

Analysis of the dynamics of vestibular stability in athletes: Experimental and control groups

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Abstract

Performances of professional athletes reflect not only individual achievement, but also carry socio-political significance for the success of the state, sports clubs and commercial organizations sponsoring them. Ukraine's representation on the international stage requires enhancing the training of young divers, particularly by improving talent identification in the early stages and aligning age specific development with the cultivation of their abilities and skill. **Purpose:** mathematically substantiate the criteria for the selection of children in children's and youth sports schools and to form the criteria for the selection of jumps into water at the stage of initial training. **Material and Methods: Subjects:** Determination of the functional state of the vestibular analyzer was carried out using a passive rotating test. 55 respondents (10.98±0.1 years; range: 9-13 years) took part in the study (KG_{man}=19; EG_{man}=17; KG_{girls}=10; EG_{girls}=8). The testing was conducted between 2022 and 2025. We studied the dynamics of nystagmus frequency during and after rotation of the left and right sides, as well as the amplitude of nystagmus during and after rotation. Research was conducted and performed in accordance with the ethical standards of the Declaration of Helsinki. **Results:** Comparative analysis of nystagmus frequency after rotations to the right of athletes EG_{man} and KG_{man} found a significant difference at the end of the experiment. Frequency of nystagmus in boys EG_{man} 3.6 fluctuations higher than in boys KG_{man} (t=2.308; p<0.05). A study of the amplitude of nystagmus during rotation to the right found that in KG_{man} a significant difference in results is observed at 12 years of age (t=2.498; p<0.05), and in EG_{man} - at the age of 11 (t=2.856; p<0.01). At the end of the experiment in athletes KG_{man} the difference relative to the original data is 2 mm (t=2.877; p<0.01), and in EG_{man} - 3.7 mm (t=4.532; p<0.001). There is also a significant difference between the indicators EG_{man} and KG_{man} at the age of 13 (t=2.072; p<0.05). The results of the girls EG_{girls}, as in the previous version, have a significant difference relative to the original data after the second stage of selection (t=2.005; p<0.05). In the future, the difference increases and is: in the third selection - 6.4 fluctuations (t=4.007; p<0.001), in the fourth selection at the end of the experiment - 7.9 fluctuations (t=5.721; p<0.001). **Conclusion.** The introduction of the author's criteria for the selection of athletes-divers in the water stimulates them to improve vestibular stability for further training in the sections of diving. The criteria do not have a direct impact on improving the vestibular stability of athletes that we studied, but the knowledge that these indicators affect the overall assessment of athletic fitness motivates young jumpers to actively improve.

Keywords: servicemen, operator, drones, psychomotor skills.

Introduction

In the conditions of dynamism of modern social and information processes in the society the psychophysiological load on schoolboys who need high-grade rest and a rational mode of motor activity

increases. Lack of swimming skills, namely the ability to stay afloat, is a significant risk factor for human life and significantly limits the possibility of full life, active recreation and health, development of physical, moral and intellectual abilities on the path of harmonious personality formation (Adi S., Fathoni A.F., 2019; Arabskyi A., Afonin V., 2018). Insufficient provision of well-equipped specialized pools for diving leads to the most efficient and rational organization of swimming and diving training, using non-standard conditions (Buts M., 2016; Bompá T., Haff G., 2009).

Systematic updating of sports records, expansion of the international sports calendar in recent years through commercial competitions have led to the individualization of the training process and competitive activities, increasing the burden on the individual athlete, which requires mobilization of functional reserves and psychological stability in competitive activities. The above determines the search for ways to select talented young people, especially in the initial stages, substantiate the age limits of development of their talents and abilities (Drozd O., 1999; Issurin V., 2017).

To date, significant rejuvenation of athletes and the complexity of the program of diving has led to the importance of the process of determining the athletic fitness of young athletes. Analysis of scientific papers has shown that the process of selecting athletes is insufficiently disclosed, especially in difficult coordination sports. Coaches and athletes point out that an athlete who has the genetic and physiological abilities that have been identified in time can master a complex jumping program and perform it flawlessly at a high technical level (Johnston, K., Wattie, N., Schorer, J., Baker, J., 2018; Krasova, I., Mullagildina, A., Krasova, E., 2012; Klimakova S., 2001). Thus, the issue of proper selection of children in children's and youth sports schools remains relevant, which determines the quality of preparation of the reserve of national teams from diving.

Materials and methods

We conducted a comparative analysis of vestibular stability of athletes in the experimental and control groups during the experiment (for four years) among young men and women. Determination of the functional state of the vestibular analyzer was performed using a passive rotary test. 55 respondents (10.98 ± 0.1 years; range: 9-13 years) took part in the study. The research was organized and carried out with athletes of the Junior High School (Lviv) and "Yantar" Junior High School (Novoyavorivsk). During the educational and training meetings, testing and measuring of anthropometric indicators, determination of the speed of a simple sensorimotor reaction and conscious self-regulation of sensorimotor activity, research of vestibular stability were carried out. All measurements were taken before training in the morning and in the afternoon at 9:00 and 15:00. The subject was rotated in the Ram's chair by hand - 10 turns for 10 seconds, followed by a "stop stimulus" with the head upright. The rotation was initially performed to the left and then to the right with intervals between rotations of 3 minutes.

Vestibular stability was assessed by vestibulo-motor and vestibulo-vegetative reactions of the organism, which were recorded on a two-channel oscilloscope ECHR-3. Vestibulo-vegetative reactions, heart rate were recorded before, during and after rotation using an electrocardiogram. To record vestibular-motor reactions, an electronystagmogram of the eyes was recorded during and after rotation. Nystagmus electrodes were applied to the degreased lateral corners of the eyes with electrode paste and secured with a vinyl chloride belt around the head. Electrocardiographic electrodes were placed on the wrists and secured with rubber bandages. In the analysis of the electronystagmogram, its components were deciphered: amplitude, frequency and duration of nystagmus. The research was conducted on a portable electronic device with digital indication "Neurochronometer".

Light stimulus - a flash of pulsed lamps with an energy of 1.25 J, was applied automatically every 7 seconds. The time of normal sensorimotor reaction was recorded with an accuracy of 0.001 seconds. Measurements were performed according to the following instructions:

1) holding the remote control with the button with one hand, keep the index finger of the other hand on the button;

2) at the sound signal - to prepare;

3) when the pulse lamp flashes, press the button.

The technique includes three series of thirty reactions. Its peculiarity lies in the identified effects of the secondary signal system on the ability of the subject to control the speed of their reactions. In the first series, the maximum rate of simple sensorimotor response (X1) was determined with the constant influence of the second signal system on the self-control system. The task of the second series was to respond accurately "with a convenient speed close to the maximum possible", which was determined by the average reaction time in the first task. The subject was provided with urgent information about the time of his motor reactions (X2). The third series duplicated the second, but in the absence of urgent information (X3).

Neurochronometer readings were recorded in a special protocol. When processing individual data, the average time of motor reactions to the flash of light was calculated from measurements from 4 to 13 and the magnitude of the variation range for each series. The difference between the reaction time data in the series (X1-X2), (X1-X3), (X2-X3), as well as the difference in the values of the variation range in the series (R1-R2), (R1-R2), (R1-R3), (R2-R3)).

Methods of mathematical statistics were used, which helped to solve the problems of our study. Methods of mathematical statistics were used to prove the patterns identified in the study. Mathematical and statistical calculations were performed using computer programs, including "Excel", "SPSS", "STATISTICA 7" in the operating system "Windows Vista". Statistical data processing included the calculation of: average values - $\bar{X}$; standard deviations - δ ; standard deviation of the mean - m .

The application of the above methods allowed to organize research and verify the indicators of the formed groups, to prove the effectiveness of the program of physical training of students of higher education institutions at the stage of primary education with the use of crossfit.

Results

Vestibular stability is one of the most important qualities in the sports activities of divers. In order to determine the impact of the author's selection criteria for athletes aged 9-13 years, we analyzed the vestibular stability of boys and girls EG and CG during the formative experiment. We studied the dynamics of nystagmus frequency during and after rotation of the left and right sides, as well as the amplitude of nystagmus during and after rotation.

During turns to the left nystagmus indicators of vestibular stability of KGman athletes have a progressive characteristic. But during the experiment nystagmus has no significant difference relative to the original data (39.4 ± 1.3 counts) ($t = 0.837$; $p > 0.05$). The nystagmus of EGman athletes from the initial data of 9-year-old boys (39.6 ± 0.8 counts) significantly improved during the experiment (43.6 ± 0.88 counts) ($t = 3.373$; $p < 0.01$). Comparative analysis of this indicator of vestibular stability of athletes EG_{man} and KG_{man} showed that the introduction of author's criteria for selection of athletes promotes the development of certain training indicators, namely, at the end of the experiment between the results of nystagmatic indicators when turning left there is a significant difference ($t = 2.048$; $p < 0.05$).

After 3 minutes of rest, the athletes performed a rotation to the right. The frequency of nystagmus during rotation in boys KG_{man} during the experiment has no significant difference. So at athletes in 9 years (40.6 ± 1.78 counts). Indicators are lower than in 13 years (41.3 ± 0.88 counts) On 0.7 fluctuations ($t = 0.353$; $p > 0.05$). The frequency of nystagmus during the turns to the right of the boys EGman during the experiment significantly improved relative to the original data (40.4 ± 1.15 counts). Thus, in athletes 13 years of age EGman frequency of nystagmus during turns to the right (43.8 ± 0.85 count.) Improves by 2.5 oscillations ($t = 2.377$; $p < 0.05$). At the end of the experiment, a significant difference was found between the indicators of nystagmus frequency during rotations to the right of EG_{man} and KG_{man} athletes ($t = 2.040$; $p < 0.05$). Execution of this exercise indicates that the vestibular stability of EGman athletes during the experiment significantly exceeds the performance of KGman athletes, which in turn affects the athletic performance of young divers.

Analysis of the results of the frequency of nystagmus after turning to the left revealed that the athletes KGman results relative to the original data (31.2 ± 1.05 counts) during training they improve by 3.2 oscillations (34.4 ± 1.03 counts) and have a significant difference ($t = 2.180$; $p < 0.05$). The results of EG_{man} athletes also significantly improved during the experiment relative to the initial data (31.4 ± 0.88 counts). A significant difference was found in the results of EG_{man} boys at the age of 12 (35.3 ± 1.05 counts.) ($t = 2.853$; $p < 0.01$) and confirmed at 13 years of age (37.0 ± 1.0 counts) ($t = 4.214$; $p < 0.001$).

As in previous cases, a significant difference between the frequency of nystagmus after turning to the left was found at the end of the experiment ($t = 2.536$; $p < 0.05$).

A similar characteristic of the frequency of nystagmus after turning to the right in athletes EG_{man} ta KGman. In both groups, the frequency of nystagmus improved during the experiment, but in KG_{man} these indicators do not differ significantly from the original data ($t = 1.315$; $p > 0.05$), and athletes EG_{man} a significant difference relative to the original data is observed in 12 ($t = 3.076$; $p < 0.01$) and 13 years of age ($t = 4.040$; $p < 0.001$).

Comparative analysis of nystagmus frequency after rotations to the right of athletes EG_{man} ta KG_{man} found a significant difference at the end of the experiment. Frequency of nystagmus in boys EGman 3.6 fluctuations higher than in boys KG_{man} ($t = 2.308$; $p < 0.05$).

The next indicator by which we studied the vestibular stability of jumpers in water is the amplitude of nystagmus during and after rotations to the left and right.

Analysis of nystagmus amplitude during left rotation revealed that KGman athletes had results relative to baseline (14.4 ± 0.6 mm) changes by 1.8 mm ($t = 2.637$; $p < 0.05$) during the experiment. The guys EG_{man} a significant difference in this indicator of vestibular stability is observed at 12 years of age ($\Delta x = 2.5$ mm; $t = 2.857$; $p < 0.01$), and during the experiment the difference increases to 3.0 mm ($t = 3.663$; $p < 0.001$).

A study of the amplitude of nystagmus during rotation to the right found that in KGman a significant difference in results is observed at 12 years of age ($t = 2.498$; $p < 0.05$), a в EGman - at the age of 11 ($t = 2.856$; $p < 0.01$). At the end of the experiment in athletes KGman the difference relative to the original data is 2 mm

($t=2.877$; $p<0.01$), and in EG_{man} – 3.7 mm ($t=4.532$; $p<0.001$). There is also a significant difference between the indicators EG_{man} and KG_{man} at the age of 13 ($t=2.072$; $p<0.05$).

After a 3-minute rest with the athletes EG_{man} and KG_{man} nystagmus amplitude during and after rotation to the right was studied. The characteristics of changes in this indicator in both groups are similar to the dynamics of the amplitude of nystagmus during and after turning to the left. The peculiarity of the dynamics of this indicator is that of athletes EG_{man} a significant difference in the results shown at the age of 9 is observed after a year of training ($p<0.05-0.01$), after the second level of selection and the third level the results of the boys EG_{man} differ in probability 99.9%.

Comparison of athletes' results EG_{man} and KG_{man} proved that at the age of 12 indicators EG_{man} higher than in KG_{man} ($t=2.169$; $p<0.05$), and at the age of 13 the difference is 2 mm ($t=2.484$; $p<0.05$).

Thus, the introduction of author's criteria for the selection of athletes at a young age can promote the development of vestibular stability of boys and further sports improvement with the most promising boys.

Table 1. Dynamics of nystagmus frequency during and after turning to the left and to the right of athletes KG_{man} and EG_{man} during the experiment

№		Name of exercises	KG _{man} (n=19)					EG _{man} (n=17)				
			9 years	10 years	11 years	12 years	13 years	9 years	10 years	11 years	12 years	13 years
1.	Frequency of nystagmus after turning to the left	$\bar{x}$	31.2	32.1	32.8	33.9	34.4	31.4	32,6	33.8	35.3	37.0
		m	1.05	1.33	1.05	0.95	1.03	0.88	0.85	0.95	1.05	0.00
2.	Frequency of nystagmus after turning to the right	$\bar{x}$	30.8	31.6	32.1	32.9	33.3	30.6	32.0	33.5	34.9	36.9
		m	1.60	1.45	1.35	1.40	1.03	1.03	0.98	1.35	0.95	1.18

$\bar{x}$ - arithmetic mean, m - standard deviation of the mean

Table 2. Dynamics of nystagmus amplitude during and after rotation to the right of athletes KG_{man} and EG_{man} during the experiment

№	Name of exercises	KG _{man} (n=19)					EG _{man} (n=17)					
		9 years		10 years	11 years	12 years	13 years	9 years	10 years	11 years	12 years	13 years
	Amplitude of nystagmus when turning to the right	$\bar{x}$	15.0	14.4	13.8	13.1	13.0	15,3	14.6	13.1	12.2	11.6
		m	0.55	0.68	0.48	0.53	0.43	0,63	0.60	0.45	0.53	0.53
	Amplitude of nystagmus after turning to the right	$\bar{x}$	17.6	17.3	17.0	14.9	14.0	17,8	17.0	15.9	13.4	12.0
		m	0.60	0.58	0.45	0.53	0.65	0.63	0.58	0.60	0.45	0.48

$\bar{x}$ - arithmetic mean, m - standard deviation of the mean

We analyzed the dynamics of vestibular stability of water jumpers (girls) based on the results of testing the same exercises as boys.

Study of the frequency of nystagmus KG_{girls} during the rotation to the left found that the results of the girls are progressive, a significant difference is observed from the third stage of selection of athletes ($t=3.100$; $p<0.001$) and continues in the fourth year of training ($t=4.769$; $p<0.001$) relative to the original data (39.3 ± 1.2 fluctuations). In athletes KG_{girls} the frequency of nystagmus during rotation to the left differs significantly from the original data (34.3 ± 0.9 fluctuations) after two years of training (39.1 ± 1.18 fluctuations) ($t=3.243$; $p<0.01$), and is also observed after the fourth stage of selection ($t=4.549$; $p<0.001$) and the fifth stage ($t=7.655$; $p<0.001$).

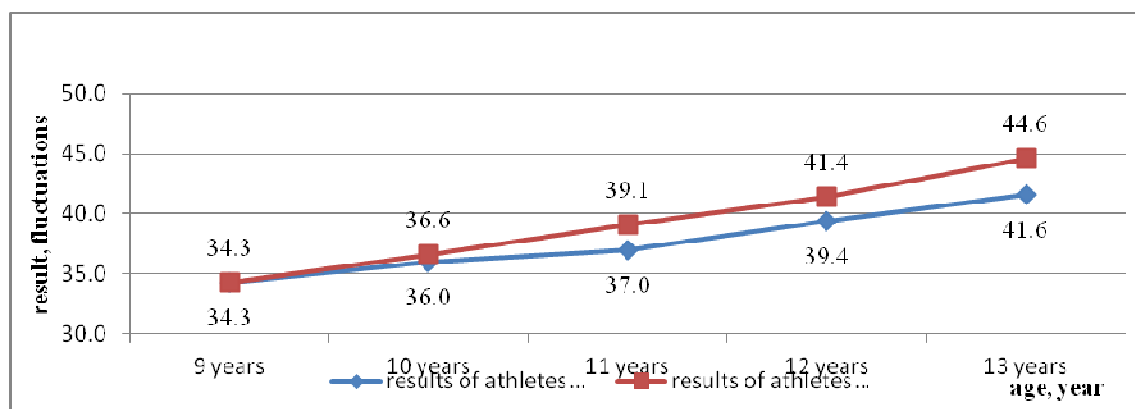


Figure1. Dynamics of nystagmus frequency when turning to the left girls - divers (in fluctuations)

Analysis of nystagmus frequency after rotation to the left also revealed a significant difference in performance KGgirls relative to the original data, but only at the end of the experiment ($t=2.683$; $p<0.05$). The results of the girls EG_{girls}, as in the previous version, have a significant difference relative to the original data after the second stage of selection ($t=2.005$; $p<0.05$). In the future, the difference increases and is: in the third selection - 6.4 fluctuations ($t=4.007$; $p<0.001$), in the fourth selection at the end of the experiment - 7.9 fluctuations ($t=5.721$; $p<0.001$).

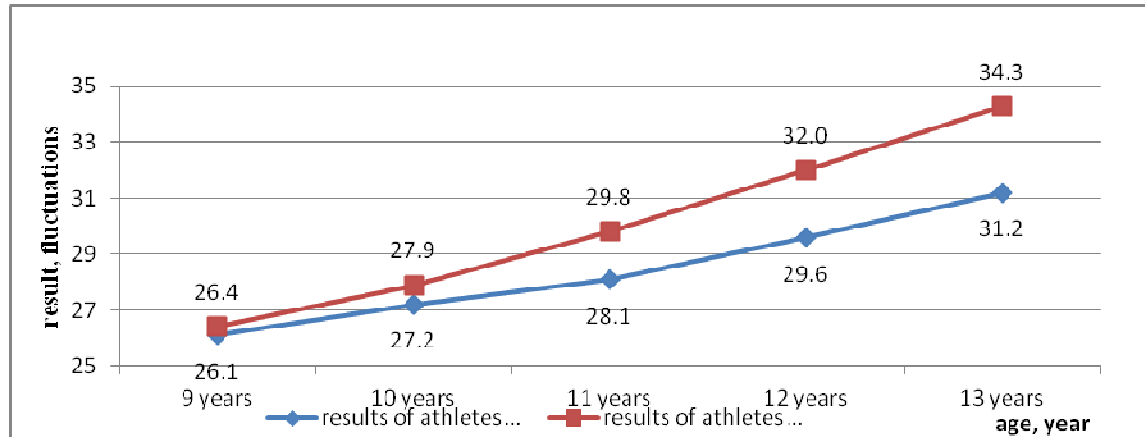


Figure 2. Dynamics of nystagmus frequency after turning to the left - girls jumping into the water (in fluctuations).

A comparative analysis of the frequency of nystagmus during and after turning to the left proved that the significant difference between the indicators EGgirls and KGgirls observed at the end of the experiment at the age of 13 athletes ($t=2.174$; $t=2.245$; $p<0.001$ in accordance).

Frequency of nystagmus during turning to the right of female athletes KG_{girls} varies throughout the experiment. There is a gradual improvement of this indicator every year. Thus, in the first year of training, nystagmus during rotation to the right improved by 1.2 oscillations ($t=0.521$; $p>0.05$) relative to the initial data for the second year of training - 1 fluctuation ($t=0.888$; $p>0.05$) relative to the previous measurement and 2.2 fluctuations relative to the initial level ($t=0.955$; $p>0.05$). Significant differences were found only between the results of the initial level and the results at the end of the experiment ($\Delta X=5.9$ кол., $t=2.717$; $p<0.05$).

Changes in nystagmus in athletes EGgirls are also progressive throughout the formative experiment. However, a significant difference in the initial data was found after the second stage of selection ($t=2.611$; $p<0.01$). Also we will note that during the third year of trainings indicators of frequency of nystagmus during rotations to the right significantly improved concerning results which were received at the end of the second year of trainings. ($t=2.058$; $p<0.05$). Also in the last year of the experiment, the determined rate of vestibular stability improved by three fluctuations ($t=2.342$; $p<0.05$).

Table 3. Dynamics of nystagmus frequency during and after turning to the right sportsmen KG_{girls} and EG_{girls} during the experiment

№	Name of exercises	KG _{girls} (n=10)					EG _{girls} (n=8)					
		9 years	10 years	11 years	12 years	13 years	9 years	10 years	11 years	12 years	13 years	
1	Frequency of nystagmus when turning to the right	$\bar{x}$	35.0	36.2	37.2	38.8	40.0	34.0	37.3	39.2	42.0	45.0
		m	1.70	1,55	1.80	1.70	1.35	1.23	1.30	1.10	0.80	1.00
2	Frequency of nystagmus after turning to the right	$\bar{x}$	26.3	26.9	27.6	28.8	29.7	26.6	27.8	29.4	34.6	36.6
		m	1.20	1.40	1.35	1.20	1.28	1.30	1.18	1.23	1.30	1.15

Analysis of the results of the frequency of nystagmus after turning to the right revealed that the performance of athletes KGgirls do not have a significant difference throughout the experiment ($t=1.941$; $p>0.05$). While the figures of girls EGgirls significantly improved after the third stage of selection relative to the original data ($t=3.535$; $p<0.01$) and at the end of the experiment ($t=5.761$; $p<0.001$). We will also note that for the last two years of research indicators of girls EGgirls significantly improved compared to previous data ($\Delta X3-2=4.8$ fluctuation, $t=2.071$; $p<0.05$ and $\Delta X4-3=3.5$ fluctuation, $t=2.016$; $p<0.05$).

Comparative analysis of the frequency of nystagmus during and after the rotation of athletes EGgirls та KGgirls found that a significant difference in the indicators when turning to the right is observed only at the end of the experiment ($\Delta X=4.1$ fluctuation., $t=2.207$; $p<0.05$). Between the incidence of nystagmus after turning to the right is a significant level of girls EGgirls та KGgirls discovered at the end of the third year of training ($\Delta X=5,8$ fluctuation., $t=3.278$; $p<0.01$) and at the end of the experiment ($\Delta X=6.9$ fluctuation, $t=3.086$; $p<0.01$).

Studies of the amplitude of nystagmus while rotating to the left found that in athletes KGgirls indicators during the experiment are progressive ($t_{3-1}=2.132$; $p<0.05$; $t_{4-3}=3.943$; $p<0.001$). Indicators of girls EGgirls also constantly improving during the experiment ($t_{4-1}=4.968$; $p<0.001$). Comparative analysis of the results of nystagmus amplitude when turning to the left of athletes EGgirls та KGgirls found a significant difference in 12-year-old girls ($t=2.313$; $p<0.05$). Further improvement of results EGgirls led to an increase in the difference in the results of the girls KGgirls at 1.5 mm ($t=2.064$; $p<0.05$).

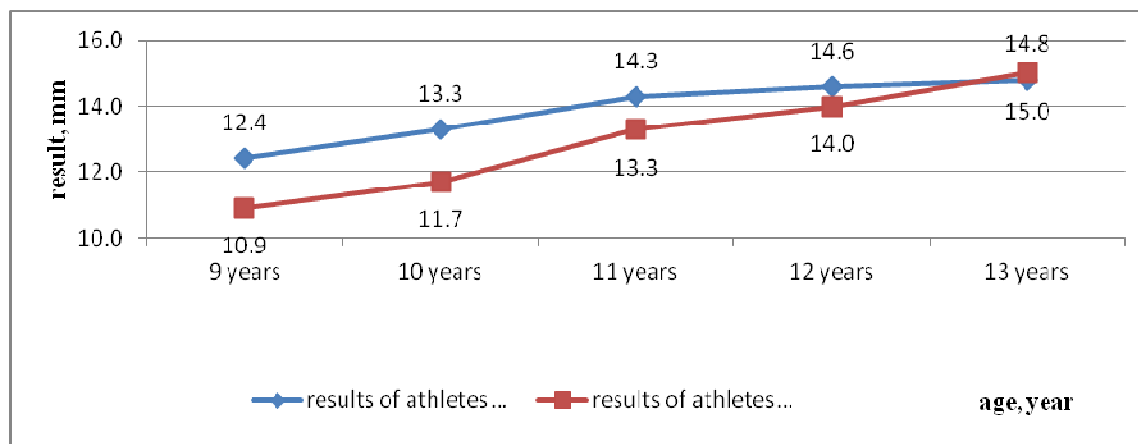


Figure 3. Dynamics of nystagmus amplitude during rotations to the left of girls - divers (mm)

A similar characteristic of the dynamics is present in the analysis of nystagmus amplitude after turning to the left of girls KGgirls та EGgirls. A significant difference in the results of polar groups was found after the third stage of selection ($t=2.695$; $p<0.05$) and at the end of the experiment ($t=2.482$; $p<0.05$).

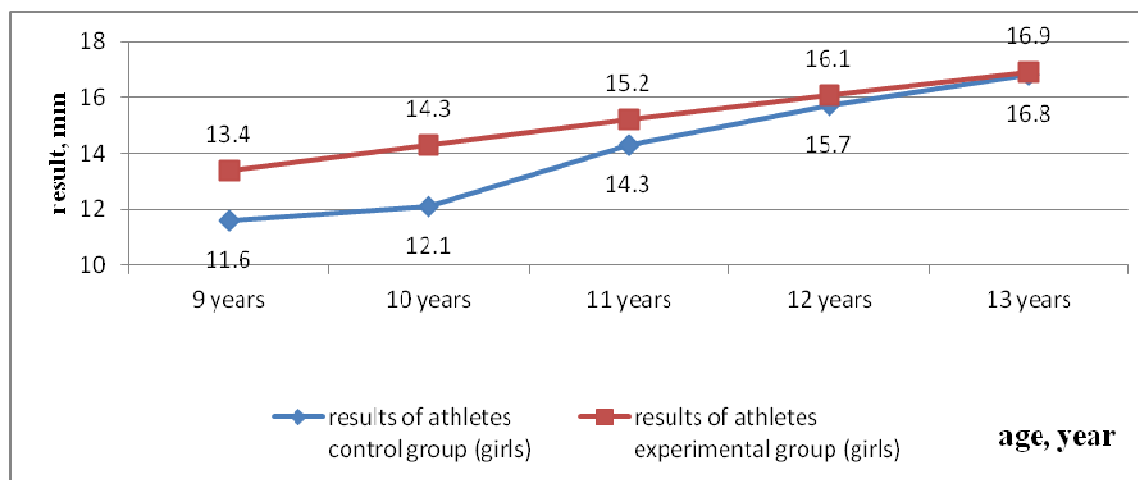


Figure 4. Dynamic amplitude dynamics after rotations to the left of the girls - divers (mm).

Analysis of nystagmus amplitude during and after turning to the right revealed a similar characteristic of changes in certain results of girls KGgirls та EGgirls. Yes, at the end of the experiment the difference in results KGgirls та EGgirls is 1.4 mm ($t=2.139$; $p<0.05$) in the amplitude of nystagmus during rotation and 1.8 mm - after rotation ($t=2.367$; $p<0.05$).

Table 4. Dynamics of nystagmus amplitude during and after rotation to the right of athletes KGgirls and EGgirls during the experiment.

№	Name of exercises	KG _{girls} (n=10)						EG _{girls} (n=8)				
		9 years	10 years	11 years	12 years	13 years	9 years	10 years	11 years	12 years	13 years	
	Amplitude of nystagmus when turning to the right	$\bar{x}$	17.6	15.6	14.3	12.8	12.4	17.5	14.9	13.3	12.6	11.0
		m	0.63	0.58	0.60	0.45	0.48	0.60	0.58	0.45	0.53	0.45
	Amplitude of nystagmus after turning to the right	$\bar{x}$	18.0	16.3	15.7	14.9	13.9	17.8	16.0	15.1	13.9	12.1
		m	0.63	0.60	0.45	0.53	0.53	0.60	0.58	0.45	0.53	0.55

Thus, the introduction of the author's criteria for the selection of athletes-divers in the water stimulates them to improve vestibular stability for further training in the sections of diving. The criteria do not have a direct impact on improving the vestibular stability of athletes that we studied, but the knowledge that these indicators affect the overall assessment of athletic fitness motivates young jumpers to actively improve.

Discussion

Scientific research of leading specialists, the results of the highest level competitions indicate that winning results can be available only to talented athletes who have natural, genetic and physiological talents for a particular sport, which were able to implement them in the long-term training process (Keller, V., Platonov, V., 1993; Klymovych, V., Oderov, A., Korchagin, M., Olkhovy, O. and Romanchuk, S., 2019; Roth M., 2012; MacNamara A., Button, A., Collins, D., 2010; Nayavko, I., 2014; Niznikowska, E., 2008; Oderov, A., Kuznetsov, M., Romanchuk, S., Pohrebniak, D., Indyka, S., Bielikova, N., 2022).

In recent years, a significant amount of research has been conducted in scientific schools on building the optimal structure of the long-term training process of athletes in various sports (Oderov A., Klymovych V., Korchagin M. Olkhovyi O., Romanchuk S., 2019; Pearson D., Naughton, G., Torode, M., 2006; Pühse, U., Gerber, M., 2006), duration of training periods during the year (Pühse, U., Gerber, M., 2005), training of athletes of different ages, modeling and forecasting in sports, individualization of the training process the age limits of athletes' career duration have been determined.

We have supplemented the scientific research of M.Buts (Romanchuk S., Oderov A., Klymovych V., Arabskyi A. at.et., 2020) that the morphofunctional status of an athlete largely determines the possibility of achieving high sports results. The conducted factor analysis made it possible to identify the factor of physical development, which was formed by morphological indicators. The value of this factor changes according to age development, but its contribution to the total variance remains quite high, which allows us to consider the physical development of young athletes as one of the leading factors. We determined that in the group of 9-year-old boys, the factor identified as physical development has the largest contribution to the generalized variance of the sample – 21.8%; at 10 years – the factor of physical development has the second largest contribution to the total variance – 11.4%, and at 11, 12 and 13 years the contribution of the factor of physical development increases, respectively 15.4%, 16.7% and 20.4%.

In order to determine the characteristics of the physical development of young water jumpers, the results obtained by us were compared with the results of scientific research by O.Drozd (Romanchuk, S., Arabskyi, A., Oderov, A., 2019), namely: with data on the physical development of schoolchildren who are not engaged in any of the sections, young athletes - gymnasts and swimmers. The analysis of research results showed that in terms of height and weight, divers occupy an intermediate position between the indicators of schoolchildren and gymnasts. The chest circumference of divers is unbelievably larger than that of gymnasts and schoolchildren. All indicators of the physical development of swimmers are equal to the upper limit of the average level of schoolchildren, which are the standard for assessing the physical development of children.

By comparing the physical development data of girls engaged in diving with schoolgirls and gymnasts, we supplemented the results of S.M.Klimakova's research (Rebutini, V.Z., Pereira, G., Bohrer, R.C.D., Ugrinowitsch, C., Rodacki, A.L.F., 2016) and found that female athletes are at the lower limit of the average height and weight indicators of schoolgirls who do not play sports, but somewhat prevail in terms of gymnasts. The chest circumference of 9-10-year-old female athletes is slightly larger, and in 11-13-year-old girls, it is slightly smaller than the average indicators of girls who do not play sports, while the indicators of gymnasts are at the lower limit of the average level of schoolgirls (Reilly, T., Bangsbo, J., Franks, A., 2000).

We improved the research of A. Zhuk (Shynkaruk, O., 2013), namely, we found that an athlete who does not possess a high level of jumping and special speed-strength qualities, which are harmoniously combined with a high level of flexibility and coordination of movements, will not be able to perform jumps with multiple rotations. So, it has been proven that only an athlete with a certain level of physical fitness can master complex jumps, that is, motor learning (Sozański H., 1999; Zhuk, A., 2013).

The developed author's criteria of sports fitness are a guideline for determining the suitability of young athletes for diving. Complex author's criteria, based on the calculation of regression equations, made it possible to compare the level of prerequisites with the level of sports preparation.

Indicators that have prognostic significance and those that did not show it were included in the criteria of sports fitness of 9-13-year-old athletes - divers. The calculated regression equations take into account the relationship between these indicators at different stages of age development.

The selected indicators do not determine sports achievements in age groups to the same extent, as evidenced by the coefficients of determination. Differences in age changes, physical and sports readiness between boys and girls are also taken into account.

The practical significance of the research results lies in the development and improvement of criteria for the selection and forecasting of sports achievements of divers at the initial stage of training, as well as the development of a unified methodology for comprehensive assessment of the sports readiness of young divers, which is based on a comprehensive study of young divers (9-13 years old) at the stage of initial and advanced sports training (Weston, M., Hibbs, A., Thompson, K., Spears, I., 2015).

Conclusions

A comparative analysis of the frequency of nystagmus during and after turning to the left proved that the significant difference between the indicators EGgirls and KGgirls observed at the end of the experiment at the age of 13 athletes.

Analysis of the results of the frequency of nystagmus after turning to the right revealed that the performance of athletes KGgirls do not have a significant difference throughout the experiment. While the figures of girls EGgirls significantly improved after the third stage of selection relative to the original data and at the end of the experiment. We will also note that for the last two years of research indicators of girls EGgirls significantly improved compared to previous data. Comparative analysis of the results of nystagmus amplitude when turning to the left of athletes EGgirls and KGgirls found a significant difference in girls 12 years old. Further improvement of results EGgirls led to an increase in the difference in the results of the girls KGgirls at 1.5 mm.

Analysis of nystagmus amplitude during and after turning to the right revealed a similar characteristic of changes in certain results of girls KGgirls and EGgirls. Yes, at the end of the experiment the difference in results KGgirls and EGgirls is 1.4 mm ($t=2.139$; $p<0.05$) in the amplitude of nystagmus during rotation and 1.8 mm - after rotation.

As for the performance of boys, there is an improvement, and the introduction of author's criteria for the selection of athletes at a young age can promote the development of vestibular stability of boys and further sports improvement with the most promising boys.

The introduction of our proposed author's criteria for the selection of athletes-divers motivates to improve vestibular stability for further training in the sections of diving. Indicators have a positive effect on the overall assessment of athletic fitness and motivate young jumpers to actively improve.

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