at motor, technical-tactical and functional level.

All these proposed theses underlie the research conducted with 6-8-year-old football players; in fact, this is also the basic reason for the given study.

Structure of the thesis: annotation, introduction, 3 chapters, conclusions and recommendations, reference list 180 sources, 13 annexes, 133 pages of basic text, 60 figures, 27 tables. The results were published in 7 scientific papers.

Key-words: football, children, somatic development, body composition, functional indices, cardiovascular indices, regulation of physical effort, effort zones, competitive activities.

1. Conceptual theoretical and methodological benchmarks regarding the training of the football players at the initial stage

Performance football is currently experiencing a special development as for the game itself, the competition and the training process as well. There is a general opinion that football is evolving towards a strength game, forgetting the technical-tactical aspects in some concrete cases. All actions of the players take place in spatial-temporal crisis conditions, increasing the game speed and the dynamic effort volume [26, 33].

Along the initial stage I of training, coaches constantly observe the evolution of each child and stimulate him in different ways. Children will differentiate themselves from a somatic point of view, predispositions, talent, morpho-physiological, intellectual, emotional skills and social abilities. Consequently, the coaches will have to operate with the psycho-diagnosis technique. At the end of stage I (U10), a first psycho-prognosis of the pre-selectable players can be drawn up, which must be reflected in their individual file for the initial selection for the next level, respectively junior C (U12 – seventh stage). Sports clubs and associations must assume this professional duty, rather difficult and complex but of great efficiency and perspective.

Specialists in the field of coaching children and juniors I believe that this the only way to ensure the well-trained and well-selected human element who can meet the requirements of high performance achievement. At the same time, children unsuitable for football can be recovered for sports as they will be guided, as per availability, towards other branches of sport. Thus it is possible to avoid the loss of promising athletes, the waste of time and energy of football coaches or a definitive and irreversible decision of the athlete to give up practicing sports in general [5, 23].

The analysis of oxygen consumption is very important. It is a criterion for assessing aerobic capacity and a proof of the functional capacity of apparatus and systems that ensure gas exchange, use and transport of oxygen to tissues in untrained adults and children aged 6-10 years (Table 1.1).

Table 1.1. Comparison of effort parameters in untrained adult /children aged 6-10 years (according to T.O. Bompa, 2006)

Parameters of physical effort	Untrained adult	Children aged 6-10 years
VO_2 adaptation time	T (1/2) 40 s	22 s
Evolution of aerobic capacity	T (9/10) 3/5 min.	2 min.
Deficit of O_2 at 70% VO_2 max.	30 ml/kg/min.	12 ml/kg/min.
Adaptation time (HR)	T (1/2) 50 s	25 s
Evolution of aerobic capacity	T (9/10) 3 min. 30 s.	2 min.
Ventilatory adaptation time	P 50%	1 min.
Effort power in % of VO_2 max.	P 90%	2 min.

Faster adaptation to effort is explained by some respiratory and cardiovascular indices involved in determining the aerobic capacity for effort. Thus, the evolution of the respiratory flow closely related to VO_2 max. and of the heart rate shows a latency until the steady state is reached, at the age of 9-12 years. As shown in the table above, a percentage of 55% of VO_2 max. is reached after 30 sec of effort, while 100% is reached in 2 min. The untrained adult has not this fast adaptation which decreases with age, while the latency to reach VO_2 max. at 9-12 years is close to that of elite athletes (90 s), with a faster recovery of oxygen deficit after effort in children [4].

As for the structural and functional characteristics of the child's heart, no differences are observed compared to those of the adult, but the growth of the somatic structures confirms that the training of the aerobic capacity has the greatest influence on all parameters of the performance capacity of the body [14, 18].

In the opinion of the authors of the „Guide for Children's Coach", there are several models of the 6-8-year-old player according to the bio-motor and technical criteria, as shown in the example below (Table 1.2.).

Table 1.2. Model of the 6-8-year-old football player

Criteria	Indices	Age		
		6 years	7 years	8 years
Anthropometric	Height (cm)	125	130	135
	Weight (kg)	22	25	30
Physiological	At rest (cm)	55	60	63
	Breathing in (cm)	59	64	67
	Breathing out (cm)	54	59	62
	Bitrochanteric diameter (cm)	19	20	21
	Vital capacity(ml)	1000	1200	1400
Motor	25 m speed (sec)	4.7	4.6	4.5
	Standing long jump (cm)	125	135	145
	5 x 5 m shuttle run (sec/no time)	8.6	8.5	8.4
	Endurance (m)	600	800	1000
	Tennis ball throwing at a distance	23	25	27
Technical	Ball driving between 5 cones	13.00	12.5	11.5

The period in which the football training of the children is carried out covers 10 years, from the age of 6-7 years up to 16-17 years. It is relatively simply to understand that children go through different transformations throughout this period, which include anthropometric, physiological, psychological, motor characteristics etc.

The particularities of both somatic-functional and mental development and of the motor and technical training of 6-8-year-old children present behavioral manifestations that have a different influence on the development of each individual child. These ones lead to the consolidation of the differentiated treatment principle in the process of orientation, initial selection and sports training. As for the content of the training process, skills specific to the mini-football game are provided, in order to develop the specific skills of football game, by applying the knowledge acquired in various individual and collective activities [11, 21, 27].

2. Determination of physical effort parameters based on cardiovascular indices in 6- 8-year-old football players

In order to regulate the physical effort parameters during the training sessions for 6-8-year-old football players, research methods were used meant to provide concrete data regarding the optimization of the parameters of effort zones based on the change in cardiovascular indices.

The following research methods were used:

Method of bibliographic study

Method of observation

Method of survey

Method of tests

Statistical method of data processing and interpretation

Organization and conduct of the research

The research was carried out at the " Concordia" Sports Club of Chiajna, Bucharest (Romania), according to the schedule established and approved by the management of this unit.

The experiment was conducted along two stages: exploratory and formative.

A group of 192 children aged from 6 to 8 years, from several Sports Clubs of Bucharest and Ilfov County (CS Champion of Bucharest, Juniorul of Bucharest, Otopeni FOT, CS Argman, Marian Cristescu Academy, CS Concordia Chiajna) participated in the exploratory stage. During the formative stage, 20 children of 6-8 years old were selected from the studied and then they were divided into two groups: experimental group (EG) (n=10) and control group (CG) (n=10). All children are registered at CS "Concordia" Chiajna. The activity in the survey groups was planned for 90 hours (3 hours /week).

Sports facilities of the "Concordia" Sports Club of Chiajna are adequate and suitable for organizing the training sessions at the highest possible level, which allowed the research to be carried out in optimal conditions.

The research was conducted *in five stages*, as follows:

The first stage (September 2020 – June 2021) had as main tasks: approval of the theme, creation of the activity plan, applying the sociological survey, studying the specialized literature, applying the questionnaire addressed to football coaches.

The second stage (July 2021 – September 2021) involved the analysis of the instructional-educational programs of the school sports specialized in football of the City of Bucharest and Ilfov county, and also the conduct of the exploratory experiment that aimed to evaluate the somatic-functional and cardiovascular development of the children included in the experiment and who obtain their medical visas at the "Chiajna Medical Center" in Chiajna. Because it was impossible to monitor physical effort parameters in both groups, training zones were tested in the experimental group only.

The third stage (September 2021 – June 2022) included the following tasks:

• making and applying the program and the learning units in conformity with the experimental methodology for the experimental group (home and away matches of the County Championship);

• assessment of physical effort parameters (effort zones) during training;

• statistical-mathematical processing, interpretation and graphic representation of the data obtained from the tests performed in the exploratory stage.

The fourth stage (May – September 2022) – included the use of the final tests for the evaluation of the somatic-functional and cardiovascular level and the physical effort parameters (effort zones) of the children who participated in the experiment, for:

• processing, statistical-mathematical interpretation and comparative graphic representation of evolution within and between groups at the initial and final testing;

•formulating the experimental conclusions.

The fifth stage (October 2022 – February 2023) – monitored the effectiveness of the application of the experimental program after the completion of the research by using the improved experimental program (Action systems and means specific to the mini-football game for the development of coordination, speed, orientation in space at U8, performance space – in the hall), elaboration of the general conclusions and practical recommendations, structuring and developing of the scientific content of the thesis.

One of the basic objectives of the conducted research was the assessment of the zones of effort and of their relationship within the training lesson for 6-8-year-old football players belonging to the experimental group.

Two categories of indices were identified on the basis of the data resulted: *specific indices* and *general indices*.

As a result of the data obtained, in accordance with the research objective, it was considered that the main index of analysis was the heart rate (HR), because this one was found out both generally throughout the training sessions and specifically in each effort zone (Table 2.1.).

The results of the statistical indicators highlight average values and their range in the case of HR (min) is 92.11±7.95 bpm (81 – 105 bpm), average HR 149.5±7.54 bpm (136 – 166 bpm) and (max) HR of 200.8±8.08 bpm (190 – 213 bpm), with high homogeneity, which represents the reaction of the body to the exerted effort.

Table 2.1. Results of HR indices (n=10)

No.	Indices of variables	Descriptive statistical indicators					
		X	SEM	SD	Cv%	Min	Max
1	HR min (bpm)	92.11	2.51	7.95	8.63	81	105
2	HR average (bpm)	149.5	2.38	7.54	5.05	136	166
3	HR max (bpm)	200.8	2.56	8.08	4.02	190	213
4	HR min (%)	46.05	1.26	3.97	8.86	41	53
5	HR average (%)	74.8	74.9	3.75	5.01	68	83
	HR max (%)	100.4	1.31	4.14	4.12	95	107

Note: bpm – beats per minute; max –maximum value; min –minimum value; SEM –standard error of the mean; SD –standard deviation; CV% – coefficient of variation

The determination of the effort zones depending on the value and duration of HR (Table 2.2.) was achieved by reporting the maximum value of HR of 200 bpm. According to the value and duration of HR, the following zones (Z) were allocated: Z1 (50 - 59%) with HR (100-119 bpm), Z2 (60 - 69%) with HR (120-139 bpm), Z3 (70 - 79%) with HR (140-159 bpm), Z4 (80 - 89%) with HR (160-179 bpm), Z5 (90 - 100 %) with HR (180-200 bpm).

Table 2.2. Results of HR duration by effort zones (n=10)

No.	Indices of variables	Descriptive statistical indices					
		X	SEM	SD	Cv%	Min	Max
1	Zone 1 (min)	5.44	0.81	2.57	47.18	3.02	11.02
2	Zone 2 (min)	14.51	1.07	3.39	23.35	7.25	19.19
3	Zone 3 (min)	18.16	1.71	5.42	29.86	11.17	25.26
4	Zone 4 (min)	12.42	1.33	4.20	33.84	4.01	18.09
5	Zone 5 (min)	6.33	1.61	5.08	80.25	0.2	18.36

Note: SEM – standard error of the mean; SD –standard deviation; CV% – coefficient of variation

Regarding the data obtained, it should be noted that the total duration of using the effort zones is 56.86 min. From the analysis of the duration of the means by zones, a higher value of 31.9% is observed at Z3 (18.16±5.42 min), corresponding to HR (140-159 bpm) and a lower duration of 9.6% at Z1 (5.44±2.57 min) – HR (100-119 bpm). A very weak or even non-existent homogeneity is noticed due to the variation of HR duration in each individual child.

Table 2.3. Results of distance-speed by effort zones (n=10)

No.	Indices of measured variables	Descriptive statistical indices					
		X	SEM	SD	Cv%	Min	Max
1	Zone 1 (m)	1573.2	54.59	172.64	10.97	1297	1818
2	Zone 2 (m)	768.7	51.38	162.47	21.14	556	1153
3	Zone 3 (m)	186.2	15.93	50.37	27.05	98	281
4	Zone 4 (m)	17.9	4.51	14.26	79.68	0	50
5	Zone 5 (m)	0.00	0.00	0.00	0.00	0	0

Note: SEM – standard error of the mean; SD –standard deviation; CV% – coefficient of variation

The assessment of distance in speeds by effort zones (Table 2.3.) was made according to the travel speed at each interval corresponding to Z1 (3.00 - 6.99 km/h), Z2 (7.00 - 10.99 km/h), Z3 (11.00 - 14.99 km/h), Z4 (15.00 - 18.99 km/h) and Z5 (19.00- km/h). The analysis of the results for the distance of travel speed by effort zones (Table 2.4.) revealed higher values at Z1 of 1573.2±172.64 m, corresponding to 61.8% of the total distance, namely 2546 m. A high homogeneity of distance speed is noticed in Z1, which shows that most of the children in the football research run at a speed between 3.00 – 6.99 km/h, where 30.2% - in Z2 and 7.3% in Z3 and very little 0.7% in Z4. One can notice that at this exploratory stage, the footballers in the research do not fully use their own strength, especially the maximum running speed.

According to the data obtained, regarding the number of accelerations per stress intervals (Table 2.4.) it can be noted that their number is higher in the interval 4 (-0.99 - -0.50 m/s²) with average values of 271.9± 29.20 accelerations, corresponding to 34.3% of the total number of accelerations, namely 793.3. A high homogeneity is also observed, meaning an optimal preparation at the level of intervals 3-6, corresponding to the value of HR duration and travel speed in zones Z1, Z2 and Z3, which corresponds to the data previously analyzed for the other specific indices.

Table 2.4. Results of the number of accelerations per intervals (n=10)

No.	Indices of measured variables	Descriptive statistical indices					
		X	SEM	SD	Cv%	Min	Max
1	-50.00 - -3.00 m/s²	0.7	0.33	1.06	151.33	0	3
2	-2.99 - -2.00 m/s²	17.8	1.93	6.11	34.31	9	31
3	-1.99 - -1.00 m/s²	135.3	4.00	12.65	9.36	120	163
4	-0.99 - -0.50 m/s²	271.9	9.23	29.20	10.74	241	329
5	0.50 - 0.99 m/s²	220.3	8.97	28.38	12.88	190	283
6	1.00 - 1.99 m/s²	117.1	3.87	12.22	10.43	98	135
7	2.00 - 2.99 m/s²	28.6	3.50	11.07	38.73	15	44
8	3.00 - 50.00 m/s²	1.6	0.40	1.26	79.05	0	4

Note: SEM – standard error of the mean; SD –standard deviation; CV% – coefficient of variation

Regarding the spatial characteristics of the training effort (Table 2.5.), the total distance has an average value of 2853.7±214.07 m with the distance / min of 48.9±3.72 m/min, highlighting 40% values above the group mean. As for the spatial-temporal characteristics of the effort, the maximum speed has an average of 16.89±1.49 km/h while the average speed has the value of 3.11±0.24 km/h, 2.8±2.62 number of sprints performed. A high homogeneity of the presented indices is found out, which shows that the children at the exploratory stage made an optimal effort during training.

In terms of effectiveness of the involvement of football players in solving the training tasks, a level of 98.8±20.51% of the training task score and 95.6±19.74% Cardio is noticed. Also, it is observed a value of 10.19±3.70 hours of recovery after effort with a consumption of 226.4±54.92 kcal. A weak homogeneity is highlighted, which draws attention to the need to improve the planning of effort parameters during training, based on the change of the functional indices.

Table 2.5. Results of general indices of training effort parameters (n=10)

No.	Indices of measured variables	Descriptive statistical indices					
		X	SEM	SD	Cv%	Min	Max
1	Total distance (m)	2853.7	67.69	214.07	7.50	2602	3361
2	Distance / min (m/min)	48.9	1.18	3.72	7.62	45	58
3	Max speed (km/h)	16.89	0.47	1.49	8.86	14.9	19
4	Average speed (km/h)	3.11	0.08	0.24	7.79	2.8	3.7
5	Sprints (reps no.)	2.8	0.83	2.62	9.34	0	9
6	Score of training task	98.8	6.49	20.51	20.76	67	145
7	Cardio	95.6	6.24	19.74	20.65	65	141
8	Recovery time (h)	10.19	1.17	3.70	36.33	6	19,9
9	Calories (kcal)	226.4	17.36	54.92	24.26	153	338

The assessment of the somatic-functional indices highlights the level of development according to the values of age particularities and the model of player proposed in the research [30]. Also, the evaluation of cardiovascular indices, using EKG data, shows the medical results and recommendations necessary for further investigations, as appropriate.

The evaluation of physical effort parameters and training effort zones was performed using the Polar Team Pro program. The following information and measured variables were obtained: minimum, average and maximum HR and their weight; time spent in each HR zone, distance (total and distance per minute); (maximum and average) speed; distance in each speed zone and number of accelerations / intervals; training task and recovery time after effort exerting.

All these findings contributed to the creation of the training programs intended to regulate the parameters of physical effort based on the change of cardiovascular indices in the football players aged 6-8 years.

After carrying out the exploratory experiment, in which the zones of physical effort of the 6-8-year-old football players were evaluated, an experimental program, was developed. This program defined several objectives related to the training of the football players aged 6-8 years by regulating the parameters of physical effort based on cardiovascular indices, within the training sessions. The experimental program carried out is presented in the appendices of the work.

The experiment was conducted throughout a period of one and a half years, namely one competitive year, from September 2021 to June 2022 (home and away matches of the Championship), continuing with the verification of the effectiveness of the experimental program application until February 2023.

3. Experimental argumentation of the effectiveness of physical effort parameters regulation in 6-- 8-year-old football players based on cardiovascular indices

The interpretation of the results of the formative experiment is based on the results obtained during the exploratory experiment. In order to show the effectiveness of applying the experimental program during the research, the effects of regulating the physical effort parameters in 6-8-year-old footballers based on cardiovascular indices will be highlighted by comparing the data used in the final test and relating them to the initial test data in both survey groups.

According to the results obtained, it was demonstrated that in the EG group progress can be achieved on several plans: anthropometric, physiological, motor, technical, tactical one, both in terms of quality and quantity. An experimental planning was used in this group, where methodically selected means were applied, consistent with the somatic-functional and cardiovascular changes of the 6-8 years old children [6, 8].

Anthropometric data were processed, evaluated and interpreted, using weight, height, body composition (fat mass, muscle mass and BMI) as basic somatic indices. The data were analyzed, compared and related to the mean of each index, calculated for both the experimental and the control group (Table 3.1).

Table 3.1. Dynamics of somatic indices evaluation (6-8 yrs) (n=10)

Indices	Groups and statistics	X; ±SD		t	P
		Initial	Final		
Weight (kg)	E	27.48±5.69	29.12±6.63	-3.98**	0.003
	C	27.08±4.60	28.04±4.84	-3.83**	0.004
t; P		0.17; 0.865	0.42; 0.682	-	-
Height (cm)	E	126.9±7.92	129.6±7.76	7.36***	0.001
	C	129.7±7.24	132.7±6.85	9.23***	0.001
t; P		-0.84; 0.412	-0.96;0.348	-	-
Fat mass (kg)	E	4.33±1.49	5.38±2.71	-1.92	0.088
	C	3.82±1.73	3. 92±1.45	-0.29	0.780
t; P		0.69; 0.498	1.50; 0.151	-	-
Muscle mass, (kg)	E	21.85±4.49	22.42±3.97	-1.45	0.182
	C	22.11±3.07	22.65±3.15	-2.10	0.065
t; P		-0.15; 0.882	-0.14;0.887	-	-
BMI (kg/m^2)	E	17.36±2.47	17.16±2.58	0.38	0.715
	C	16.01±1.62	15.8±1.66	1.29	0.226
t; P		1.44; 0.166	1.40; 0.178	-	-

Note: E – Experimental group, C – Control group; SD – standard deviation, P - calculated
n= 10;   P – 0.05*;   0.01**;   0.001***. r = 0.632
f = 18;   t = 2.101   2.878 3.922
f = 9;   t = 2.262   3.250 4.781

To show the effectiveness of the experimental program, it was carried out the comparative analysis of the means both within the groups and differences between groups at the initial testing and final testing.

From the analysis of the studied somatic indices, it results that the height and weight are the most important indices for highlighting the growth and development of the child. In this sense, it can be mentioned that these parameters of the children in the EG and CG prove a quantitative growth of the body along one year of training.

Next, functional indices of children football players will be analyzed. These indices can contribute to the regulation of effort parameters during one and half years of training after using the experimental program. For this purpose, the selected children from both EG and CG were tested (F.T.) at the end of the formative experiment as well. As previously mentioned, the data of the exploratory experiment served as the initial level of development, followed by a more thorough comparative analysis meant to prove the formulated hypotheses (Table 3.2.).

Regarding the data obtained, it can be stated that for the most of the evaluated functional indices, the children of EG demonstrated better results in terms of functional adaptability to the effort made, but the differences are *insignificant* statistically, with the exception of the BP at I.T. between groups, where the differences are significant at P<0.05. This phenomenon is due to the influence of the means used during the training sessions; differences are found out in both cases.

Table 3.2. Dynamics of functional indices evaluation (n=10)

appwns	Groups and statistics	X; ±SD		t	P
		Initial	Final		
BP (bpm)	E	79.4±14.07	76.9±10.82	0.69	0.505
	C	80.6±10.49	78.5±10.39	0.73	0.485
t; P		-0.22;0.831	-0.34;0.739	-	-
SBP (mmHg)	E	109.6±4.50	112.4±7.15	-1.15	0.279
	C	118.8±9.73	117.7±6.11	0.38	0.708
t; P		2.71*;0.014	-1.78; 0.09	-	-
DBP (mmHg)	E	69.4±5.68	70.6±10.29	-0.49	0.630
	C	76.9±7.85	74.7±5.83	0.96	0.362
t; P		-2.45*;0.024	-1.09;0.288	-	-
SO2 (%)	E	98.9±0.74	99.3±0.67	-1.31	0.223
	C	99.4±0.52	99.3±0.67	0,.36	0.726
t; P		-1.76; 0.096	0.00; 1.00	-	-

Note: E –Experimental group, C – Control group; SD – standard deviation
n= 10;   P – 0.05*;   0.01**;   0.001***. r = 0.632
f = 18;   t = 2.101   2.878   3.922
f = 9;   t = 2.262   3.250   4.781

One of the main objectives of the experimental research was the assessment of the cardiovascular indices of the children who play football, for which a comparison

was proposed between the initial data of the exploratory research and the results of the final testing following the application of the experimental program.

In that regard, in conformity with the data shown in Table 3.3, it is found out that the main cardiovascular indices for the football players-subjects of the research are included in EKG results. 20 children selected from the total number participated in this research. On the basis of the medical results, the data obtained both within the groups and between the groups at the beginning (I.T.) and the end (F.T.) of the research can be compared and analyzed (Appendices 7 and 8).

From the algorithmic analysis for the interpretation of EKG in the research children, the following changes can be compared:

Regarding the HR index, it presents data comparable to the normal reference values from the specialized literature in both research groups, keeping within the normal limits of the age. The comparative analysis of the averages between tests reveals better values of 2.5 bpm in EG at F. T., with average values of 79.4±14.06 bpm and 76.9±10.81 bpm, where t=0.69 and P>0,05. As for the differences of averages between groups at F. T., better values of 3.1 bpm are noticed in EG, with average values of 76.9±10.81 bpm and 80.0±9.58 bpm, where t=-0.68 and P>0.05. Comparing the individual values, it can be mentioned values >100 bpm with 10% in EG at the I. T., while at the F.T., thanks to application of the experimental program, these data improved within the normal limits, recommended for this age.

The blood pressure index (BP) shows normal limits corresponding to age. The comparative analysis results highlight better values in EG, namely at systolic blood pressure (SBP) differences higher than 2.3 mmHg at F. T., with average values of 110.1±4.93 mmHg and 112.4±7.15 mmHg, where t=-0.93 and P>0.05. But diastolic blood pressure (DBP) has a difference smaller than 1.2 mmHg in F. T., with average values of 69.4±5.68 mmHg and 70.6±10.29 mmHg, where t=-0.49 and P>0.05.

Concerning the comparison of data between groups SBP, there are better values in EG, with an increase of 9.1 mmHg at I.T. and significant differences, where t=-2.60 and P<0.05. Also, the differences at F.T. increase by 5.8 mmHg, with average values of 112.4±7.15 mmHg and 118.2±6.32 mmHg, where t=-1.92 while P>0.05. Conversely, in the case of DBP, the differences are better in EG, decreasing by 4.1 mmHg at F. T., with average values of 70.6±10.29 mmHg and 74.7±5.85 mmHg, where t=-1.09 and P>0.05. Even if the differences are insignificant, the negative value justifies the improvement of the functional capacity at BP, due to the correct application of the experimental program. Comparing the individual data, values exceeding the normal limits of SBP >120 are also observed (2 two cases in EG and 3 cases in CM). These particular cases require additional investigations and monitoring, which is proposed to be done when obtaining the medical visa.

The RR interval shows the heart rate according to the regularity of R-R intervals. The analysis of the comparative results between tests highlights, at F.T., differences increased by 21.1 ms in EG (P>0.05) and decreased by 47.2 ms in CG, (P>0.05). As for the differences between groups at F.T., there are values higher than 32.5 ms in EG (P>0.05). These data prove that several cardiovascular changes occur at this age because of the insufficient adaptation to the effort made.

Table 3.3. Dynamics of the evolution of cardiovascular indices

Indices	Groups & statistics	X; ±SD		t	P
		Initial	Final		
HR (bpm)	E	79.4±14.06	76.9±10.81	0.69	0.505
	C	80.4±11.06	80.0±9.58	0.18	0.858
t; P		-0.18; 0.862	-0.68; 0.506	-	-
RR (ms)	E	774.5±120,45	795.6±121.46	-0.64	0.538
	C	810.3±146.15	763.1±102.79	1.03	0.329
t; P		-0.59; 0.557	0.65; 0.526	-	-
SBP (mmHg)	E	110.1±4.93	112.4±7.15	-0.93	0.377
	C	119.2±9.91	118.2±6.32	0.36	0.726
t; P		-2.60*; 0.018	-1.92; 0.071	-	-
DBP (mmHg)	E	69.4±5.68	70.6±10.29	-0.49	0.630
	C	76.7±7.82	74.7±5.85	0.883	0.400
t; P		-2.39*; 0.028	-1.09; 0.288	-	-
P (ms)	E	94.6±8.85	94.0±5.58	0.19	0.849
	C	89.4±8.28	86.4±30.77	0.28	0.783
t; P		1.36; 0.191	0.77; 0.452	-	-
PQ (PR) (ms)	EG	141.6±11.77	140.6±12.00	0.29	0.773
	CG	134.4±14.19	124.0±32.14	1.12	0.29
t; P		1.23; 0.232	1.53; 0.143	-	-
QRS (ms)	E	81±9.85	80.2±9.16	0.26	0.804
	C	75.6±8.37	75.8±6.36	-0.09	0.925
t; P		1.32; 0.203	1.25; 0.228	-	-
QT (ms)	E	361.4±22.82	359.6±21.95	0.24	0.813
	C	357.8±25.62	354.7±20.09	0.64	0.537
t; P		0.33; 0.744	0.52; 0.608	-	-
P axis (degrees)	E	30.4±17.83	31.5±18.76	-0.29	0.773
	C	39.7±20.58	34.9±22.95	0.64	0.533
t; P		-1.08; 0.294	-0.36; 0.721	-	-
QRS axis (degrees)	E	51.5±43.96	51.6±45.07	-0.01	0.995
	C	57.00±29.92	58.7±26.93	-0.635	0.541
t; P		-0.33; 0.747	-0.43; 0.674	-	-
T axis (degrees)	E	33.8±10.74	28.4±6.70	2.05	0.069
	C	45.4±15.46	40.3±13.67	1.51	0.165
t; P		-1.94; 0.067	-2.47*; 0.024	-	-
QTc (Baz) (ms)	E	412.4±13.17	402.5±15.99	2.59*	0.029
	C	407.9±18.86	402.3±24.75	0.99	0.345
t; P		0.62; 0.544	0.02; 0.983	-	-

Note: E – Experimental group, C – Control group; SD – standard deviation
n= 10; P – 0.05; 0.01**; 0.001***. r = 0.632*
f = 18; t = 2.101 2.878 3.922
f = 9; t = 2.262 3.250 4.781

In terms of EKG intervals indices, the following differences are noted:

- the P *wave* shows atrial depolarization, with increased values, with smaller differences between tests of 0.6 ms in EG (P>0.05). Regarding the comparison of the results between groups at F.T., differences higher than 7.6 are noticed in EG, with average values of 94.0±5.58 ms and 86.4±30.77 ms, where t=0.77 and P>0.05;

- the PQ (PR) *segment* shows the time interval between the onset of atrial activation and the onset of ventricular depolarization. Comparative analysis of data between tests reveals differences smaller than 1.0 ms in EG, (P>0.05). Regarding the differences between groups at F.T., the EG has values higher than 16.6 ms, with average values of 140.6±12.00 ms and 124.0±32.14 ms, where t=1.53 and P>0.05;

- the QRS *complex* indicates ventricular activation and records differences between tests with values higher than 0.8 ms in EG, (P>0.05). As for the comparative averages between groups at F.T., differences higher than 4.4 ms are noticed in EG, with average values of 80.2±9.16 ms and 75.8±6.36 ms, where t=1.25 and P>0.05;

- the QT *interval* shows ventricular electrical systole and reveals differences between tests of averages lower than 1.8 ms in EG (P>0.05). The comparison of data between groups at F.T. highlights differences higher than 4.9 ms in EG (P>0.05);

- the QTc *interval* is the total value of ventricular electrical activity and shows significant differences between tests in EG, with a value of 9.9 ms, with average results of 412.4±13.17 ms and 402.5±15.99 ms, where t=2.59* and P<0.05. Concerning the differences between groups at F.T., almost equal results are noted, with higher differences of 0.2 ms in EG (P>0.05).

In *conclusion*, it can be stated that the comparative analysis of EKG intervals highlights insignificant differences; thus, the QTc interval values are close between groups at F. T., with better differences in EG, which is due to the effective application of the experimental program. The final medical result is 70% normal EKG in both groups; there are also deviations as a result of an insufficient adaptation to effort.

Regarding the *EKG axes*, they represent the direction of the electromotive force of the heart and have the following differences:

- the *P axis* records differences between tests at F.T. with increased values of 1.1 degrees in EG (P>0.05) and differences between groups at F.T., lower values in EG by 3,4 degrees, P>0.05;

- the QRS *axis*: the obtained results reveal differences between tests in EG with values lower than 0.1 degrees (P>0.05) and differences between groups with smaller values of 7.1 degrees in EG, (P>0.05). All values above normal limits show deviations of the axis to the right and to the left as well, vector orientation between +30 and + 60 degrees, (extreme limits -29 and +110 degrees);

- the *T axis* has normal values between +30 and + 60 degrees, showing positive thoracic deviations. The comparative analysis between tests reveals close differences of 5.4 degrees in EG and significant differences between groups at F.T., values lower than 11.9 degrees in EG, where t=-2.47* and P<0.05. A comparison with the interval of normal values highlights the existence of deviations in all directions (positive and negative), keeping within normal limits, that characterize a normal EKG in most cases.

According to the analysis of the medical results, presented in detail in Appendices 7 and 8 of the paper, the following cardiovascular changes can be found:

a) Experimental group:

- at I. T. (60%), where 30% show changes: *Tachycardia with narrow QRS complexes, *Tall P wave, * P wave broadening, *Variable PQ (PR) interval, *Right axis deviation, *Marked left axis deviation, *Wide QRS complex due to age, *Suspected left ventricular hypertrophy, * Aberrant ventricular complexes found, and 30% borderline abnormal EKG.

- at F.T. (70%), where 20% show changes: * Suspected left ventricular hypertrophy, * Marked left axis deviation, * Marked right axis deviation, * Aberrant ventricular complexes found, * Wide QRS complex due to age, * Sinus bradycardia, abnormal EKG, borderline abnormal EKG, and 50% near normal EKG.

b) Control group:

- at I. T. - changes: * Right axis deviation, * Marked left axis deviation, *Variable PQ (PR) interval, and 70% near normal EKG;

- at F.T. – changes: * Marked left axis deviation, * Suspected left ventricular hypertrophy, * Sinus tachycardia, borderline abnormal EKG, and 40% near normal EKG.

In *conclusion*, according to the specialized literature data, the changes that occur in the EKG of a child can be normal in the absence of other signs and symptoms. The comparative analysis of the medical results of the research children reveals changes in the cardiovascular indices that are more obvious in EG, as a result of the application of the experimental program and of the improvement of the physical and technical training level.

Following the data obtained and in accordance with the researched objective, the possibility of regulating the physical effort parameters in the 6-8-year-old footballers based on the cardiovascular indices was experimentally argued. To achieve the purpose of the research on the regulation of the physical effort parameters, in the planning of the specific means and action systems used in the football game for children aged 6-8 years, it was necessary to take into account the changes in the somatic-functional and cardiovascular indices, as well as in the indices specific to effort zones and the general indices of the training effort.

The evaluation of the dynamics of effort zones parameters in the 6-8-year-old footballers was performed on the basis of the initial testing data, following the application of the experimental program and comparing them to the final testing data (Tables 3.4 – 3.10, Appendices 7 and 8).

The main functional index, considered as both specific and general index, is the heart rate (HR). This index was also proposed after analyzing the opinions of the specialists who show that the most common parameter for regulating the training physical effort is HR.

Depending on value and duration, HR was distributed in following zones (Z): Z1 (50 - 59%) – FC (100-119 bpm), Z2 (60 - 69%) – FC (120-139 bpm), Z3 (70 - 79%) – FC (140-159 bpm), Z4 (80 - 89%) – FC (160-179 bpm), Z5 (90 - 100 %) – FC (180-200 bpm).

Table 3.4. Dynamics of HR indices evaluation

Indices	X; ±SD		t	P
	Initial	**Final**		
HR min (bpm)	92.1±7.95	93.0±22.96	-0.12	0.911
HR average(bpm)	149.5±7.55	159.4±8.91	-2.22	0.054
HR max(bpm)	200.8±8.08	198.9±9.12	0.52	0.617
HR min (%)	46.5±3.98	46.7±11.73	-0.05	0.961
HR average (%)	74.9±3.75	80.0±4.67	-2.22	0.053
HR max (%)	100.5±4.14	99.4±4.48	0.59	0.567

Note: SD –standard deviation
n= 10;   P – 0.,05;   0.01**;   0.001***. r = 0.632*
f = 9;   t = 2.,262   3.250   4.781

Starting from these two directions of approach within the research, HR shows - at F.T. - differences between tests: an increase by 0.9 bpm at the minimal value, with average values of 92.1±7.95 bpm and 93.0±22.96 bpm, where t=-0.12 and P>0.05, corresponding to the weight of 46.5%; an increase of 9.9 bpm at average HR, with values of 149.5±7.55 bpm and 159.4±8.91 bpm, where t=-2.22 and P>0.05 and a decrease by 1.9 bpm in HR maximum, with values of 200.8±8.08 bpm and 198.9±9.12 bpm, where t=0.52 and P>0.05.

The analysis of the minimum and maximum values reveals the decrease in the size of the interval, by the increase of the minimum value and the decrease of the maximum value, highlighting the adaptation of the body to the exerted effort and the influence of the parameters of physical effort upon this one.

Regarding the dynamics of HR duration per effort zones (Table 3.5.), the comparative analysis between tests highlights (at F.T.) increases of the duration by 3.0 min in Zone (Z) 1 and insignificant differences at P>0.05, by 5.39 min in Z2, with average values of 14.51±3.39 min and 9.12±3.49 min, where t=2.74 and P<0.05, decreases by 5.2 min in Z3, with values of 18.16±5.42 min and 2.96±3.19 min, where t=2.39 and P<0.05 and increases by 5.62 min in Z4, with values of 12.42±4.20 min and 18.04±3.45 min, where t=-3.37 and P<0.01 and by 4.59 min in Z5 and insignificant differences at P>0.05.

Table 3.5. Dynamics of evaluating HR duration per effort zones

Indices	X; ±SD		t	P
	Initial	**Final**		
Zone 1 (min)	5.44±2.57	2.44±3.31	2.06	0.068
Zone 2 (min)	14.51±3.39	9.12±3.49	2.74*	0.023
Zone 3 (min)	18.16±5.42	12.96±3.19	2.39*	0.039
Zone 4 (min)	12.42±4.20	18.04±3.45	-3.37**	0.008
Zone 5 (min)	6.33±5.08	10.92±7.35	-1.34	0.215

The decrease in HR duration indices in Z1, Z2 and Z3 and the significant increase in Z4 and Z5 led to the optimization of the parameters of effort zones, namely to the maintaining of the intensity of the effort made above >80-100%.

The assessment of the distance by effort zones (table 3.6.) was made according to the travel speed at each interval corresponding to the level for Z1 (3.00 - 6.99 km/h), Z2 (7.00 - 10.99 km/h), Z3 (11.00 - 14.99 km/h), Z4 (15.00 - 18.99 km/h) and Z5 (19.00- km/h). Pursuant to the data obtained, as regards the dynamics of the assessment of the distance-speed by effort zones, differences between tests are found, namely: decrease of the distance by 339.5 m in Z1; average values of 1573.2±172.64 m and 1233.7±169.77 m, where t=3.55 and P<0,01; increases of the distance by 581.9 m in Z2, where t=-6,99 and P<0.001, by 290.2 m in Z3, where t=-13,56 and P<0.001, by 76.9 m in Z4, where t=-3,34 and P<0,05 and initiation Z5 by 12.6 m at F. T. The analysis of data highlights the optimization of distance-speed per effort zones by decrease with 21.5% in Z1 and increase in the other zones with 43.1% in Z2 - %, with 60.9% in Z3 - %, with 81.1% in Z4 - % and with 40% in Z5 related to group total.

Table 3.6. Dynamics of distance-speed evaluation per effort zones

Indices	X; ±SD		t	P
	Initial	Final		
Zone 1 (m)	1573.2±172.64	1233.7±169.77	3.55**	0.006
Zone 2 (m)	768.7±162.47	1350.6±226.07	-6.99***	0.001
Zone 3 (m)	186.2±50.37	476.4±99.23	13.56***	0.001
Zone 4 (m)	17.9±14.26	94.8±69.42	-3.34**	0.009
Zone 5 (m)	0.00±0.00	12.6±28.03	-1.42	0.189

Approximately the same tendency is also noticed in the evaluation of the accelerations number per intervals before and after using the experimental program (table 3.7.), and at the evaluation of the general indices of training effort (table 3.8.).

Table 3.7. Dynamics of evaluating the accelerations number per intervals

No.	Index / interval	X; ±SD		t	P
		Initial	Final		
1	-50.00 - -3.00 m/s²	0.7±1.06	4.3±5.59	-1.93	0.086
2	-2.99 - -2.00 m/s²	17.8±6.11	39.4±14.41	-6.25***	0.001
3	-1.99 - -1.00 m/s²	135.3±12.65	167.8±20.07	-5.31***	0.001
4	-0.99 - -0.50 m/s²	271.9±29.20	292.5±30.86	-1.35	0.209
5	0.50 - 0.99 m/s²	220.3±28.38	273.0±17.87	-5.06***	0.001
6	1.00 - 1.99 m/s²	117.1±12.22	124.3±18.85	-1.00	0.342
7	2.00 - 2.99 m/s²	28.6±11.07	45.0±8.65	-3.36**	0.008
8	3.00 - 50.00 m/s²	1.6±1.26	7.3±6.02	-2.75*	0.022

In the analysis of the effort zones dynamics in the children aged 6-8 years who play football, general indices were also used, which deepen the knowledge of training effort parameters.

Table 3.8. Dynamics of evaluation of general indices of training effort

Indices	X; ±SD		t	P
	Initial	**Final**		
Total distance (m])	2853.7±214.07	3416.9±148.42	-9.73***	0.0001
Distance / min (m/min)	48.9±3.72	62.3±2.79	-14.54***	0.0001
Maximum speed (km/h)	16.89±1.49	19.57±3.14	-2.72*	0.023
Average speed (km/h)	3.11±0.24	3.93±0.19	-13.04***	0.0001
Sprints (no. of reps)	2.8±2.62	11.9±8.02	-3.16*	0.011
Score of the task	98.8±20.51	116.2±21.65	-1.54	0.159
Cardio load (points)	95.6±19.74	111.1±22.16	-1.37	0.204
Recovery time (h)	10.19±3.70	12.75±4.15	-1.23	0.248
Calories (kcal)	226.4±54.92	241.6±61.19	-0.79	0.446

In accordance with the data obtained (table 3.9.), the analysis of the results shows the share of the duration of the power zones, inverse of the power value (decreasing): 42.4% in Z1, 20.5% in Z2, 19.7% in Z3, 11.7% in Z4 and 5.6% in Z5. The difference in the size of the intervals compared to the value of the mean and their total is higher by 37% in Z1, 23.9% in Z5, 16.4% in Z4, 11.9% in Z2 and 10.7% in Z3 and does not influence the homogeneity value (CV%), being good in the zones 2 and 3, weak in Z1 and non-existent in zones 4 and 5.

Table 3.9. Analysis of the duration of power zones in training

Indices	Descriptive statistical indices					
	X	**SEM**	**SD**	**CV%**	**Min**	**Max**
Zone 1 (70 - 84%), min	2.56	0.16	0.51	20.05	2.1	3.59
Zone 2 (85 - 99%), min	1.24	0.04	0.14	11.18	1.03	1.51
Zone 3 (100 - 129%), min	1.19	0.04	0.14	11.66	1.02	1.45
Zone 4 (130 - 179%), min	0.71	0.09	0.28	40.26	0.4	1.06
Zone 5 (180 - 800%), min	0.34	0.09	0.28	84.41	0.12	1.08

The share of muscle load by power zones (table 3.10.) shows higher values by 28% in Z1, 20.1% in Z3, 18.4% in Z4, 17.2% in Z2 and 15.7% in Z5. The difference in the size of intervals related to the value of the mean and their total is greater by 65.9% in Z5, 12.7% in Z1, 7.4% in zones 2 and 4 and 6.4% in Z3. These differences highlight the scatter of the data in relation to the mean and do not influence the homogeneity value (CV%), being moderate in zones 2 and 3, weak in zones 4 and 1 and non-existent in Z5. Muscle load has a value of 139.5 with a range by 34.5 under average (43.7%) and 44.5 above average (56.3%).

Table 3.10. Analysis of muscle load of power zones in training

Indices	Descriptive statistical indices					
	X	SEM	SD	CV%	Min	Max
Zone 1 (70 - 84%)	15.8	1.38	4.37	27.64	10	22
Zone 2 (85 - 99%)	9.5	0.60	1.90	20.00	6	13
Zone 3 (100 - 129%)	11.1	0.62	1.97	17.74	8	14
Zone 4 (130 - 179%)	10.2	0.76	2.39	23.47	7	14
Zone 5 (180 - 800%)	8.7	2.23	7.04	80.92	25	87
Muscle load	139.5	9.03	28.56	20.47	105	184

Note: ±SD – standard deviation; Zone 1 (70 - 84%), Zone 2 (85 - 99%), Zone 3 (100 - 129%), Zone 4 (130 - 179%), Zone 5 (180 - 800%)

In *conclusion*, the additional evaluation of the duration of power zones and the effect of training by measuring the muscle load per zones of power highlighted the efficiency of planning the action systems and means at the end of the experimental research. Thus, it was proved the optimal regulation of physical effort parameters which was achieved based on both functional and cardiovascular indices.

One of the objectives of this research was to study the competitive activity and behavioral manifestation of 6-8-year-old children in football**.** In our view and that of the FRF, until the age of 9, children must go through an experience similar to "street" football or the football practiced during sport lessons, playing for pleasure; their motivation must come from within. During this period, children aged 6-8 years must develop their love for football.

As part of the research carried out, the results achieved in the U8 County Championship, 2021-2022 were analyzed. For highlighting the effectiveness of the regulation of physical effort parameters in training, a game behavioral analysis of the children in the research was carried out (Appendix 12). A number of 15 played matches, friendlies and official as well, were analyzed in order to monitor the behavioral manifestation of the children in various situations and conditions of the game. The grades for appreciation are issued at the initial testing: 10% satisfactory (S), 60% good (G), 30% G/very good (VG) and 10% VG while at the final testing – 30% G and 70% - VG. The differences between the game behavioral indices in the home and away matches of the Championships present the manifestation in the group and the homogeneity in the team. These ones are ensured by the application of the action systems and means specific to the U8 mini-football game, processed, developed and applied through the training programs.

Regarding the game behavioral analysis of the 6-8-year-old children in football (Table 3.11), differences are observed at the end of the research (F. T.) with 4.6% when getting ball possession ($P<0.001$), 10.1% at getting past the opponent ($P<0.001$), 11.4% at pass / decisive pass ($P<0.001$), 9.4% positioning in attack / defense ($P<0.001$), 8.1% at blocking ($P<0.01$), 12.1% at successful dribbling ($P<0.001$), 11.4% at successful tackles ($P<0.001$), 10.4% at center passes (running /building actions) ($P<0.001$), 12.4% at shot on goal ($P<0.001$) and 10.1% successful goal ($P<0.001$).

Table 3.11. Results of the analysis of game actions in 6-8-year-old football players (n=10)

No.	Game actions	X; ±SD		t	P
		Home	Away		
1	Getting ball possesion	2.73±1.35	4.00±1.48	-6.53	0.0001***
2	Getting past opponents	1.00±1.00	3.82±1.47	-7.04	0.0001***
3	Pass / decisive pass	0.82±0.23	4.00±1.34	-7.17	0.0001***
4	Positioning in attack/defense	1.45±1.04	4.09±1.45	-10.81	0.0001***
5	Blocking	0.73±0.79	3.00±1.26	-4.34	0.0015**
6	Successful dribbling	2.36±1.03	6.09±1.45	-7.12	0.0001***
7	Successful tackles	1.45±1.04	4.64±1.28	-6.86	0.0001***
8	Center passes(running/ building actions)	1.73±1.19	4.36±1.21	-10.81	0.0001***
9	Shot on goal	1.36±0.92	4.82±1.72	-6.54	0.0001***
10	Successful goal	0.45±0.68	3.27±1.85	-6.35	0.0001***

Significant results were recorded in the analysis of the somatic-functional and cardiovascular indices, where EG has better values compared to those in CG for the most of the investigated indices.

The analysis of the cardiovascular indices reveals better values in the experimental group compared to the control group and significant differences at $P<0.05$ between groups at the initial testing, also at SBP and DBP within the EKG indices. Significant differences between groups are also noticed in final testing at T Axis at $P<0.05$, with better values of the average in EG.

The results of the capacity for performance presented through the game actions of the 6-8-year-old football players during the competitions demonstrated a clear superiority of the children in the experimental group, where the training process was carried out in conformity with the proposed experimental programul. All these differences in the home and away matches of the U8 championship (held in two competitive years) are due to good planning and management of the training of the children who participated in the research.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

At the end of this scientific approach with 6-8-year-old football players regarding the regulation of the physical effort parameters on the basis of the cardiovascular indices, in accordance with the developed objectives, the following conclusions were formulated:

1. Following the analysis and synthesis of the specialized literature, both from Romania and abroad, on the methodological benchmarks of the training of the footballers at the initial stage of preparation, it is found out that there is sufficient information about the content of the training process in the football game at this preparation stage, about the influence of the training sessions on the morpho-functional and bio-motor changes in children aged 6-8 years, about the methodological recommendations concerning the application of the training norms etc.

2. The results of several studies have shown that the traditional training technologies, intended for the preparation of the 6-8-year-old footballers, in most cases do not ensure a high level of sports training, a fact demonstrated by the evolution of the football players during the away matches of the U8 County Championship, by the unofficial ranking made and by the game actions manifestation. The data of the exploratory experiment, including the results that identified the somatic, functional and cardiovascular particularities of the football players-subjects of the research in each age category, highlighted the state of health, the training level and the indices of the parameters of training effort zones as well.

3. After the preliminary research, within the exploratory experiment, the level of somatic-functional development was demonstrated compared to the values of age particularities, the model of player and the recommendations of the Romanian Football Federation. The evaluation of cardiovascular indices reveals the values and their changes, which keep within the normal limits of the measured indices.

4. The exploratory experiment enabled the determination of the specific indices of effort zones and the general indices corresponding to training effort, which provide additional information necessary for the regulation of the physical effort parameters. Also, performing the correlation analysis between the indices of the effort zones highlights changes of the heart rate (HR) related to the average value, strong connections and share of the HR duration, of the distance-speed per effort zones, of the score of training task, the recovery time, spent calories, average and maximum speed and number of accelerations at different required intervals.

5. Throughout the training process of the 6-8-year-old football players, the training was carried out in groups and individually, meeting some basic requirements in order to achieve the purpose and the objectives of the training. The application of the action systems and means specific to football game aimed at regulating the parameters of physical effort, using specific means in the form of a circuit in 4-5 workshops. Thus, the Coordination / Speed/ Orientation in space were developed in relation with the learning of the basic technical actions.

6. The results of the exploratory experiment highlighted that the poorest results were recorded at the level of the functional and cardiovascular capacity, because the

contraction capacity of the myocardium is still insufficient, uneconomical, without large functional reserves, which requires optimal regulation of the specific means used and appropriate adaptation to the effort made.

7. The results of the formative experiment showed that in the case of somatic and body composition indices, significant differences were found in both groups regarding weight and height, systolic blood pressure (SBS) and diastolic blood pressure (DBS), also as for SBS and DBS within the EKG indices; in terms of T axis, the experimental group has better results. These are due to the growth period, but also to the effectiveness of the regulation of physical effort parameters throughout training.

8. Analyzing the dynamics of the evaluation of effort zones parameters in the football players aged 6-8 years after using the experimental program, based on changes in the somatic-functional and cardiovascular indices, it was considered that the main regulatory index is the heart rate (HR). This one showed the increase of the minimum value and the decrease of the maximum value, revealing the body adaptation to the effort made. The decrease in HR duration indices in Z1, Z2 and Z3 zones (optimal intensity) and the significant increase in Z4 and Z5 (sub-maximum and maximum intensity) led to the optimization of the parameters of effort zones, namely keeping the effort intensity above >80-100% and at improving the distance-speed per effort zones by decreasing with 21.5% in Z1 and increasing in the other zones by 43.1% in Z2, by 60.9% in Z3, by 81.1% in Z4 and by 40% in Z5 compared to group total.

9. The significant results for most of the tested indices along the formative experiment are largely due to the content of the experimental program applied to the children of the experimental group. The program was focused on the regulation of physical effort according to the cardiovascular indices, namely physiological indices.

Thus, by recording the performances related to the competitive activity and the game behavioral manifestation 6-8-year-old football players, the *research issue* was solved. This issue aimed to regulate the physical effort parameters by optimizing the effort zones along the training sessions and by improving their functional capacity.

<div align="center">***</div>

The organization and carrying out of the research conducted with football players aged 6-8 years allowed the formulation of the practical-methodical recommendations as follows:

- The physical and psychomotor training programs specific to football game, both for training activity and competitions in which participate the experimental group, lead to the percentage achievement of the aspects within the profile and theoretical model recommended by UEFA/SFA/FRF for this age, an essential stage in the initiation and discovery of the performance football.

- The process of verifying and regulating the parameters of the physical effort specific to this age category, U8 (under 8 years old), is carried out through a systematization of physical, psycho-motor and technical-tactical tests and events, recommended by UEFA/SFA/FRF, set of actions that are part of this research and practical experimentation.

- The means and physical, psycho-motor and technical-tactical action systems, with or without ball, are processed and designed according to the actions of

psychomotor and technical-tactical behavioral manifestation, both by observing and monitoring the training themes and the competition games. The standards and recommendations of UEFA/SFA/FRF Commission regarding the load of effort parameters, the breaks and body recovery periods after effort are carefully respected.

- The design of physical, psychomotor and technical-tactical training programs specific to U8 football players is considered to be the opportune moment to optimize the instructional process at this age category and an essential stage in the discovery of performance football, because it is in real accordance with the dynamics and continuous improvement of the current football performances.

- The systematic application of fitness tests, in order to verify the effort parameters and behavioral manifestation during the mini – football games, is done in friendly matches but especially in those included in the competitive system. Those are the source of periodical reactivation of the psycho-behavioral, physical and especially technical-tactical side, at the intensity used in the mini-football game but with the appropriate demands and complexity offered by the evolution of current football game.

- By systematized application of the battery of fitness tests and control events, of the registration sheets of the behavioral manifestation specific to the mini – football game at the level of U6 – U8 groups, it is considered that the quality of processing and achievement of the training programs, of actuation systems and means, of effort parameters load, volume, intensity, complexity and number of repetitions specifically adapted to U8 football players can be verified in real time.

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ADNOTARE

Timnea Andreea-Consuela: *Reglarea parametrilor efortului fizic la fotbaliştii de 6-8 ani în baza indicilor cardiovasculari*. Teză de doctor în ştiinţe ale educaţiei, specialitatea 533.04. Educaţie fizică, sport, kinetoterapie şi recreaţie. Chişinău, 2023.

Structura tezei: adnotare, introducere, 3 capitole, concluzii şi recomandări, bibliografie 180 surse, 13 anexe, 133 pagini text de bază, 60 figuri, 27 tabele. Rezultatele au fost publicate în 7 lucrări ştiinţifice.

Cuvinte - cheie: fotbal, copii, dezvoltare somatică, compoziţie corporală, indici funcţionali, indici cardiovasculari, reglare efort fizic, zone de efort, activităţi competiţionale.

Domeniul de studiu: pedagogie.

Scopul cercetării constă în cercetarea eficienţei reglării parametrilor efortului fizic în cadrul lecţiilor de antrenament în jocul de fotbal la copii de 6-8 ani în baza modificării indicilor cardiovasculari.

Obiectivele cercetării:

1.Studierea reperelor conceptuale privind antrenamentul sportiv al fotbaliştilor la etapa iniţială de pregătire.2.Determinarea parametrilor efortului fizic pe baza indicilor cardiovasculari la copiii fotbalişti de 6-8 ani. 3. Analiza opiniilor specialiştilor privind reglarea parametrilor efortului fizic a copiilor fotbalişti la etapa iniţială de pregătire. 4. Elaborarea programului experimental privind reglarea parametrilor efortului fizic în cadrul lecţiilor de antrenament cu fotbaliştii de 6-8 ani în baza indicilor cardiovasculari. 5. Validarea experimentală a eficienţei reglării parametrilor efortului fizic în cadrul lecţiilor de antrenament cu fotbaliştii de 6-8 ani în baza indicilor cardiovasculari.

Noutatea şi originalitatea ştiinţifică a lucrării constă în faptul că a fost elaborat şi implementat un program experimental axat pe problema reglării parametrilor efortului fizic la copiii fotbalişti de 6-8 ani pe baza indicilor cardiovasculari. Au fost determinaţi parametrii zonelor de efort în cadrul lecţiilor de antrenament pe baza indicilor cardiovasculari. De asemenea a fost realizată analiza corelativă privind influenţa indicilor somato-funcţionali şi cardiovasculari a copiilor fotbalişti de 6-8 ani asupra parametrilor zonelor de efort în cadrul lecţiilor de antrenament.

Problema ştiinţifică importantă soluţionată în domeniu vizează reglarea parametrilor efortului fizic la fotbaliştii de 6-8 ani, prin elaborarea şi implementarea programului experimental, axat pe indicii cardiovasculari, care va influenţa optimizarea zonelor de efort în cadrul lecţiilor de antrenament şi în consecinţă, va duce la îmbunătăţirea capacităţii funcţionale a acestora.

Importanţa teoretică a lucrării se desprinde din faptul că în urma analizei literaturii de specialitate şi a opiniilor specialiştilor din domeniu cetate pe parcursul cercetării, au fost stabilite reperele metodologice privind reglarea parametrilor efortului fizic la copiii fotbalişti de 6-8 ani pe baza indicilor cardiovasculari, care, la rândul lor, contribuie la completarea concepţiilor existente în domeniul teoriei şi metodicii antrenamentului sportiv la fotbal, în special la etapa iniţială de pregătire.

Valoarea aplicativă a lucrării oferă posibilitatea implementării programului experimental şi a reperelor metodologice la etapa iniţială de pregătire, elaborate pe baza indicilor cardiovasculari la copiii fotbalişti de 6-8 ani. Rezultatele obţinute pot fi folosite în calitate de ghid metodologic de către antrenorii şcolilor sportive specializate de fotbal, precum şi de către studenţii instituţiilor de învăţământ superior de educaţie fizică şi sport cu specializarea "fotbal".

Implementarea rezultatelor ştiinţifice. Rezultatele cercetării au fost implementate în cadrul antrenamentelor sportive cu fotbaliştii începători din cadrul Cluburilor Sportive din România ca: CS Chiajna, CSM Otopeni, CS FC Argeş din Piteşti, CSŞ 1 Pajura, Bucureşti.

АННОТАЦИЯ

Тимня Андрея Консуела: Управление параметров физических нагрузок у футболистов 6-8 лет на основе кардиоваскулярных показателей, ”. диссертация на соискание степени доктора педагогических наук, специальность 533.04 – Физическое воспитание, спорт, кинетотерапия и рекреация. Кишинёв, 2023.

Структура диссертации: аннотация, введение, 3 главы, выводы и рекомендации, библиография, 180 источников, 13 приложения, 133 страниц основного текста, 60 фигуры, 27 таблиц. Результаты опубликованы в 7 работах.

Ключевые слова: футбол, дети, физическое развитие, сложения тела, функциональные показатели, кардиоваскулярные показатели, регулирование физических нагрузок, зоны нагрузок, соревновательные действия.

Область исследования: педагогика.

Цель исследования состоит в исследование эффективности управление физических нагрузок в тренировочных занятиях с футболистами 6-8 лет на основе модификации сердечнососудистых параметров.

Задачи исследования: 1. Исследование концептуальных основ касающихся спортивной тренировки футболистов на начальном этапе подготовки. 2. Определение параметров физических нагрузок на основе сердечночочудистых параметров футболистов 6-8 лет. 3. Анализ мнений специалистов по управлению параметров физических нагрузок у детей футболистов на начальном этапе подготовки. 4. Разработка экспериментальной программы по управлению параметров физических нагрузок у футболистов 6-8 лет на основе кардиоваскулярных показателей. 5. Экспериментальное обоснование эффективности управление параметров физических нагрузок у футболистов 6-8 лет на основе кардиоваскулярных показателей.

Научная новизна и оригинальность исследований состоит в разработки и экспериментальном обосновании экспериментальной программы основана на управление параметров физических нагрузок у футболистов 6-8 лет на основе кардиоваскулярных показателей. Были определены зоны физических нагрузок в рамках тренировочных занятий на основе сердечно-сосудистых показателей. Также был проведён корреляционный анализ касающиеся влиянию сомато-функциональных и сердечнососудистых показателей детей футболистов 6-8 лет на параметрах зон нагрузок в рамках тренировочных занятий.

Научная проблема исследования определена управлением параметров физических нагрузок у футболистов 6-8 лет посредством разработки и экспериментальном обосновании экспериментальной программы основана на модификации параметров сердечно-сосудистых показателей, в результате которых положительно влияет на оптимизацию зон физических нагрузок на тренировочных занятиях, в следствие чего улучшится функциональные способности детей.

Теоретическая значимость работы исходит из того что в результате анализа литературных источников по футболу и анализа мнений специалистов в результате проведённых исследований, были определены методические основы касающиеся управлению параметров физических нагрузок у детей футболистов 6-8 лет на основе сердечно-сосудистых показателей, которые способствуют дополнению существующих концепций в области теории и методики спортивной тренировки по футболу, в частности на начальном этапе подготовки.

Практическая значимость работы исходит из возможности применения на практике экспериментальной программы и методических основ на начальном этапе подготовки, разработаны на основе сердечно-сосудистых показателей футболистов 6-8 лет. Полученные результаты могут быть использованы в качестве методического пособия для тренеров спортивных школ специализирующихся по футболу, а также для студентов высших учебных заведений по физическому воспитанию и спорту по специализации «футбол».

Внедрение научных результатов. Результаты исследований были использованы в процессе спортивных тренировок с начинающими футболистами из Спортивных Клубов Румынии как: CS Chiajna, CSM Otopeni, CS FC Argeş, Питешты, CSȘ 1 Pajura, Бухарест.

ANNOTATION

Timnea Andreea-Consuela: *Regulation of physical effort parameters in 6-8-year-old soccer players based on cardiovascular indices.*

Doctoral thesis in educational sciences, specialty 533.04. Physical education, sport, kinesiology and recreation. Chișinău, 2023.

Thesis structure: annotation, introduction, three chapters, conclusions and suggestions, bibliography sources (180), annexes (13), basic text (133 pages), figures (60), tables (27), research results published in 7 scientific papers.

Keywords: football, children, somatic development, body composition, functional indices, cardiovascular indices, regulation of physical effort, effort zones, competitive activities.

Field of study: Pedagogy.

The purpose of research consists in studying the effectiveness of regulating the physical effort parameters within the football training sessions in 6-8-year-old children based on the change in cardiovascular indices.

Objectives:

1.Studying the conceptual benchmarks regarding the sports training of football players at the initial stage of preparation. 2.Determining the physical effort parameters on the basis of cardiovascular indices in 6-8-year-old football players. 3. Analysis of the opinions of specialists regarding the regulation of physical effort parameters in children who play football at the initial stage of training. 4. Development of the experimental program on the regulation of physical effort parameters based on cardiovascular indices within the training sessions with football players aged 6-8 years. 5. Experimental validation of the effectiveness of physical effort parameteres regulation based on cardiovascular indices during training lessons with 6-8-year-old football players.

The novelty and scientific originality of the paper consists in the fact that an experimental program focused on the regulation of the physical effort parameters in 6-8-year-old football players based on cardiovascular indices was developed and implemented. The parameters of effort zones within the training sessions were determined on the basis of cardiovascular indices. It was also carried out a correlation analysis regarding the influence of the somatic-functional and cardiovascular indices on the effort zones parameters during the training lessons.

The important scientific issue solved in this field refers to the regulation of physical effort parameters in 6-8-year-old footballers by developing and implementing an experimental program centered around the modification of cardiovascular indices. This program will influence the optimization of the effort zones within the training lessons and consequently will lead to the improvement of their functional capacity.

The theoretical importance of the paper derives from the fact that methodological benchmarks regarding the regulation of the physical effort parameters in football players aged 6-8 years, based on cardiovascular indices, were established after analyzing the specialized literature and the opinions of the specialists in the field cited during the research. These benchmarks, in turn, contribute to the completion of the existing conceptions in the field of theory and methodology of football sports training, especially at the stage of initial preparation.

The applicative value of the work offers the possibility of implementing the experimental program and the methodological benchmarks at the initial training stage, developed on the basis of the cardiovascular indices. The results can be used as a methodological guide by the coaches of the specialized football sports schools and also by the students of the higher education institutions of physical education and sport specializing in ”football”.

Implementation of scientific results. The results of the research were implemented in the sports training sessions with the beginner football players within the sports clubs of Romania such as: CS Chiajna, CSM Otopeni, CS FC Argeș of Pitești, CSȘ 1 Pajura of Bucharest.

Timnea Andreea-Consuela

REGULATION OF PHYSICAL EFFORT PARAMETERS IN 6 -8-YEAR-OLD FOOTBALL PLAYERS BASED ON CARDIOVASCULAR INDICES

Specialty 533.04. Physical education, sports, kinesiotherapy and recreation

Summary of the doctoral thesis in education sciences