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RESISTANCE, PULSEOXIMETRY AND SPECIFIC MEANS OF ATHLETICS AND FOOTBALL

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ABSTRACT. ***Purpose****:* Predictive and summative knowledge of the level of arterial oxygenation and of cardiac frequency, after two semesters of training in physical education classes with specific means of athletics versus football. ***Objective:*** To optimize the development of the body`s resistance in lessons with specific means of athletics or football, which have greater efficiency. ***Hypothesis:*** The systematic training of students in lessons with football means and methods ultimately leads to changes in heart rate and oxygen saturation, which measured after the exercises offer better values compared to using the specific athletics means and methods. ***Material and Method:*** The experiment was applied on two experimental and control groups, which were randomized containing 28 pupils from the 9th to 12th grade. The development of resistance in lessons was carried out by the method of inter-effort and variable efforts, the experimental sample with specific means of football, and the control sample with specific means of athletics. Subjects of both groups were sampled with the device called pulseoximeter. The first evaluation with the pulseoximeter was predictive and took place at the beginning of the school year, and the second was applied summarily after two semesters with diversified means for the two samples. ***Results:*** Working with football-specific means produced greater progress in the subjects of the experimental sample compared to those of the control sample subjects who were trained with specific means of athletics over the same period of time. ***Conclusion:*** The statistical and mathematical calculations carried out as a result of the experiment confirm the assumptions of the hypothesis, so the results of the experiment confirm the hypothesis of the research.

Keywords: r*esistance, pulsometry, means, athletics, football.*

REZUMAT. ***Rezistența, pulsoximetria și mijloacele specifice atletismului și fotbalului. Scop:*** Cunoașterea nivelului oxigenării arteriale și a frecvenței cardiace, predictiv și sumativ după două semestre de instruire în orele de educație fizică cu mijloace specifice atletismului vs fotbalului. ***Obiectiv:*** Optimizarea

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dezvoltării rezistenţei organismului elevilor în lecţii prin mijloace specifice din atletism sau fotbal, care au eficienţă mai mare. ***Ipoteza:*** Instruirea sistematică a elevilor în lecţii cu mijloace şi metode specifice fotbalului, determină în final modificări ale frecvenţei cardiace şi a saturaţiei arteriale cu oxigen, care măsurate post efort dau valori mai bune comparativ cu folosirea mijloacelor şi metodelor specifice atletismului. ***Material şi metodă:*** Experimentul s-a aplicat pe două eşantioane, experimental şi de control, formate randomizat cu câte 28 elevi din clasele IX-XII. Dezvoltarea rezistenţei în lecţii s-a efectuat prin metoda eforturilor pe intervale şi a eforturilor variabile, la eşantionul experimental cu mijloace specifice fotbalului, iar la eşantionul de control cu mijloace specifice atletismului. Subiecţii ambelor eşantioane au fost supuşi probei cu aparatul numit pulsoximetru. Prima evaluare cu pulsoximetrul a avut loc predictiv la început de an şcolar, iar a doua s-a aplicat sumativ după două semestre de lucru cu mijloace diversificate pentru cele două eşantioane. ***Rezultate:*** Lucrul cu mijloace specifice fotbalului a produs progres mai mare la subiecţii eşantionului experimental, comparativ cu cel înregistrat la subiecţii eşantionului de control, care au fost instruiţi cu mijloace specifice atletismului pe aceeaşi perioadă de timp. ***Concluzii:*** Calculele statistico-matematice efectuate ca urmare a aplicării experimentului au confirmat presupunerea ipotezei, deci rezultatele experimentului confirmă ipoteza cercetării.

Cuvinte cheie: ***r****ezistenţă, pulsoximetrie, mijloace, atletism, fotbal.*

Introduction

Knowing from the time before the teaching the mobilization and the great physical commitment to the students` effort when approaching the means and methodology specific to football for the development of resistance, compared to the physical commitment to the effort when working with specific means of athletics, we decided that by formulating the theme, to scientifically research if it is confirmed that the specific means of football, applied systematically during a school year, can further develop the resistance, the capacity of the students' body. According to Popescu-Neveanu's considerations, the effort is a "mobilization, concentration, accelerating of the physical and psychic forces within a system with self-conscious and unconscious self-regulation [....] The effort implies a certain finality and therefore characterized by focusing, obstacle, tension and unification of physical, mental, intellectual resources " (Bota, 2000). Considering these, we used the elements, processes and the game of football as a means of physical school education, knowing that they are loved by pupils and that they mobilize them and concentrate on depositing all physical and mental capacity for the success of more accurate and effective executions, to bring their success to execution and into the game.

By studying football in the preliminary research and observing the students' involvement in the sustained effort, compared with those of athletics, we deduced that these are the means they like and which mobilize the students. The exercises that are specific to the football game have become the means of exercising which assures the students the general resistance of the body, the positive attitude towards the repeated effort, the long-lasting work that produces fatigue, a basic condition for the development of resistance. "Modern competitive football requires general resistance (as a basis of physical condition) and special" (Buiac, 1985). Football has become a social phenomenon, generating emotions and joy when goals are scored or matches are won, and sadness when games are lost. By using the means of football play that are so accessible to high school students, the teacher can make the most of pupils' potential during extra-curricular classes and sporting activities, while at the same time providing them with specific skills, developing their motor, psychic, moral and willpower, rapid decision-making capacities: "Being appreciated and practiced with pleasure by the great mass of students, playing football forms skills and capabilities of maximum utility: moral and psychic qualities; skills in behavior in the community and in its interest; specific motor skills; ability to orient and decide, imagination and spontaneity" (Neța & Popovici, 2000).

The resistance development in the physical and sports education lessons are in close correlation with the physiological and psychological mechanisms of the high school student. "Ensuring the satisfaction through movement of a permanent and richer emotional sphere, the perspective of the realization of certain aspirations and skills is the basic bond of attracting and retaining young people in systematic sporting activity" (Alexe, 1972). Using in the lessons the football games, enthusiastically expected by the students, we have assured their positive attitude towards the repeated and variable effort, compared to a large work volume that produces the fatigue necessary for the resistance development. Until a few years ago, I have prioritized the formation and consolidation of specific motor skill and other sports than football (volleyball, basketball, hand ball). At the end of the school year, we found their contribution to the development of resistance harder. This was due to the nonparticipating attitude of all students to a high level of effort (at the planned schedule by the teacher) as a result of the pretentious technique that did not allow fluency in practice and play. We also added to it the popularity of these branches in our county, compared to football. As a result of this finding, I decided to address the development of pupils' resistance by means that are more accessible and enjoyable to them, belonging to the football field - more popular, more accessible, loved by students and practiced in free time. Sports performance is also determined by the pleasure of tackling the activity in lessons.

Football is so popular, precisely because of its high degree of accessibility, and it is approached with high potential by the students, while at the same time removing the attention from the high level of the effort made, resulting in fatigue which then allows the teacher to resume adapting their body to an immediate higher level of effort, through proper dosing, which ultimately develops resistance. This sporting branch can be practiced not only by boys, but also by girls, without being stigmatized. It also has an advantage, that it can be approached on any unmarked vacant surface within the school without major danger of injury.

By making a system of means belonging to football, and applying it to the preliminary research, we rationalized and standardized it to meet the goal, to develop the resistance of the students' body, their ability to exercise, more than the means specific to athletics. Knowing that the effort is a "systematic repetition of motor actions, aimed at improving performance without obvious morphological changes" (Hollmann and Hettinger, cited by Bota, 2000), we relied on building the specific means of football, choosing the methods of resistance development and their systematic implementation throughout the school year, both in physical education classes and in sports teams. From a physiological perspective, the effort "causes a series of disturbances in the body that affect major functions, adapting the devices and the systems being dependent on its nature" (Demeter, cited by Bota, 2000). For a positive adaptation of the devices and systems of the students' body, in the sense of optimizing the effort capacity, we have worked in lessons with the means and methods specific to football, rationalized and dosed accordingly from the preliminary research period.

The predictive and summative pulseoximeter testing aimed to know the level of arterial oxygenation and heart rate, after two semesters of training in physical education classes with specific means of football vs athletics.

Objectives

Optimizing the development of the body resistance in lessons by specific means of football or athletics, and deciding has greater efficiency.

Methods

In order to verify the hypothesis in practice, we decided to carry out the scientific research by experimenting, thus objectivizing its aspects and moments ("Scientific analysis aims at the objectification of all its aspects and moments. The objectivizing is accomplished by measuring objects, phenomena

and other variables subject to research" - Epuran & Marolicaru, 1998). The experiment was applied on two experimental and control groups, which were randomised containing 28 pupils from the 9th to 12th grade. The development of resistance in lessons was carried out by the method of intervals and variable efforts, in the experimental sample with specific means of football, and in the control sample with means specific to athletics. Subjects of both groups were sampled with the device called pulseoximeter. The first evaluation with the pulseoximeter was predictive at the beginning of the school year, and the second was applied summarily after two semesters of work with diversified means. For the students' instruction in the two school semesters were used the calendar schedules that included the specific means of football to the experimental sample and the specific means of athletics for the control sample. The exercises of both sports disciplines have been rationalized and dosed specifically to the development of the resistance of the students' body. The workload in the lessons was similar for both samples throughout the school year.

Results

Working with the specific means of football used in the experiment in physical and sports education lessons for the development of resistance was a pleasure for the students ("Experimental Knowledge uses observation as an essential condition, as a source of hypothesis and as a source of information from deliberate provocation of the facts - Epuran & Marolicaru, 1998). They have produced motivation and emulation, positive factors for engaging students at great effort. In this context, we noticed a much better participation in their sustained effort and an increase in time of the body resistance index, which confirms Massimo Giacomini's statements: "The development of resistance is limited by other factors, the first being the psychological factor: children are slowly adapting to slow-moving activities, which stretch over a longer period of time. In recent years, intermittent methods of resistance training have developed a lot, especially in team sports, so long and slow exercises for the development of aerobic resistance have been almost completely abandoned. "[....]" To train the resistance there should be used specific ball exercises, exercise cycles or mixed exercises (with and without a ball), matches and other activities designed to maintain a high level of motivation. The goal-oriented game that needs to be attained is the teaching environment that should be at the core of physical training programs." (Romanian Football Federation, 2014). The systematic training of pupils during a school year with specific means of football has led to biological and psychological increases of the experimental sample subjects, that have led to greater progress in summative assessment

compared to the progress achieved by subjects of the control sample that have worked systematically on the same time, but with specific means of athletics. By statistical and mathematical calculations based on the data recorded on the pulseoximeter functional sample, to determine the oxygen concentration in the blood (Sp O2), before effort and post-exercise (after 6 minutes of aerobic run) the values of the statistical parameters indicators for the control sample and the experimental sample are presented in the following table:

Table 1. The values of the statistical parameters indicators for the control sample and the experimental sample

SpO_2 (%)	CONTROL SAMPLE						EXPERIMENTAL SAMPLE					
	Predictive Assessment		Summative Assessment		Progress		Predictive Assessment		Summative Assessment		Progress	
	Before effort (TP1)	Post effort (TP2)	Before effort (TS1)	Post effort (TS2)	Before effort (TS1-TP1)	Post effort (TS2-TP2)	Before effort (TP1)	Post effort (TP2)	Before effort (TS1)	Post effort (TS2)	Before effort (TS1-TP1)	Post effort (TS2-TP2)
sum	2759. 0	2700.00	2761.00	2719.00	2.00	19.00	2753.00	2616.00	2766.00	2714.00	13.00	98.00
minimum	97.00	94.00	98.00	96.00	-1.00	-1.00	97.00	90.00	98.00	95.00	0.00	2.00
maximum	99.00	98.00	99.00	98.00	1.00	2.00	99.00	96.00	99.00	98.00	1.00	6.00
number	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00	28.00
half	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Arithmetic mean	**98.54**	**96.43**	**98.61**	**97.11**	**0.07**	**0.68**	**98.32**	**93.43**	**98.79**	**96.93**	**0.46**	**3.50**
median	99.00	96.00	99.00	97.00	0.00	1.00	98.00	94.00	99.00	97.00	0.00	3.00
Standard irregularity	**0.68**	**1.02**	**0.49**	**0.67**	**0.46**	**0.76**	**0.71**	**1.61**	**0.41**	**0.80**	**0.50**	**1.05**
amplitude	2.00	4.00	1.00	2.00	2.00	3.00	2.00	6.00	1.00	3.00	1.00	4.00
variation factor	0.69	1.05	0.50	0.69	640.31	111.77	0.72	1.73	0.42	0.82	107.42	30.06
The STUDENT test	766.26	502.62	1068.38	763.61	0.83	4.73	732.97	306.48	1273.93	642.25	4.93	17.60
average error of arithmetic mean	0.13	0.19	0.09	0.13	0.09	0.14	0.13	0.30	0.08	0.15	0.09	0.20
Homogeneity	High	high	high	high	low	low	high	high	high	high	low	low

In predictive and summative testing, the pulseoximeter shows that in the pre-exercise measurement the oxygen concentration in the blood is higher than in the post-exercise measurement, where it decreases due to 6 minute aerobic run (desaturation occurs). In the summative evaluation SpO2 values were mitigated in both samples, but more in the experimental sample where the subjects worked with different means and methods than those of the control sample.

From the above table, we find an improvement in the arterial values of oxygen saturation (SpO2) obtained at TS2 vs. TP2, increased in the experimental sample versus the control sample (96.93 vs. 93.43 and 97.11 respectively compared to 96.43). The coefficient of variation at TS2 and TP2 shows high homogeneity in the summative assessment in the experimental sample (0.82) and in the control sample (0.69), and the standard deviation (0.80 and 0.67,

respectively) indicates a group near the average, so it is a small scattering. The value of the student test being greater than 2.58 (the critical value tabulated) at the threshold p <0.01 has the significance with a probability of 99%.

The progress of the experimental sample of 3.04% of oxygen saturation (SpO2) versus 0.61% of the control sample is due to the work of the subjects with means and methods specific to the football game, which proved to be more effective compared to the means and the specific athletic methods that the subjects of the control sample worked on. This conclusion highlights our hypothesis. Consequently, the null hypothesis (the random difference between environments) is invalidated and the hypothesis formulated is accepted.

Table 2. Table of values of the average values of the control sample and the experimental sample, in the predictive and summative post-exercise evaluation at the sample with the Spo2-Pulseoximeter. (oxygen concentration in the blood)

Control sample		**Experimental sample**	
Predictive assessment	**Summative assessment**	**Predictive assessment**	**Summative assessment**
Post effort (TP2)	**Post effort (TS2)**	**Post effort (TP2)**	**Post effort (TS2)**
96.43 %	97.11 %	93.43 %	96.93 %

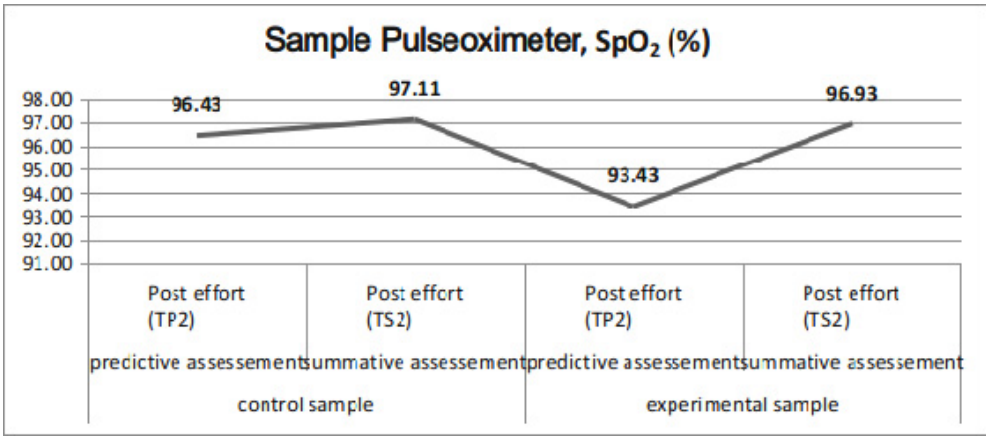

Fig. 1. The progress and values of the arithmetic mean of the control sample and the experimental sample, in the predictive and summative post-exercise evaluation at the Pulse Oximeter-SpO2 sample.

From the previous table with the arithmetic mean values and the associated graph we find an increase in the final value of the mean oxygen

saturation (SpO2) obtained at TS2 vs. TP2, increased in the experimental sample versus the control sample (in the control sample increased with 0.68%, and 3.50% in the experimental sample). This higher increase in the subjects in the experimental sample represents the greater efficiency of the means and methods of football specific to the means and methods specific to athletics. In the experimental sample, the mean of the progress of oxygen saturation (SpO2) was 3.04% and in the control sample only 0.61%.

Table 3. Table of the values of the statistical parameter indicators of the control sample and of the experimental sample in the predictive and summative evaluation at the Pulse Oximeter Functional Pulse Oximeter (PR)

PR (bpm)	Control sample						Experimental sample					
	Predictive assessment		Summative assessment		Progress		Predictive assessment		Summative assessment		Progress	
	Before effort (TP1)	Post effort (TP2)	Before effort (TS1)	Post effort (TS2)	Before effort (TS1-TP1)	Post effort (TS2-TP2)	Before effort (TP1)	Post effort (TP2)	Before effort (TS1)	Post effort (TS2)	Before effort (TS1-TP1)	Post effort (TS2-TP2)
sum	2214.00	4815.00	2215.00	4410.00	1.00	-405.00	2217.00	4767.00	2143.00	4067.00	-74.00	-700.00
Minimum	68.00	160.00	70.00	138.00	-8.00	-22.00	69.00	157.00	66.00	138.00	-10.00	-38.00
Maximum	90.00	182.00	86.00	170.00	8.00	-1.00	89.00	186.00	85.00	164.00	6.00	-19.00
Number	28.00	28.00	28.00	28.00	28.00	28,00	28.00	28.00	28.00	28.00	28.00	28.00
Half	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Arithmetic mean	**79.07**	**171.96**	**79.11**	**157.50**	**0.04**	**-14.46**	**79.18**	**170.25**	**76.54**	**145.25**	**-2.64**	**-25.00**
Median	78.00	170.00	80.00	158.00	-2.00	-16.00	80.00	168.00	77.00	143.00	-4.00	-25.00
Standard irregularity	**5.83**	**5.99**	**4.74**	**8.19**	**4.06**	**4.96**	**4.54**	**7.88**	**4.23**	**6.68**	**3.47**	**4.15**
Amplitude	22.00	22.00	16.00	32.00	16.00	21.00	20.00	29.00	19.00	26.00	16.00	19.00
Variation factor	7.37	3.48	5.99	5.20	11360.90	-34.29	5.73	4.63	5.53	4.60	-131.16	-16.60
The STUDENT test	71.76	151.89	88.34	101.74	0.05	-15.43	92.37	114.30	95.75	114.97	-4.03	-31.88
Average error of arithmetic mean	1.10	1.13	0.90	1.55	0.77	0.94	0.86	1.49	0.80	1.26	0.66	0.78
Homogeneity	high	high	high	high	low	high	high	high	high	high	high	high

Initially, after the effort, the predictive pulse (PR) testing was higher. It decreased in the summative testing of both samples, but the decrease was more pronounced in the subjects of the experimental sample than those of the control sample. So the values diminished in the summative evaluation more in the subjects of the experimental sample who worked with the means and methods specific to football. From the above table, we find a decrease of the arithmetic mean values of the pulse (PR) obtained at TS2 vs. TP2, increased in the experimental sample compared to the control sample (145.25 vs. 170.25 and 157.50, respectively 171.96). The coefficient of variation at TS2 and TP2 shows high homogeneity in the summative assessment of the experimental sample (4.60) and the control sample (5.20), and the standard deviation (6.68 and 8.19) indicates a group near arithmetic mean, better performance of the subjects from the experimental sample. The value of the Student test is greater

than the critical table (2.58), so it is significant at the threshold p <0.01 and has a high probability of 99%.

The progress of the experimental sample was manifested by the decrease of the heart rate at the effort by 25 beats per minute (bpm), and in the control sample the adaptation to effort specific to the specific means and methods of athletics decreased the pulse by only 14.46 bpm, from which it follows that the means the specific methods of playing football used to train the subjects in the experimental sample gave better performance, developed greater student effort. According to the aforementioned, one can say that in the case of pulse (PR) the null hypothesis is rejected and the hypothesis formulated is accepted.

Table 4. Table of values of the arithmetic mean values of the control and the experimental sample, in the predictive and summative post-exercise evaluation at the Pulseoximeter – PR

Control sample		**Experimental sample**	
Predictive assessment	**Summative assessment**	**Predictive assessment**	**Summative assessment**
Post effort (TP2)	**Post effort (TS2)**	**Post effort (TP2)**	**Post effort (TS2)**
171.96 bpm	157.50 bpm	170.25 bpm	145.25 bpm

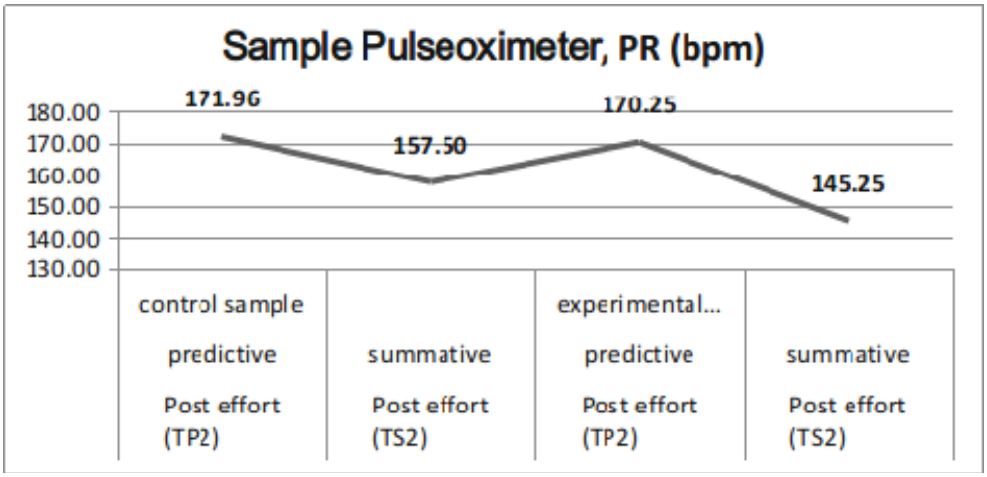

Fig. 2. Graph with the progress and values of the arithmetic mean of the control sample and the experimental sample, the predictive and summative post-exercise evaluation at the Pulseoximeter PR

From the previous table and the associated chart we find a decrease in the final value of the mean heart rate (PR) obtained at TS2 compared to TP2,

increased in the experimental sample compared to the control sample (in the control sample decreased by 14.46 bpm, and at the experimental sample with 25 bpm). This higher pulse decrease in subjects in the experimental sample represents the increased efficiency of football's means and methods versus athletic means and methods. In the experimental sample, mean pulse rate (PR) was -25 bpm, and in the control sample only -14.46 bpm. Predictive measurement with the pulseoximeter before the experimental experiment showed normal values of oxygen saturation (99% - 97%) and heart rate (76 bpm - 89 bpm). After the 6-minute aerobic run physiological changes occurred at the vital pulseoximeter parameters: high heart rate (PR) (180 bpm - 162 bpm) and normal oxygen saturation (SpO2) (96% - 94%), but also with values ranging from 93% to 90%, being installed in small hypoxic subjects.

After two semesters of systematic training with the means and methods specific to football, the post-effort summative measure, the subjects of the experimental sample improved their SpO2 values (99% - 98%), there was not any low hypoxia at any pupil and it decreased in cardiac frequency (155 bpm - 139 bpm). In the pre-exercise control sample, predictive pulseoximetry showed values close to those of the experimental sample at oxygen saturation (99% - 97%) and pulse (70 bpm - 87 bpm). After effort, the measurements showed a heart rate ranging from 180 bpm to 160 bpm and normal oxygen saturation (99% - 94%), but also subjects with low hypoxia (93% - 90%). And here physiological changes occurred after a school year of systematic training with means and methods specific to athletics, but at a lower level than the experimental sample that worked with football means and methods: pulse between 165 bpm - 138 bpm and saturation oxygen with oxygen between 99% and 97%.

In post-exercise summative assessments, the measurements showed both pulsation decreases and an increase in oxygen saturation, more prominent in the experimental sample versus control, and in their predictive post-exercise assessment, for example the exercise capacity increased resistance of the students' body to the effort. By carrying out the 6 minute aerobic effort of the subjects, changes in the physiological indices occurred: the increase of the pulse during the effort and the decrease of the blood oxygen saturation with lower values than the predictive evaluation (the pulse values being inversely proportional to the saturation values of the oxygen). The exercise capacity of the subjects who performed the 6-minute aerobic run at summative assessment was assessed by correlating it with post-exercise physiological indexes: PR and SpO2 in predictive assessment. The lower the subject's pulse value and the oxygen saturation value was higher after the effort, the more they were rated as having improved exercise capacity.

Conclusions

The statistical and mathematical calculations carried out as a result of the experiment have confirmed the assumption of the hypothesis, the superiority of the efficiency of the specific means of football, compared to the use in the lessons of the specific means of athletics, when working to optimize the development of the resistance of the high school students. From the values obtained by measurement with the pulseoximeter we can see the positive differentiation in favor of the experimental sample that we assign to the systematic work with means and methods specific to the football game in the physical and sports education classes throughout the school year which have maintained a high level of motivation of students. So the systematic use of football-specific means and methods in physical and sport education lessons optimizes the development of resistance, they are more effective than using the specific athletics. So, by confirming the hypothesis of our research, the null hypothesis is rejected and the working hypothesis is accepted. The development of high school students' resistance must be considered a priority task of school physical education, as it has a direct influence on the development of their motor skills, which is also an objective to be achieved.

The football game itself, and the football-specific exercises used for the development of resistance contribute to a great extent also to the formation of certain volitional qualities such as the psychic ability to withstand, the self-mastery and the desire for progress. Practicing students in physical education and sports classes, the football game contributes substantially to achieving the tasks of physical education: "The playing conditions, the complexity of the movements and the specific character of the players' actions, attribute to football itself the role of the middle of physical and sports education, because it contributes to the accomplishment of its tasks" (Neţa & Popovici, 2000); "The practice of the game influences the restructuring of the functions of different organs and systems that favor the mechanism of adapting to the effort of the entire organism by increasing its functional capacity" (Neţa & Popovici, 2000); "The football game develops at a higher level the general and specific motricity, as well as the physical qualities that are also an important objective of physical education" (Neţa & Popovici, 2000); "Learning and practicing the football game in the school environment, in the form of mini-football, in small spaces (specific to the conditions offered by most schools), contributes to solving the important tasks of the training and education process through its multiple formative valences" (Neţa & Popovici, 2000).

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