The cardiovascular system's adaptation among judokas of preschool and primary school age (on the example of the general preparatory stage in the yearlong macrocycle)

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Abstract. The research touches on an interesting and important scientific problem that lies in the contradiction between two circumstances. The first circumstance is the lowering of the age limit for doing judo. And the second circumstance is the necessity to carefully dosing the load, training young judokas, taking into account their active growth and development. Thus, the analysis of the cardiovascular system's reactions to the applied load among judokas of preschool and primary school age is relevant and new for experimental research. The purpose of this research is to determine the cardiovascular responses ("costs" / "physiological price") among judokas of preschool and primary school age to mental and physical stress (using the example of the general preparatory stage in the yearlong macrocycle, in particularly, on the example of the first retracting and the first basic mesocycles). The methods of this research: comparative method, longitudinal method, a method of included pedagogical observation, a method of recording, a method of control tests, a forming natural closed sequential pedagogical experiment (according to the scheme of a single difference), case studies, frequence's analysis, correlation's analysis, regression's analysis, genetic method, theoretical modeling. As a result of the study, a beneficial effect of the pedagogical technology "Safe Judo" on the trainness's increasing of the cardiovascular system's functions among judokas of preschool and primary school age was revealed (in particularly, an increasing in systolic blood volume, an increasing in minute blood volume, as well as a decreasing in the number of arrhythmias).

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1 INTRODUCTION

Judo is a complex coordinating sport. The success of mastering complex coordinating motor actions in judo is determined by the level of special creative abilities' formation (psychomotor, spiritual and social). These abilities develop the better, the less muscle clamps and psycho-corporal complexes a judoka has. The range of judoka's special creative abilities' formation is determined genetically, as in other types of activity. So, we can talk about the maximum amount of ability's growth and the speed of this growth's formation. In this regard, it is important to take into account the possibility of external (for example, pedagogical) influence on the variability of ability's formation. For the effective formation of any creative ability, it is important to start this pedagogical influence, the sooner the better. For judo, including in this regard, a decrease in the age limit of training sessions is now characteristic. So, in Japan, as the ancestral country of judo, judo training sessions for preschool and preteen children (from six to twelve years old) are practiced in mixed groups. Previously, the Japanese experimented with the format "Judo for children from three to twelve years old", however, they came to the conclusion that children from three to six years old can only be engaged as an exception (based on individual testing of the abilities and behavioral style of each such child and by individual agreement between the coach and the child's parents). Thus, children from three to six years old also train together with everyone (preschool and preteen children), but as an exception, from which it follows that there are not many of them and the emphasis in training is on the achievements of older ones.

This situation raises the following questions. How is it expedient to train children from three to twelve years old (by what methods)? In what ranges should physical and mental stress be dosed for children from three to twelve years old? How do the leading functional systems of the body of preschool and preteen children (in particular, preschool and primary school age's judokas) respond to physical and mental stress?

2 LITERATURE REVIEW

Let's look at previous studies. So, over the past twelve years, we have proposed in publications approved versions of the author's pedagogical technology "Safe Judo" for children, both preschool and primary school age [1–8]. Our colleagues are also conducting researches on this topic in parallel with us. It can be seen that there are much more works on the methods of training judokas of primary school age [9–12], compared to the number of works on the technologies of training judokas of preschool age [13–14]. This fact allows us to conclude that the composition of technologies for preparing preschoolers in judo is still a new topic for scientific analysis. At the same time, a comparative analysis allows us to conclude that the methods and technologies of sports training for children of both primary school age [15–23] and preschool age [24–32] in the theory and methodology of physical culture have been studied quite well. Returning to the physiological theme of this work, it should be noted that if, in general, the reactions of the body's functional systems to physical activity also are quite well studied (including the cardiovascular system's reactions; for example, we can refer to a number of recent studies [33–34]), then the same questions with concretization for the characteristics of physical and mental loads in judo have been studied to a lesser extent. In particular, there are several works [35–37] concerning the judoka's physiological reactions. However, there are no works that would reveal the adaptation's features of the functional systems among preschool and primary school age judokas. Our article is devoted to the elimination of this gap in scientific knowledge in terms of the cardiovascular system's adaptation among young judokas.

3 THE METHODOLOGY OF THE RESEARCH

Organization of the research. The organizational research's structure of the forming natural closed sequential pedagogical experiment (according to the scheme of a single difference)

included mixed group, which was formed during five years of the educational and training process (data of eight preschool and primary school age judokas, who attended all training sessions within the analyzed retracting and basic mesocycles of the general preparatory stage in the yearlong macrocycle, were taken for processing). This mixed group included three fourth year's judokas, three second year's judokas and two first year's judokas. The single difference was the year of study (in other words – the complexity of solving educational problems, volume and intensity of the training load).

The methods of this research: comparative method, longitudinal method, a method of included pedagogical observation, a method of recording, a method of control tests, a forming natural closed sequential pedagogical experiment (according to the scheme of a single difference), case studies, frequence's analysis, correlation's analysis, regression's analysis, genetic method, theoretical modeling.

4 RESULTS OF THE RESEARCH

4.1 The analyze of the components of the author's training model of the yearlong macrocycle for judokas of preschool and primary school age

As shown in Figure 1, the author's structure of the yearlong macrocycle for judokas of preschool and primary school age is the model for the implementation of classes in a sports and recreation complex / organization. This model is based on our pedagogical technology "Safety judo" [8]. Our annual planning model is single-cycle, with twenty-seven weeks (nearly seven months) of preparation, eight weeks of competition (two months), and eighteen weeks (including four weeks of the Covid–19 pandemic) of transition. The preparatory period includes five mesocycles, which can be conditionally divided into a general preparatory stage (the first retracting and basic mesocycles) and a special preparatory stage (the second retracting and basic, as well as control and preparatory mesocycles).

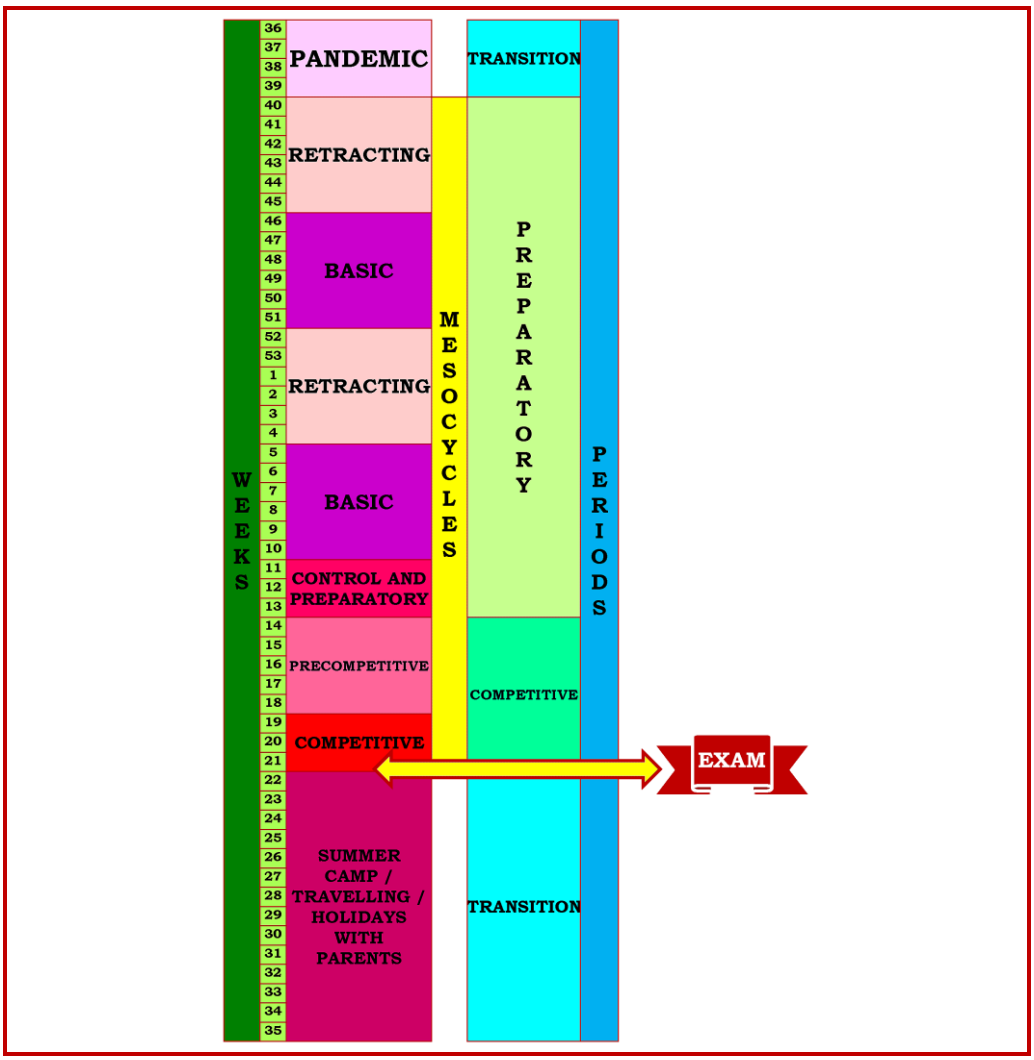

Fig. 1. The author's structure of the yearlong macrocycle for judokas of preschool and primary school age (the model for the implementation of classes in a sports and recreation complex / organization). Pedagogical technology "Safety judo"

As the main control event of the training year, taking into account Covid–19 restrictions, a kyū grade's qualifying examination for fourth year's judokas was considered.

Figure 2 shows the stage planning model for the general preparatory stage of the preparatory period.

So, both retracting and basic mesocycles include six weeks each. Each week includes two microcycles: restorative, covering Monday and Tuesday, and the main one, including the training process from Wednesday to Sunday. In the retracting mesocycle, retracting microcycles are used as the main ones. In the basic mesocycle, the alternation of shock and retracting microcycles is used as the main microcycles.

This model allows us to wave-like alternating the intensity of physical and mental stress. The volume of load is stable throughout the yearlong macrocycle, and includes three training sessions per week for two hours (Wednesday, Friday, Sunday). Thus, the dosing of the load is carried out by varying the intensity of the load for children of different preparedness, and

when solving educational problems – by varying the composition and difficulty of training tasks.

From week to week, the load intensity in the retracting mesocycle varies from 50 to 60%, and in the basic mesocycle – from 60 to 70% of the maximum.

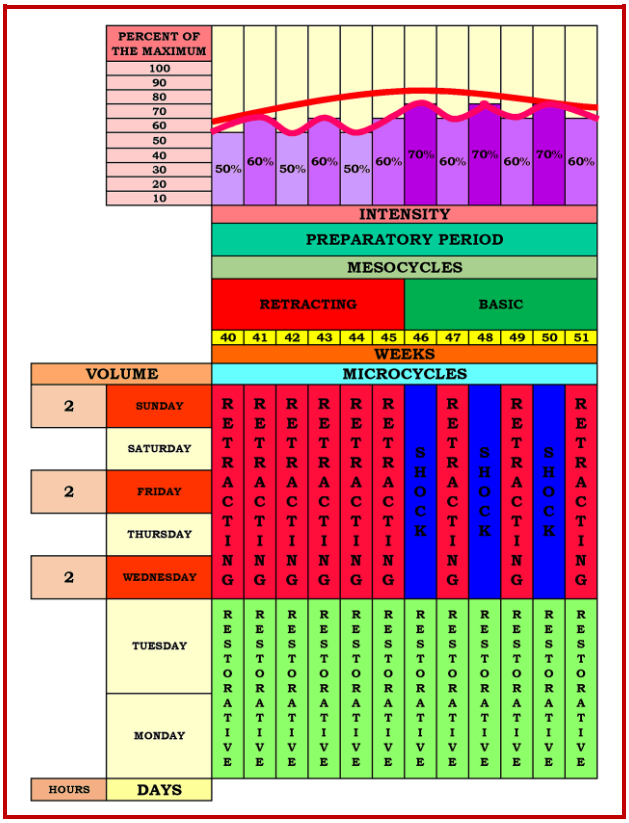

Fig. 2. The author's structure of the retracting and the basic mesocycles of the general preparatory stage in the yearlong macrocycle for judokas of preschool and primary school age (the model for the implementation of classes in a sports and recreation complex / organization). Pedagogical technology "Safety judo"

4.2 Results from descriptive statistics (frequence's analysis)

As shown in Figure 3, there is an increasing in general indicators in health-made diapasonof the cardiovascular system's adaptation among judokas of preschool and primary school age (the smean systolic blood pressure, the mean diastolic blood pressure, the mean heart rate, the mean pulse blood pressure), which is due to the implementation of physical exercises according to the pedagogical technology "Safety judo". Also, we see, that the mean arrhythmia's presence is low before training sessions, it is higher at the end of training sessions in comparative with the start, but it isn't high in whole (the highest rate is 16% within the framework of the basic mesocycle). The general arrhythmia's grade is shown in Figure 4, it is twice as high within the framework of the basic mesocycle in comparative with the framework of the retracting mesocycle, which suggests that an increasing of mental and physical loads' intensity increases the number of arrhythmias among judokas of preschool and primary school age. Then, in Figure 4 we see, that the systolic blood volume and minute volume of blood are almost identical within all frameworks (the general preparatory stage or the retracting mesocycle or the basic mesocycle). This This situation is probably due to the fact we are analyzing the indicators of a mixed group of preschool and primary school age's judokas with different levels of preparedness. So, accordingly, judokas of the first and, for example, the fourth years of training react to the mental and physical presented loads in different ways.

Let us consider these nuances in more detail using the methods of explanatory statistics.

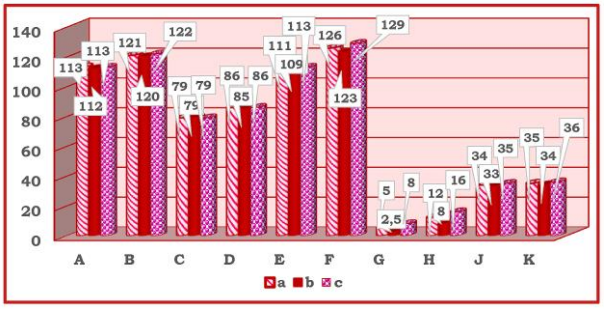

Fig. 3. Grouped bar chart for the general indicators of the cardiovascular system's adaptation among judokas of preschool and primary school age (on the example of the general preparatory stage, of the retracting mesocycle, of the basic mesocycle in the yearlong macrocycle). Part I (n = 8)

Note to Fig. 3: A – the mean systolic blood pressure before training sessions (mmHg); B – the mean systolic blood pressure at the end of training sessions (mmHg); C – the mean diastolic blood pressure before training sessions (mmHg); D – the mean diastolic blood pressure at the end of training sessions (mmHg); E – the mean heart rate before training sessions (bpm); F – the mean heart rate at the end of training sessions (bpm); G – the mean arrhythmia's presence before training sessions (% of the training sessions' number); H – the mean arrhythmia's presence at the end of training sessions (% of the training sessions' number); J – the mean pulse blood pressure before training sessions (mmHg); K – the mean pulse blood pressure at the end of training sessions (mmHg); a – within the framework of the general preparatory stage; b – within the framework of the retracting mesocycle; c – within the framework of the basic mesocycle.

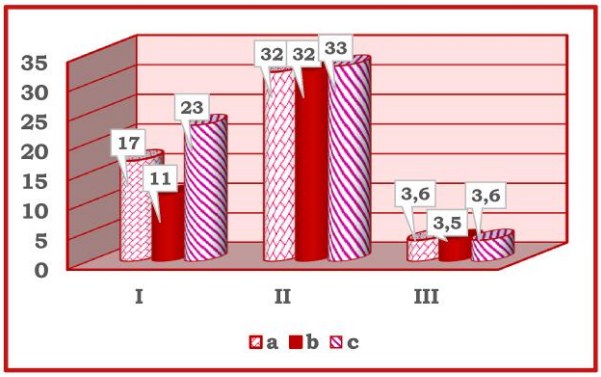

Fig. 4. Grouped bar chart for the general indicators of the cardiovascular system's adaptation among judokas of preschool and primary school age (on the example of the general preparatory stage, of the retracting mesocycle, of the basic mesocycle in the yearlong macrocycle). Part II (n = 8)

Note to Fig. 4: 1 – the arrhythmia's grade (%); 2 – the systolic blood volume (ml); 3 – minute volume of blood (L); a – within the framework of the general preparatory stage; b – within the framework of the retracting mesocycle; c – within the framework of the basic mesocycle.

4.3 Results from explanatory statistics (correlation's analysis, regression's analysis)

The dependence of the judokas' minute volume of blood on the year of training within the framework of the general preparatory stage (Fig. 5)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.619, so this dependence is positive and middle.

2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us the Linear model.

So, $Y = 2{,}656 + 0{,}369*X$ (1),

where **Y** is the judokas' minute volume of blood, **X** is the year of training and R Square is 0.583.

Thus, this means that the year of training is the main factor determining the judokas' minute volume of blood within the framework of the general preparatory stage, but not the only one.

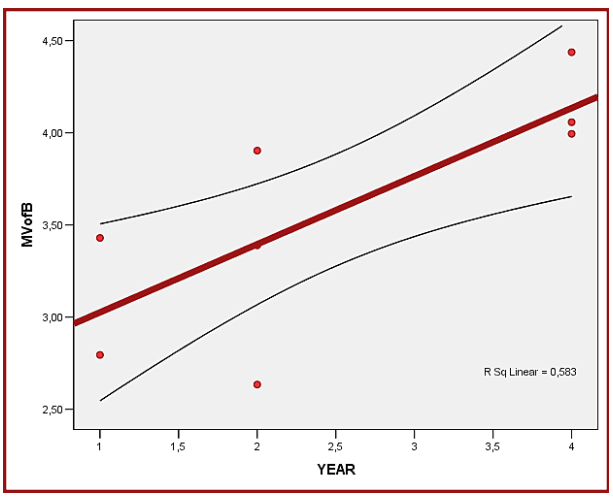

Fig. 5. Scatterplot for the dependence of the judokas' minute volume of blood (L) on the year of training within the framework of the general preparatory stage (n = 8)

Note to Fig. 5: along the x-axis – the year of training; along the y-axis – the minute volume of blood within the framework of the general preparatory stage.

The dependence of the judokas' arrhythmia's grade on the year of training within the framework of the general preparatory stage (Fig. 6)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is – 0.784, so this dependence is negative and high.
2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us three most likely models.

The Power model.

So, $Y = 28{,}061 * X^{-1{,}220}$ (2),

where **Y** is the judokas' arrhythmia's grade, **X** is the year of training and R Square is 0.644.

The S model.

So, $Y = e^{(1{,}117+2{,}384*1/X)}$ (3),

where **Y** is the judokas' arrhythmia's grade, **X** is the year of training and R Square is 0.714.

The Growth model.

So, $Y = e^{(3{,}609-0{,}490*X)}$ (4),

where **Y** is the judokas' arrhythmia's grade, **X** is the year of training and R Square is 0.533.

Thus, the S model to the greatest extent shows us the influence's degree of the year of training on the judokas' arrhythmia's grade within the framework of the general preparatory stage.

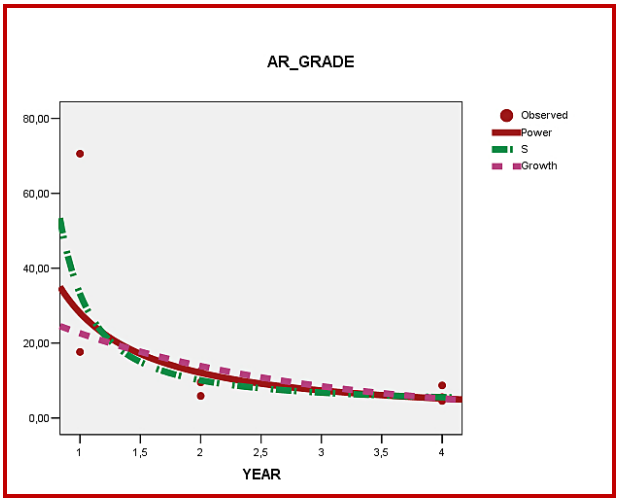

Fig. 6. Scatterplot for the dependence of the arrhythmia's grade among judokas (%) on the year of training within the framework of the general preparatory stage (n = 8)

Note to Fig.6: along the x-axis – the year of training; along the y-axis – the arrhythmia's grade among judokas within the framework of the general preparatory stage.

The dependence of the judokas' minute volume of blood on the year of training within the framework of the retracting mesocycle (Fig. 7)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.701, so this dependence is also positive and middle (the same as the indicators within the framework of the general preparatory stage).
2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us the Linear model.

So, $Y = 2{,}417 + 0{,}427*X$ (5),

where **Y** is the judokas' minute volume of blood, **X** is the year of training and R Square is 0.552.

Thus, this means that the year of training is the main factor determining the judokas' minute volume of blood within the framework of the retracting mesocycle, but not the only one (the same as the indicators within the framework of the general preparatory stage).

The dependence of the judokas' systolic blood volume on the year of training within the framework of the basic mesocycle (Fig. 8)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.619, so this dependence is positive and middle.
2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us the Linear model.

So, $Y = 23{,}648 + 3{,}550*X$ (6),

where **Y** is the judokas' systolic blood volume, **X** is the year of training and R Square is 0.557.

Thus, this means that the year of training is the main factor determining the judokas' systolic blood volume within the framework of the basic mesocycle, but not the only one.

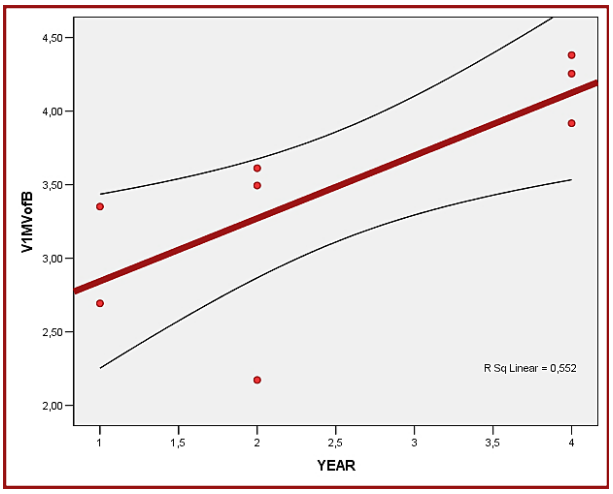

Fig. 7. Scatterplot for the dependence of the judokas' minute volume of blood (L) on the year of training within the framework of the retracting mesocycle (n = 8)

Note to Fig. 7: along the x-axis – the year of training; along the y-axis – the minute volume of blood within the framework of the retracting mesocycle.

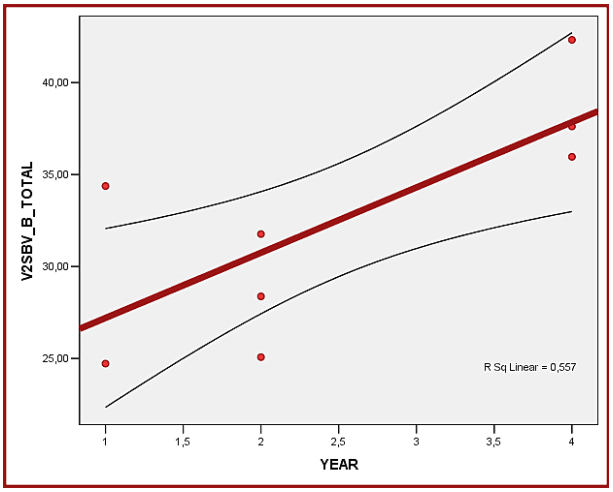

Fig. 8. Scatterplot for the dependence of the judokas' systolic blood volume (ml) on the year of training within the framework of the basic mesocycle (n = 8)

Note to Fig. 8: along the x-axis – the year of training; along the y-axis – the systolic blood volume within the framework of the basic mesocycle.

The dependence of the judokas' systolic blood volume on the attendance within the framework of the general preparatory stage (Fig. 9)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.718, so this dependence is positive and high.

2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us the Inverse model.

So, $Y = 66{,}116 - 1842{,}950/1/X$ (7),

where **Y** is the judokas' systolic blood volume, **X** is the attendance (%) and R Square is 0.504.

Thus, this means that the attendance (%) is the main factor determining the judokas' systolic blood volume within the framework of the general preparatory stage, but not the only one.

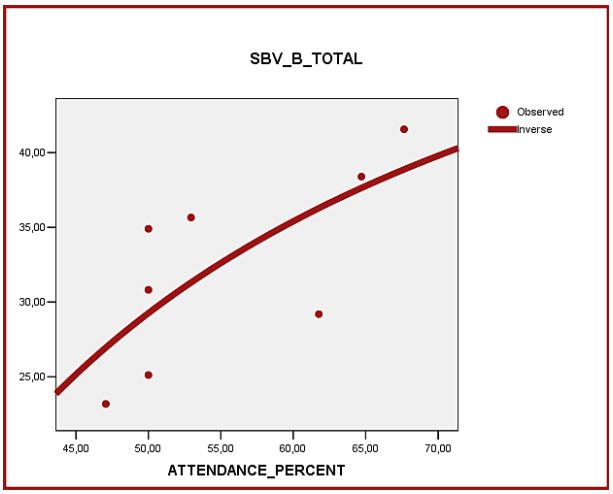

Fig. 9. Scatterplot for the dependence of the judokas' systolic blood volume (ml) on the attendance within the framework of the general preparatory stage (%; n = 8)

Note to Fig. 9: along the x-axis – the attendance (%); along the y-axis – the systolic blood volume within the framework of the general preparatory stage.

The dependence of the judokas' systolic blood volume on the attendance within the framework of the retracting mesocycle (Fig. 10)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.772, so this dependence is positive and high (the same as the indicators within the framework of the general preparatory stage).
2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us three most likely models.

The Logarithmic model.

So, $Y = -52{,}975 + 21{,}758*\ln(X)$ (8),

where **Y** is the judokas' systolic blood volume, **X** is the attendance (%) and R Square is 0.742.

The Inverse model.

So, $Y = 54{,}391 - 1075{,}552/1/X$ (9),

where **Y** is the judokas' systolic blood volume, **X** is the attendance (%) and R Square is 0.764.

The S model.

So, $Y = e^{(4{,}189 - 35{,}878*1/X)}$ (10),

where **Y** is the judokas' systolic blood volume, **X** is the attendance (%) and R Square is 0.747.

Thus, the Inverse model to the greatest extent shows us the influence's degree of the attendance (%) on the judokas' systolic blood volume within the framework of the retracting mesocycle.

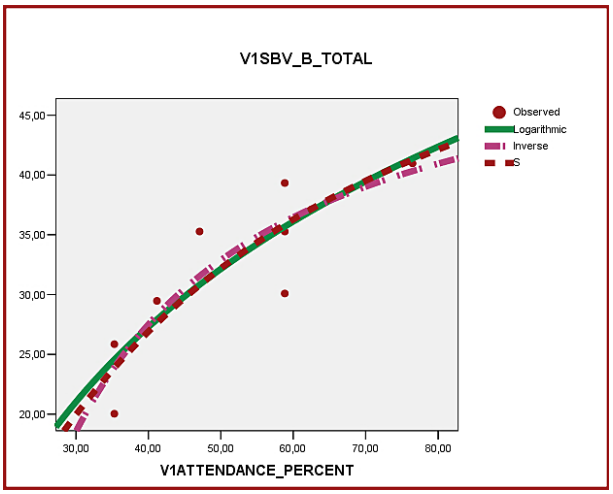

Fig. 10. Scatterplot for the dependence of the judokas' systolic blood volume (ml) on the attendance within the framework of the retracting mesocycle (%; n = 8)

Note to Fig. 10: along the x-axis – the attendance (%); along the y-axis – the systolic blood volume within the framework of the retracting mesocycle.

The dependence of the judokas' minute volume of blood on the attendance within the framework of the retracting mesocycle (Fig. 11)

1. *Correlation's analysis* (considering the small sample size $p \leq 0.05$; by Kendall's τ correlation coefficient) shows us that **r** is 0.617, so this dependence is positive and middle.
2. *Regression's analysis* (considering the small sample size $p \leq 0.05$) shows us two most likely models.

The Inverse model.

So, $Y = 5{,}717 - 107{,}424/1/X$ (11),

where **Y** is the judokas' minute volume of blood, **X** is the attendance (%) and R Square is 0.666.

The S model.

So, $Y = e^{(1{,}926 - 33{,}706*1/X)}$ (12),

where **Y** is the judokas' minute volume of blood, **X** is the attendance (%) and R Square is 0.660.

Thus, both models to the greatest extent show us the influence's degree of the attendance (%) on the judokas' minute volume of blood within the framework of the retracting mesocycle.

5 THE DISCUSSION OF THE RESULTS

So, we can conclude, that three of the seven dependences are the most reliable for assessing the adaptability of the cardiovascular system among judokas of preschool and primary school age.

We refer to them:

- ✓ the dependence of the judokas' minute volume of blood on the year of training within the framework of the general preparatory stage;
- ✓ the dependence of the judokas' minute volume of blood on the year of training within the framework of the retracting mesocycle;
- ✓ the dependence of the judokas' systolic blood volume on the year of training within the framework of the basic mesocycle.

This is due to the fact, that these dependences are linear (confirmed by both correlation's analysis and regression's analysis).

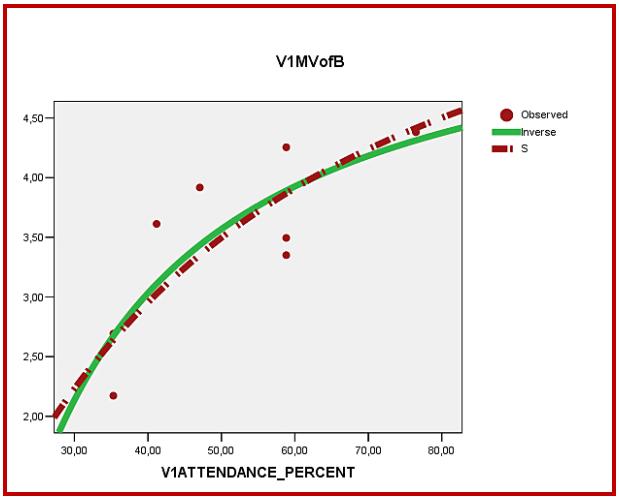

Fig. 11. Scatterplot for the dependence of the judokas' minute volume of blood (L) on the attendance within the framework of the retracting mesocycle (%; n = 8)

Note to Fig. 11: along the x-axis – the attendance (%); along the y-axis – the minute volume of blood within the framework of the retracting mesocycle.

6 CONCLUSION

Consequently, it can be argued, that judokas of preschool and primary school age, who have been practicing for up to four years, show signs of long-term cardiovascular system's adaptation. Training influences for one or two years give judokas of preschool and primary school age, mainly, the effects of urgent adaptation. Further researches of the cardiovascular system's adaptability among judokas of preschool and primary school age should cover the entire spectrum of influencing factors using factor analysis.

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