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CONTENTS

EFFECTIVENESS OF METHODIC SYSTEM OF MOTOR FUNCTIONING'S PREVENTIVE DEVELOPMENT IN SIXTH YEAR OF CHILDREN'S LIFE IN THEIR PHYSICAL CONDITION'S IMPROVEMENT

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Abstract. *Purpose:* to determine effectiveness of simulated system of motor functioning's preventive development of pre-school children for improvement of their physical (motor) qualities at physical culture classes. *Material:* In research 5 years old children participated. In control groups they were 75 girls and 75 boys (25 with ambidexterity, 25 withright and 25 with left manual asymmetry). Experimental groups consisted of 60 girls and 60 boys (20 with every variant of manual motor asymmetry). *Results:* we registered positive influence of symmetric approach to training of children to main movements. It implies realization of all form of physical exercises' practicing in certain day of working week through creation of motor environment with aerobic mode of children's motor functioning. It is recommended to use breathing exercises with accent on relaxation and activation of functioning for regulation of mental state in required direction. *Conclusions:* for achievement of positive results it is important to take measures, oriented on home physical exercises. Interaction with parents for formation of children's conscious attitude and further practical realization of offered by us means and methods ensure more effective solution of this problem.
Key words: experimental, system, effectiveness, motor, asymmetry, qualities, children, pre-school age children.

Introduction

In pre-school period motion is the main function of a child [2; 4]. At present stage physical culture classes do not facilitate achievement of required physical condition and other important qualities and functions by children before starting learning at school [10, 17, 18, 21-23]. In this connection children's social and psychological adaptation to new conditions of life activity in learning can not be adequate [7]. It results in worsening of health [14], functional potentials [5], appearing of tiredness from mental functioning even in free from this work days of week [6].

On the other hand theory and practice of physical culture accumulated social values, usage of which facilitates positive changes of external and internal (mental) characteristics of individual, development of his (her) abilities and skills, formation of world-vision settings, motives, interests [13]. But considering the above mentioned such social values are not effective enough. One of reasons of this is not adequate scientific-methodic provision of physical culture classes as pedagogically organized process. In other words there is certain contradiction between accumulated social-historical experience in sphere of physical culture on the one hand and practice of its realization in pedagogic theory and practice of pre-school children's teaching. This contradiction shall be eliminated as quickly as possible.

Purpose, tasks of the work, material and methods

The purpose of the research: is to determine effectiveness if simulated system of preventive motor functioning's development for pre-school children in order to improve their physical (motor) skills at physical culture trainings. The tasks of the research were the following: determine orientation of manual motor asymmetry (MMA) and output indicators of motor skills; carry out one-year forming experiment; determine summarizing indicators of motor skills; conduct comparative analysis of changes in the tested groups.

The following *methods of the research* were used: general scientific (analysis, generalization of literature sources' information); pedagogic (testing, experiment); oral questioning, hand dynamometry and methodic of M.M. Bezrukikh [3] for determination of children's MMA orientation, mathematical statistic. In experiment 5 years old children participated: 60 girls and 60 boys [20 with ambidexterity (AMA), 20 with left (LMA and 20 with right (RMA) motor orientation]. These children composed experimental groups (EG). 75 girls and 75 boys (25 for each variant of MMA) composed control groups. In all EG the worked out methodic system of children motor functioning's preventive development was realized at physical culture classes. In all CG approach to physical culture trainings was traditional. Pedagogic testing was conducted in September and in April. We used commonly used tests, which required metrological requirements.

In most general aspect distinction of experimental factor was in detailing of pedagogic process's components (purpose, tasks, principles, means, methods, forms) and determination of methodic principles of their realization in practice. In applied aspect (depending on changes of the tested indicators during using of experimental factor) distinctions were the following: in EG we used symmetric approach to training of main movements. It stipulated training of a movement in several stages: at first and second - by passive arm (leg, direction); then – by active; at third stage – alternating fulfillment by every limb or in different directions. We did not influence on the studied motor skills intentionally. Indirectly we rendered influence by outdoor games for perfection of main movements' skills, mastered by children at previous training. Through realization of all physical exercises' forms in certain day of working week we created "motor environment" with aerobic mode of children's functioning. We used affirmations, breathing exercises with accent on relaxation and activation of functioning for regulation of mental state in required direction. At methodic seminars and consultations we improved knowledge and skills of instructors in conducting of physical exercises. In

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common with instructors we formed parents' conscious position concerning importance of children's practicing physical exercises at home. With it, we considered the mentioned methodic principles. Parents conducted such trainings of their children during one year at days off; significant quantity of parents directly participated in fulfillment of the exercises.

Results of the research

Before experiment it was detected that boys and girls of EG and CG with certain MMA orientation did not differ by the tested indicators. At the end of academic year we received quite different results.

G i r l s. By criterion of indicators' quantity, values of which were registered during all year there were substantial changes (p at level from <0.05 to <0.001). The tested groups distinguished by certain features. For example in *girls' EG with AMA* all indicators of the tested motor skills improved. In CG the following indicators improved: explosive power of lower limbs' muscles (increment 6.6 %); coordination in throws for distance by right (14.3) and left (26.8) arms and for accuracy (accordingly by 16.6 and 10 %). Thus, during academic year in EG all motor skills improved. In CG – only 5 from 9 tested indicators.

By quantity of indicators, value of which was much better in one group than in other, results of EG were much higher than in CG. Development of mobility in lumbar spine and in coordination in throws for accuracy became practically equal. The other results were not equal. In particular, in EG and CG the picture was as follows:

- absolute muscular strength by data of hand dynamometry was accordingly 8.5±0.5 and 7.1±0.3 kg,
- speed power (20 meters' run from walking) at level 6.7±0.06 and 7±0.1 sec,
- coordination in cyclic motions (shuttle run 3x5 meters) – 7.7±0.09 and 8.2±0.2 sec.,
- throw for distance by right arm – 7±0.13 and 6.4±0.17 meters ($p<0.05$),
- explosive power (long jump from the spot) – 98.1±1.3 and 92.2±1.2 cm,
- coordination in throws for distance by left arm – 6±0.19 and 5.2±0.16 m ($p<0.01$).

Thus, results of EG, in comparison with CG girls with AMA were higher in 6 indicators from 9 tested.

In tested groups of *girls with RMA* we received result, which witnessed about the following: during academic year mobility in lumbar spine in EG girls remained on unchanged level. The same concerned coordination in throws for accuracy by left (passive) and right (active) arms. At the same time in CG coordination in throws for accuracy [accordingly by active and passive arms] worsened by 13.7 and 22.1% (p was from <0.01 to $p<0.001$)]. The rest of the tested motor skill substantially improved.

Generalizing the received results we noted that in EG 6 from 9 tested indicators improved. In CG only 3 indicators improved with simultaneous worsening of 2 other motor skills.

As per other used criterion we received the following result: in EG all motor skills (except mobility in lumbar spine) improved by the end of academic year in comparison with CG. It was witnessed by the following data:

- in EG indicator of absolute muscular strength was 10.2±0.3 kg. In CG - only 8.9±0.5,
- speed power – accordingly 6.1±0.07 and 6.6±0.2 sec,
- coordination in cyclic motions – 7.1±0.09 and 7.6±0.18 sec ($p<0.05$).

Still higher differences were detected in the following indicators:

- coordination in throws for accuracy by active and passive arms: in EG at level 52.3±1.7 and 48.1±2.6 cm accordingly. In CG – 61.6±1.9 and 69.5±2.3 am;
- coordination in throws for distance – by passive arm (5.7±0.13 and 4.9±0.13 m), by passive - (7.8±0.12 and 6.6±0.11 m),
- explosive power of lower limbs' muscles – 101.2±0.62 and 96.1±1.1 cm ($p<0.001$).

Generalizing the above mentioned we received the following result: from all 9 indicators of motor skills in EG 8 were much higher. In CG no indicator improved.

In EG *girls with LMA* at the end of academic year we detected improvement of all motor skills. Their increment was within 7.7–55.2 %. In CG such improvements were only in the following:

- absolute muscular strength (increment 21.5%),
- coordination in throes for distance by active left arm (increment 23.4 %), and by passive right arm (11.8 %),
- coordination in throws for accuracy by passive arm (28.5 %) (p from <0.01 to $p<0.001$).

At the same time we noted that increment of such motor skills in EG was accordingly 45.5 %, 44.4, 38 and 55.2 %.

Thus, in EG, during academic year all motor skills improved. In CG only 4 from 9 tested skills.

By criterion of indicators' quantity, value of which in one group was much better than in other: in EG all indicators (except mobility in lumbar spine) were better than in CH (8 from 9).

B o y s. In tested groups of boys with different MMA orientation we obtained results, analogous to the mentioned above. In generalized form they witnessed the following: in EG of *boys with AMA* all indicators substantially improved. In CG – only 5 indicators (see table 1). Values of indicators at the end of academic year were as follows: in EG in all indicators (except coordination in throws for accuracy by right and left arms) their values were substantially better than in CG boys. In CG no indicator improved.

Table 1

Change of motor skills' indicators in tested groups of boys with AMA in the course of forming experiment

Indicator	Group	At the beginning		At the end		Change		*Confidence of difference, t*	
		$\bar{x}_1$	*m*	$\bar{x}_2$	*m*	*Abs.*	*%*	$\bar{x}_1 - \bar{x}_2$	*EG-CG*
Active hand's dynamometry, kg	EG	5.9	0.17	9.4	0.12	3.5	59.3	16.8***	9.6 ***
	CG	5.7	0.15	7.9	0.1	2.2	38.6	12.2***	
Forward bent from sitting position, cm	EG	8.0	0.9	10.8	0.4	2.8	35.0	2.84*	2.5 *
	CG	8.2	0.7	9.1	0.55	0.9	11.0	1.01	
20 meters' from walking, sec.	EG	6.9	0.12	5.7	0.09	–1.2	17.4	8.0***	2.38 *
	CG	6.8	0.18	6.2	0.19	–0.6	8.8	2.29*	
Long jump from the spot, cm	EG	94.1	1.7	110.1	1.0	16.0	17.0	8.11***	2.41 *
	CG	94.7	1.8	104.5	2.1	9.8	10.3	3.54**	
Shuttle run 3x5 meters, sec.	EG	7.9	0.15	7.1	0.11	–0.8	10.1	4.3***	3.36 **
	CG	7.9	0.14	7.6	0.1	–0.3	3.8	1.74	
Throw for distance with right arm, meters	EG	7.0	0.14	8.8	0.12	1.8	25.7	9.76***	4.69 ***
	CG	7.1	0.22	7.9	0.15	0.8	11.3	3.0**	
Throw for distance with left arm, meters	EG	5.7	0.19	8.1	0.12	2.4	42.1	10.7***	6.0 ***
	CG	5.6	0.15	6.7	0.2	1.1	19.6	4.4***	
Error in throw for accuracy with right arm, cm	EG	35.2	2.4	26.1	2.9	–9.1	25.9	2.42*	0.81
	CG	34.1	2.7	29.2	2.5	–4.9	14.4	1.33	
Error in throw for accuracy with left arm, cm	EG	28.1	2.2	19.4	1.8	–8.7	31.0	3.06**	1.29
	CG	27.4	2.1	22.5	1.6	–4.9	17.9	1.86	

Notes: *abs.* – absolute, hereinafter confidence of difference between two mean values is noted at level: «*» – $p<0.05$, «**» – $p<0.01$, «***» – $p<0.001$

In EG of *boys with RMA* all motor skills, except coordination in throw for accuracy by active and passive arms, improved. In CG – only 4 indicators improved with simultaneous worsening of the mentioned above coordination (accordingly by 16.4 % ($p<0.05$) and 18.5 % ($p<0.01$)]. With it, at the end EG boys had much better all indicators

Than CG boys (see table 2).

Analogous results were received in boys' groups with LMA, except certain features. For example, in EG 8 indicators improved (except mobility in lumbar spine). In CG – only 7 with exception of mobility in lumbar spine and speed power (see table 3). With it, at the end in EG all indicators were much better than in CG.

Table 2

Change of motor skills' indicators in tested groups of boys with RMA in the course of forming experiment

Indicator	Group	At the beginning		At the end		Change		*Confidence of difference, t*	
		$\bar{x}_1$	*m*	$\bar{x}_2$	*m*	*Abs.*	*%*	$\bar{x}_1 - \bar{x}_2$	*EG-CG*
Active hand's dynamometry, kg	EG	7.8	0.18	10.9	0.16	3.1	39.7	12.9***	13.3 ***
	CG	7.6	0.2	8.4	0.1	0.8	10.5	3.58**	
Forward bent from sitting position, cm	EG	9.7	0.49	12.1	0.13	2.4	24.7	4.73***	2.56 *
	CG	9.9	0.55	10.9	0.45	1.0	10.1	1.41	
20 meters' from walking, sec.	EG	6.4	0.13	5.4	0.12	–1.0	15.6	5.65***	3.84 **
	CG	6.4	0.11	6.0	0.1	–0.4	6.3	2.69*	

Long jump from the spot, cm	EG	98.5	1.2	110.9	1.3	12.4	12.6	7.01***	2.52
	CG	99.2	1.6	105.1	1.9	5.9	5.9	2.38*	*
Shuttle run 3x5 meters, sec.	EG	7.6	0.14	7.0	0.1	–0.6	7.9	3.49**	2.56
	CG	7.6	0.17	7.4	0.12	–0.2	2.6	0.96	*
Throw for distance with right arm, meters	EG	7.1	0.17	9.2	0.12	2.1	29.6	10.1***	7.9
	CG	7.1	0.15	7.9	0.11	0.8	11.3	4.3***	***
Throw for distance with left arm, meters	EG	4.9	0.16	8.1	0.14	3.2	65.3	15.1***	10.9
	CG	4.8	0.14	5.7	0.17	0.9	18.8	4.09***	***
Error in throw for accuracy with right arm, cm	EG	41.1	2.3	36.9	2.4	–4.2	10.2	1.26	3.23
	CG	40.2	2.5	46.8	1.9	6.6	–16.4	2.1*	**
Error in throw for accuracy with left arm, cm	EG	48.9	1.9	39.8	2.4	–9.1	18.6	2.97**	5.99
	CG	49.7	1.6	58.9	2.1	9.2	–18.5	3.48**	***

Note: *abs.* – absolute

Table 3

Change of motor skills' indicators in tested groups of boys with LMA in the course of forming experiment

Indicator	Group	At the beginning		At the end		Change	*Confidence of difference, t*		
		$\bar{x}_1$	*m*	$\bar{x}_2$	*m*	*Abs.*	*%*	$\bar{x}_1 - \bar{x}_2$	*EG-CG*
Active hand's dynamometry, kg	EG	7.0	0.3	9.5	0.19	2.5	35.7	7.04***	5.5
	CG	6.8	0.2	7.9	0.22	1.1	16.2	3.7**	***
Forward bent from sitting position, cm	EG	9.4	0.4	10.1	0.3	0.7	7.4	1.4	2.06
	CG	9.3	0.6	8.9	0.5	–0.4	4.3	0.51	*
20 meters' from walking, sec.	EG	6.3	0.11	5.4	0.12	–0.9	14.3	5.53***	3.2
	CG	6.2	0.16	5.9	0.1	–0.3	4.8	1.59	**
Long jump from the spot, cm	EG	105.8	1.3	117.2	1.0	11.4	10.8	6.95***	2.67
	CG	107.1	2.1	112.6	1.4	5.5	5.1	2.18*	*
Shuttle run 3x5 meters, sec.	EG	8.5	0.16	6.6	0.09	–1.9	22.4	10.4***	3.32
	CG	8.5	0.2	7.0	0.08	–1.5	17.6	6.96***	**
Throw for distance with right arm, meters	EG	6.1	0.18	8.5	0.19	2.4	39.3	9.17***	4.94
	CG	6.2	0.16	7.1	0.21	0,.9	14.5	3.41**	***
Throw for distance with left arm, meters	EG	6.7	0.17	9.2	0.16	2.5	37.3	10.7***	5.4
	CG	6.6	0.15	7.9	0.18	1.3	19.7	5.55***	***
Error in throw for accuracy with right arm, cm	EG	41.4	2.2	19.7	2.1	–21.7	52.4	7.13***	3.04
	CG	40.7	2.1	28.1	1.8	–12.6	31.0	4.56***	**
Error in throw for accuracy with left arm, cm	EG	22.1	1.7	11.2	1.3	–10.9	49.3	5.09***	2.83
	CG	21.8	1.6	16.2	1.2	–5.6	25.7	2.8*	*

Note: *abs.* – absolute

Discussion

The data received in boys' and girls' tested groups were connected with complex of reasons. In the most general form better results of EG were conditioned by application of the worked out methodic system. This system is oriented on preventive development of pre-school age children's motor functioning during physical culture classes in different forms. Concerning specifying of the mentioned reasons, one of them was connected with application of symmetric approach to training of main movements in EG; in CG children fulfilled movement in comfortable for them manner [by active arm, leg or in convenient direction]. The mentioned is proved by works of other researchers [1, 11, 15, 16, 19, 20]. Improvements are conditioned by involving of both semi-spheres in functioning. As it is noted in works by V.A. Moskvin B.A. [8] and V.M. Orzhekhovska [12] with any orientation of MMA the necessary condition of high activity and successful training of a child is development of his (her) interaction between brain semi-sphere: coordinated movement of left and right arms increase degree of such interaction.

Other reason was ensuring of aerobic mode of children's functioning by all available means: consideration of sensitive period in development of such energy supply mechanism facilitated more intensive development of organism's different systems, in particular, nervous-muscular, breathing, cardio systems. Such changes made positive effect on manifestation of motor skills [2].

At the same time measures, oriented on home practicing of exercises, were also important. Interaction with parents for formation of their conscious position and further practical realization of the offered means and methods by them ensure more effective solution of this problem [9].

Conclusions

1. Application of the offered system of preventive motor functioning's development in 6th year of child's life ensures improvement of most indicators of motor skills in comparison with traditional approach: from 9 indicators girls with AMA showed improvement of 9 and 5 accordingly; girls with RMA – 6 and 4 with simultaneous worsening of the rest 2 indicators; girls with LMA demonstrated improvement of 9 and 4 indicators; boys with AMA – 9 and 5, with RMA – 7 and 5 with simultaneous worsening of the last two indicators; boys with LMA showed improvement of 8 and 7 indicators.

2. At the end of academic year experimental groups reach higher values of indicators than control groups with the exception: in all girls – mobility in lumbar spine; girls with AMA – additionally coordination in throw for accuracy; exception of boys with AMA – coordination in throw for accuracy.

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The further researches imply determination of effectiveness of the worked out system in formation of main movements' skills, in prevention from adverse to required functional potentials, adaptation to learning functioning of children with different MMA orientation.

Conflict of interests

The author declares absence of any conflict of interests.

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DYNAMIC OF PROFESSIONALLY IMPORTANT QUALITIES' CHANGES IN CADETS OF HIGHER FLIGHT ESTABLISHMENTS

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Abstract. *Purpose:* determination of dynamic of professionally important qualities changes in cadets- flighters in the course of study. *Material:* The research convered 223 cadets during 4 years' study with the help of complex of prognosis-informational psychological methods. Testing was fulfilled at devices RKN and PPV-2. *Results:* it was found that at the end of studying temp of development of such qualities as quickness of psycho-motor skills' mastering, ability to operate space images, distribution and re-switching of attention increase noticeably. Indicators of emotional stability, re-construction of psycho-motor skills, resistance to obstacles substantially reduce. Scope of attention, reproductive thinking, operative memory, coordination of movements, ability to work in forced temp change in negligible limits. As per prognosis stabilizing of most of professionally important qualities that is connected with over-tension of organism's physiological reserves is envisaged. *Conclusions:* We have found steady positive dynamic of cognitive psychic processes' development, reduction of some psycho-physiological and psycho-motor qualities' development in last period of studying.
Key words: dynamic, qualities, cadets, flighter, studying.

Introduction

Professional formation of specialist in higher military educational establishment of flight profile is a complex psychological-pedagogic process, which is to solve the following tasks: formation of positive professional orientation; comprehensive development of pilot's personality, his cognitive and will-emotional spheres; acquiring of main knowledge in special disciplines, skills; formation of principles of professionally important qualities (PIQ) [1, 4, 5, 9, 18].

Studying influence of professional functioning in period of re-training for new machinery, R.M. Kadyrov (1980), Yu. Borodin (2004), A.A. Gorelov (2008) [3, 5, 12, 20], O.M. Kernitskiy (2004), M.S. Kovalchuk (2004) established factors, which influence on flighters' PIQ [11, 13, 19]. D.V. Gander (2003), F.I. Popov (2004), M.A. Khairemdinov (2007), V.M. Kirpenko (2012) determined dependence between level of PIQ and readiness for independent flights [6, 14, 16].

In scientific works of V.A. Tovt (1987), Yu.K. Demyanenko (1988) authors studied influence of professional functioning on military pilots' PIQ development [3, 8, 10, 17]. But we have not found data about dynamic of PIQ development in new conditions of flight training. Though it is rather urgent because at initial stage of flight training reduction of these qualities influences on effectiveness of flight training [3, 7, 10, 16].

Purpose, tasks of the work, material and methods

The purpose of the research: determination of dynamic of professionally important qualities' changes in cadets- pilots during process of their study.

The research covered 223 cadets of flight faculty of KhUAF, named after Ivan Kozhedub, in whom changes of PIQ development were studied during 4 academic years. Level of movements' coordination and emotional stability of the tested were assessed during testing on device RKN. Determination of sensor-motor responses was carried out with the help of device PPV-2 [4, 7, 9]. The received data were processed with methods of mathematical statistics.

Results of the research

In the course of separate PIQ and their structural changes in psychic sphere under influence of social, professional and other factors studying we found principle regularities of their development [7].

For example, during first period of studying (1^{st}-2^{nd} academic years) there is expressed increase of such indicators ($p \leq 0.001$) as operative memory, coordination of movements, emotional stability, quickness of psycho-motor skills' mastering; some increase of ($p \leq 0.05$) reproductive thinking, stability, distribution and re-switching of attention and reduction of resistance to obstacles and ability to work in forced temp.

In second period of cadets' studying (2^{nd}-3^{rd} academic years) there happen further substantial increase ($p \leq 0.001$) of movements' coordination and re-construction of psycho-motor skills; a little reduction of temps of increase ($p \leq 0.01$) of operation of space images, reproductive thinking, stability of attention and emotional stability; there also happened noticeable raising of attention, resistance to obstacle and ability to work in forced temp ($p \leq 0.001$).

The third period of cadets' studying (3^{rd}-4^{th} academic years) is characterized by especially expressed PIQ dynamic: noticeable increase in temp of such qualities as quickness of psycho-motor skills' mastering, ability to operate space images, distribution and re-switching of attention development ($p \leq 0.05$-0.001); but indicators of emotional stability, reconstruction of psycho-motor skills, resistance to obstacles substantially reduce ($p \leq 0.05$-0.001); a number of other qualities (level of attention, reproductive thinking, operative memory, coordination of movements, ability to work in forced temp) change rather little. It should be noted that indicators of all PIQ significantly grow during 4-years period.

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It is conditioned by change and combine action of different by content and complexity kinds of functioning (theoretical study, training on stimulators, physical training, initial stage of flight training, replacement of training aircraft with training combat one, piloting with instructor and independent flights, different flight tasks and etc.), by different cadets' adaptation to conditions and content of flight training, distinctions in initial level of mental and physical condition and so on.

Discussion

In the course of our research we confirmed the data, regarded in scientific works by Yu.A. Bazhenov (2004), E.V. Muminov (2006), about influence of professional functioning on PIQ development of military pilots [3, 11]. The found in the course of our researc fact of PIQ structure's change permits to make prognosis for 5th academic year (changes in curriculum admit acquiring of magister degree). Approximation results are given in table 1. Poly –nominal and linear equations of approximation were selected with confidence value $R^2 > 0.94$. As per prognosis it is stipulated stabilization of most PIQ development that is connected with over-tension of functional and physiological organism's reserves, resulted from increasing of professional loads.

Table 1

Prognosis of cadets' professionally important qualities for the period of study (x ± m in points)

№	Professionally important qualities	Approximation equation	Prognosis for 5th ac. year
1	Operating with space images	$y = 0.0657x^2 + 0.1216 x + 4.8002$	6.338 ±0.129
2	Reproductive thinking	$y = - 0.1845x^2 + 1.1763 x + 5.4675$	7.221±0.189
3	Operative memory	$y = - 0.2963x^2 + 2.0079 x + 2.9863$	6.277±0.122
4	Distribution and re-switching of attention	$y = 0.2726x + 6.1775$	7.268±0.106
5	Stability of attention	$y = 0.3938x + 5.316$	6.891±0.133
6	Coordination of movements	$y = - 0.345x^2 + 2.2401x + 3.21$	6.650±0.093
7	Emotional stability	$y = - 0.481x^2 + 2.7194x + 2.979$	6.161±0.098
8	Quickness of psycho-motor skills' mastering	$y = 0.6731x + 3.257$	5.949±0.105

The found fact of PIQ structure's change in the process of study permits to specify influence of increase of professional loads on cadets' functional state [2, 12, 13, 15].

Conclusions

In the process of the researches we determined influence of specificity of professional functioning on development of some individual psychic, physical qualities and functional state of cadets. By the end of studying period temp of the following qualities noticeably increase: quickness of psycho-motor skills' mastering, ability to operate with space images, distribution and re-switching of attention ($p \leq 0.05$-0.001). Indicators of emotional stability, re-construction of psycho-motor skills, resistance to obstacles significantly reduce ($p \leq 0{,}05$-$0{,}001$). Scope of attention, reproductive thinking, operative memory, coordination of movements, ability to work in forced temp change insignificantly ($p \geq 0.05$). In such conditions training's continuation it is envisaged to stabilize the most of PIQ development that is connected with over-tension of organism's reserves, resulted from increase of professional loads.

The prospects of our research imply determination of influence of professional functioning's specificity on cadets-pilots' functional state.

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Conflict of interests

The author declares that there is no conflict of interests.

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EXPERIMENTAL SUBSTANTIATION OF METHODIC OF 11-13 YEARS OLD BOXERS' COORDINATION DEVELOPMENT

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Abstract. *Purpose:* experimental substantiation of methodic of junior boxers' coordination training. *Material:* in the research 18 boxers of 11-13 year old age participated. In total, during 4 months 42 trainings were conducted. Total time of coordination load's fulfillment at each training was 15-45 minutes. *Results:* dynamic of results in control tests was statistically confident in the tested parameters of movements. It proves effectiveness of usage the tasks with complex-coordination orientation, accented on impact on sensor-informational and motor systems of movements in junior boxers' trainings. *Conclusions:* coordination training in boxing at initial stage shall include specialized varied means and methods, which would facilitate formation of motor condition and skills' basis. Motor condition and skills are a reserve for further rising of coordination abilities' level of junior sportsmen.
Key words: boxers, coordination abilities, sensor, motor systems, vestibular apparatus.

Introduction

At present successful performance of boxers at international competitions to large extent depends on purposeful and well planned work with reserve, starting from children and juniors. Especially important and valuable stage in many years' training process of preparation of elite sportsman is stage of initial training, which starts at age of 10-11 years [1, 2]. Exactly at this stage the basis of boxing technique is formed in junior boxers as well as the basis of general and special physical fitness.

On modern stage of boxing development scope and intensity of motor loads, realized in probable and sudden situations have significantly increased. It requires quick responses, ability for concentration and re-switching of attention, space-time accuracy and bio-mechanical rationality of movements. All these characteristics are connected by specialists [3-7] with conception of coordination abilities (CA).

High quickness of a boxer, great number of various movements of different complexity create strict conditions of duel conduct, in which it is required to find effective neutralizing or attacking technique in tenth parts of a second [2, 8]. These tasks require high level of all sides of boxer's sport fitness. They also stipulate seeking of new approaches, which would open additional reserves for realization of organism's motor-coordination potentials.

Variety of motor-coordination forms of boxers' functioning during fight requires high mobility of nervous processes and mobilization of sensor-perceptive mechanisms. The most successful in competitions are boxers, who have high level of sensor-perceptive abilities. These abilities are realized under the following perceptions: space time characteristics of movements (own and opponent's), specialized perceptions (sense of distance, sense of time, sense of temp), muscular-motor perceptions at direct contact with opponent. All these leading perceptions shall be closely interconnected and influence on each other [3, 9-11].

Besides, modern boxer shall have high level of motor coordination structure of movements at the account of muscular efforts' differentiation in certain situation [8], accuracy of movements (to external irritator, with responding to moving object), ability to sustain static and dynamic balance with irritation of vestibular apparatus [9, 12].

The most favorable period for development of motor coordination and junior boxers' ability to create new motor program is age of 11-12 years. Just this age range is especially sensitive to purposeful influences of sport trainings [9, 10, 13, 14].

For example, traditional forms of boxing training's organization include functioning in conditions of space-time and alternative indefiniteness. However, these conditions, as a rule, used to be of similar type and stereotype for trainees [8, 9]. In situations of probability adaptation to functioning conditions starts rather quickly. That is why effect in training of junior boxers' coordination abilities is determined not only by complexity of psycho-motor tasks but by their novelty and constant variability.

In this connection (***on the one hand)***, it is necessary to rationally vary training conditions in boxing. The, it is necessary to strive for systemically putting of trainees in situation, which would require manifestation of adequacy, quickness, rationality, mobility and improvisation of motor functioning in conditions of time and alternative indefiniteness. ***On the other hand***, it is necessary to constantly scope of specialized exercises and change coordination complexity of motor structure. It is possible only at the account of simulation of competition functioning conditions.

In spite of importance and urgency of the problem in modern theory of boxers' sport training methodic of coordination's training is still remaining to be developed insufficiently. There is no clear understanding of coordination abilities' basis, the data about their structure and age specificities of their manifestation are rather divergent; criteria of assessment of coordination abilities have not been worked out; specificities of their development technologies with regard to boxing at initial stage of training have not been determined.

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Contradictions of many questions, concerning development of junior boxers' coordination abilities, and absence of their solution condition significance of subject of this work and require further scientific researches.

Purpose, tasks of the work, material and methods

The purpose of the work is experimental substantiation of methodic of coordination abilities' training of junior, 11-13 years old age, boxers.

The tasks of the research: to determine effectiveness of the worked out author's methodic of boxers' coordination abilities' training by means of different motor coordination orientation.

The methods and organization of the research: analysis and generalization of scientific and methodic literature; pedagogic observation; testing of coordination abilities with the help of control tests [4, 10, 13], which have high values of reliability and informative.

The battery of control tests included:

1. Repeated jumps with maximal rotation to right and left sides on coordination meter of V. Starosta – for determination of CA level and tiredness in motor and information parts of motor system's structure.

2. Forward rolls with 180° turn – for vestibular stability. The tested were offered to fulfill a series of forward rolls with following 180° turn (forward roll - 180° turn, forward roll and so on). The test was fulfilled up to first signs of giddiness and absence of ability to fulfill roll in straight line (it was assessed and failure in informational part of motor system's structure). The time of fulfillment of control exercise was measured in seconds.

3. Romberg's test (balance on one foot) and Yarotskiy's test (rotation by head) – for determination of static coordination and vestibular stability.

4. «Shuttle run» – for determination of ability for re-construction of motor actions. The tested were offered to run 9 meters, then return to start line. The run 6 meters and turn to start line. Then run 3 meters and turn back. The time of fulfillment was measured in seconds.

5. «Run around obstacles» – determination of orientation in space. At site of 10 meters length, at marks 2,5 m and 7.5 m high poles were installed. The tested were offered to run from start line to finish, running the 1st pole from the right, 2nd – from the left, 3rd – from the right. In second attempt they were offered to ru the 1st pole from the left, 2nd – from the right and 3rd- from the left. Before fulfillment of every control attempt the tested were given one trial start. The time of fulfillment was measured in seconds.

Besides control tests for determination of tiredness in information part of motor system's structure we used in training two more tests: 1 – finger-nose coordination (dynamic coordination); 2 – testing of walking by methodic of V.G. Strelets. Both tests were fulfilled freely, individually during all training and usually after tasks with complex coordination load.

Pedagogic experiment was conducted on the base of Brest SCJSOR №1 from January to April 2014 at time of trainings. In experiment 18 junior boxers of 11-13 yrs. Age participated. All they were practically healthy.

Results of control tests before and after experiment were processed with methods of mathematical statistics. There were determined: mean arithmetic (x); standard mean-square deviation (σ); average-statistical errors (m); t-criterion of Stjudent for dependent samples. Mathematical processing of statistical parameters was realized with the help of computer program Statistika 6.0.

Results of the research

The principle in experimental program of coordination abilities' development was the fact that structure of motor functioning system consisted of informational and motor parts. Informational part of the structure included coordination of nervous and sensor systems' functioning. The motor part was complex of coordination abilities' manifestation.

Trainings of coordination orientation in experimental group were realized on the basis of physical load distribution with prevalence of complex-coordination exercises and increased attention to informational and motor parts of motor system's structure. The program of author's methodic of CA training was included in preparatory and main parts of training that was 60% of total time. In total, during 4 months in experimental group 42 trainings were conducted.

In first complex of exercises (oriented on development of upper and lower limbs' coordination) we used different asymmetric and symmetric movements with different trajectories, exercises for static and dynamic balance, various jump exercises, game exercises with objects or without them (see table 1).

Table 1

Approximate complex of exercises for coordination of movements for warming up part of training during 1st and 2nd months)

№	Description of exercises
1	Initial position (i.p.) – main stance (m.s.). 1-left foot standing ahead on toe, right arm directed aside, left – on waist; head is turned to the left (to the right); transfer body mass on left foot, right one – direct backward on toe, drop arms. 2. Right leg directed forward on toe, left arm directed leftward, right hand – on waist; turn head rightward and transfer body mass on right foot; drop arms. 3. Turn around; at the end of turn clap with hands over head, have a look at hands. 4. i.p. Dozing – 3-4 times.

2	I.p. – m.s.. 1 – turn torso rightward with right leg forward, on toe; left hand – behind head, right hand – on waist, bend forward. 2- i.p.. 3 – turn torso leftward; left leg put forward on toe; right hand – behind head, left hand – on waist; bend to the left. 4 – take position of swimmer's start and turn in jump around; hands – upward, have a look at hands. 5 – Direct arms by arches inside- outside. 6 – i.p. Dozing – 3-4 times.
3	I.p. – right arm directed forward-upward; left arm – downward-backward. 1 – jump, part feet, change arms' position. 2 – jump, close feet, change arms' position. Dozing – 3-4 times.
4	I.p. – m.s. 1 – jump on right foot, left one directed backward with arms – forward. 2 – jump on left foot with right one – backward and arms – aside. 3- jump on both feet with rmas directed backward by arch trajectory. 4- forward roll. 5 – high jump, hands upward – aside. 6 – i.p. Dozing – 3-4 times.
5	I.p. – m.s. 1 – step with left leg; by arch trajectory one and half forward turns by right arm. 2 – step with right leg and by arch trajectory one and half forward turns by left arm. 3 – jump with feet apart and clap behind back; jump – feet closed and arms aside with hands upward. 4 – i.p. Dozing – 4-5 times.

In second complex of exercises at the beginning of warming up part we offered main typical kinds of exercises for vestibular stability (rotations, bends, turns, acrobatic) with changing of their coordination complexity and load. Besides, we used outdoor games or relay races oriented on development of boxers' sensor system (see table 2).

Table 2

Approximate complex of exercises for coordination of movements and vestibular stability (for warming up part of training during 3rd and 4th months)

№	Description of exercises
1	2
1	*Walking with rotation of head (dozing – by 10″-20′)* Walking with back forward and rotation of head; walking with twisting of pelvis rightward-leftward; usual run; run by cross step (right side – left side forward); run with back forward; run with rotation around own axis; run with "throwing" of arms and legs freely forward, backward, rightward, leftward; run with shins backward, with "juggling" with ball; run with change of direction by command; "snake" run with change of direction; run with high jumps and rotations by coach's signal; run on "bumps"; usual run with rotation of head; minced run with simultaneous rotation of closed arms.
2	***Walking exercise (dozing 10″-20′):*** Walk with lunges and twisting to forward leg; walk with rotation of torso; walk in bent position with twisting to forward leg; walk with rotation of hands and head simultaneously; walk with alternate and simultaneous rotation of arms in elbow joints; walk with arms rotation in shoulders in different directions (right – forward circle, left – backward circle); walk "pump" with rotation around own axis; walk with straight blows and twisting to forward leg (with face – forward, with back – forward).
3	***Exercises at the spot (for static balance) (dozing 10″-20′)*** I.p. – standing on right foot, left leg is raised (angle 90°) arms directed aside, simultaneous rotation of hands and foot, in shoulder and hip joints. Standing on right foot, left leg is raided higher knee level. Move leg by figure eight trajectory. I.p. – stance on right foot, left leg is directed backward-upward arms are aside (position "Robin"). I.p. – stance on right foot, left leg is raised and bent in knee (angle 90°). Torso is bent forward. Imitation of flight with arms.
4	***Exercises in pairs (for sense of balance) (dozing* 20″-30″)** On gymnastic bench: rhythmic pushes with one or both arms with fakes. On gymnastic bench - rhythmic pushes with both arms simultaneously in chest, shoulder, diaphragm with jumps on one or two legs. Pushes with one or both arms in squatting position.
5	***Special warming up exercise for coordination of movements (dozing 30″-1′):*** By signal clap of coach boxer, standing in combat stance apply certain defensive or attacking technique depending on signal. By instructor's

	signal (one clap) boxer makes one blow, by 2 claps he uses certain defense. Moving in combat stance boxers play "tag". Moving in combat stance boxers "tamp" tennis balls on floor. Moving in combat stance boxers throw big or small balls with left or right arms. Moving in combat stance near wall boxers go away from balls, thrown to them by partners.

In main part of training we selected specific exercises, permitting to concord movements as well as to reconstruct skill depending on varied conditions. This methodic is given in the following algorithm: 1 – space orientation (sense of "blow distance"); 2 – accuracy of space parameters of movements; 3 – accuracy of time parameters of movements (sense of time) (see table 3).

Таблица 3

Approximate complex of exercises for coordination of movements and vestibular stability (for main part of training)

№	Description of exercises
1	2
Special warming up exercises for quickness and coordination of movements (dozing by 1′)	
1	*Instructor imitates jabs and disciples quickly and variably defend (bent back, bent aside and so on).*
2	Instructor imitates jabs and disciples instantly defend and response by single counter blow (straight**).** Преподаватель
3	Standing in front of group in combat stance, instructor open different parts of body. Trainees instantly and rationally imitate appropriate jabs.
Exercises, to be fulfilled at distance higher than combat	
4	Distance between boxers – 2-3 steps. One boxer imitates different single or double blows; his opponent takes appropriate defense and imitates counter attack (jab) (dozing by 2 x 1′)
Exercise in combat with shadow	
5	By instructor's signal temp of different actions increases (dozing by 4 x 15′)
Exercise at combat distances	
6	Boxers move in front each other. One of them strives to break distance. By instructors command "stop" both boxers stop and distance is checked.
7	Boxers move in front of each other at different distances. One of boxers opens glove for a moment. It is a signal for opponent's attack. Opponent can attack only if glove is in open position at blow distance. Attacks can be quite different (dozing by 2 x 1′).
8	Boxer intentionally opens different parts of body. Partner selectively responds by jab or combination of blows and takes defense against possible counter blows (dozing by 2 x 1′).
Exercises on apparatuses (bags) *(dozing by* 1′).	
9	By signal clap (command) of instructor boxer makes single jab at head level; by two claps – one jab at head and one – at torso levels; three claps – series of two jabs (one at head level and second at torso level).
10	By clap of instructor boxer defend against imaginative blow, by two claps – boxer makes defense and counter blowПо хлопку преподавателя боксер делает защиту от воображаемого удара, по двум хлопкам – боксер jab; by three claps – boxer defends against imaginative blow, makes single blow and again defends.
Exercises on boxing paws (dozing by 2 x 1′)	
11	Boxer responds to certain position of paws by single blow.
12	Boxer makes blows on paws, when they are at certain distance (middle, far, close).

The listed above means of coordination orientation are based on different special and general motor actions, permitting to expand the basis of motor skills (motor experience) for activation of certain perceptive functions and specialized perceptions of the trainees.

Total time of fulfillment of coordination load in every training was 15 – 45 minutes. Increase of scope of load was realized at the account of increasing of every exercise's repetitions in one series, quantity of series and quantity of different exercises in series with preservation of equal quantity of repetitions.

In process of trainings there were the following regulators of increasing of coordination tasks' intensity: increase of coordination complexity on the base of increasing of variability of exercises; increasing of requirements to accuracy, quickness, purposefulness and stability of techniques' fulfillment simultaneously; fulfillment of coordination exercises in conditions of time deficit; change of means and parameters of movements' fulfillment; change of conditions in the process of fulfillment of motor tasks; reduction of pauses between tasks and series of coordination exercises; against the background of tiredness. Duration of coordination work in certain task varied in average from parts of a second to several minutes.

Duration of rest intervals was set depending on tasks of coordination training and was in the whole from 30 to 45 seconds to 2-3 minutes. It permitted to restore organism's workability for effective fulfillment of the next task. Character of rest between coordination exercises was passive or active. In the process of active rest we used exercises for relaxation and stretching.

The main principle of the author's approach of CA development shall be not achievement of certain adaptation to loads but constant expansion of its limits with varying of different general and special motor-coordination actions. Opening of coordination potentials of junior boxers creates efficient basis for coordinated actions with application of modern combat techniques, for activation of motor intellect, increasing of space and time accuracy of movements, vestibular stability and quickness of responses. In this connection it is logical to assume that the offered methodic shall increase reserve level of informational and motor components of junior boxers' coordination abilities.

By results of control tests of junior boxers it is possible to find out general trends of changes of coordination potentials. The conducted by us research resulted in the following:

1) Before experiment in test "jumps with maximal rotation rightward/leftward (from 15 attempts): only results of second attempt (287.0±18.41) were statistically significant (t=2.92; P<0.05) and exceeded indicators of the first attempt (262.5±15.21). In further attempts there were no statistically significant differences (P> 0.05).

2) After experiment in test "jumps with maximal rotation rightward/leftward (from 15 attempts) we found a number of differences:

– results of second attempt with rightward rotation (278.50±13.19) were statistically significant (t=4.30; P<0.01) and exceeded results of the first attempt (267.50±13.71).

– in third attempt with leftward rotation (290.50±12.28) statistically significant (t=2.71; P< 0.05) trend to increasing of results, comparing with the second attempt (278.50±13.19) preserved. This trend was observed also in forth attempt (304.00±11.85), results of which substantially (t=3.48; P<0.01) exceeded indicators of the previous one.

– further, in up to the eighth attempt there were no substantial changes of the regarded indicator (P>0.05). However, in 9 (235.00±17.58), 10 (242.50±18.68) and 11 (246.50±18.97) attempts we observed statistically significant changes (t=2.75-395; P<0.05-0,01).

When fulfilling repeated jump with maximal leftward/rightward rotations the tested had only 15 attempts. At 16^{th} attempt there happened informational failure (i.e. wrong choice of rotation side). Full tiredness in 16^{th} attempt was determined by us as presence of certain physiological limits of tiredness (intrinsic for junior, 11-13 yrs. age, boxers). Analysis of dynamic of mistakes in choice of rotation side permitted to determine that before experiment the first mistake happened already in 6^{th} attempt. After experiment failure happened only in 12^{th} attempt.

Comparison of the received data permitted to detect that before and after experiment percentage of mistakes in 12^{th} attempt was 10%; in 13^{th} attempt – before experiment – 40% and after experiment – 10%: in 14^{th} attempt, before experiment – 60% and after – 50%; in 15^{th} attempt, before experiment – 80% and after – 70%.

Results of the conducted analysis witness about trend of CA improvement after experiment (see table 5).

Table 5

Results of control tests before and after experiment

№	Description of tested parameters	Statistical characteristics				
		Before experiment		After experiment		t\P
		$\overline{x}$	m	$\overline{x}$	m	
1	Push by two legs with leftward rotation (the best attempts) °	297.50°	17,53	322,50°	13,67	3,18/ P<0,05
2	Forward roll with rotation by 180°, sec.	20.50	2,20	25,60	2,19	6,78/ P <0,05
3	Romberg's test (on right leg)	15.10	2,97	16,10	2,63	1,54/ P >0,05
4	Romberg's test (on left leg)	10.80	1,91	12,60	1,81	3,67/ P <0,05

№	Description of tested parameters	Statistical characteristics				
		Before experiment		After experiment		t\P
		$\overline{x}$	m	$\overline{x}$	m	
5	Yarotskiy's test (rightward)	53.70	15.08	57,00	11,89	1,29/ P >0,05
6	Yarotskiy's test (leftward)	52.10	15.66	67,00	14,70	2,29/ P <0,05
7	Shuttle run (3,6,9 m), sec.	13.03	0.20	12,32	0,28	2,12/ P <0,05
8	Running around poles (from right side), sec.	3.10	0.07	2,91	0,05	2,27/ P <0,05
9	Running around poles (from left side), sec.	3.22	0.06	3,01	0,05	2,53/ P <0,05

Comparative analysis of Romberg's test results and Yarotskie's test results (rotation by head) showed improvement of results only in leftward rotation. At left limb there were registered substantial differences (P<0.05) from indicators of right side (and limb). This fact is conditioned by the fact that before experiment in functional state of vestibular analyzer there was present functional asymmetry with prevalence of right limb. However, after purposeful pedagogic influences of coordination orientation to symmetrizing of movements we found reserve potential of junior boxers in left limb. It permitted to increase the level of vestibular stability.

The offered methodic of CA development on the base of competition functioning's simulation rendered substantial influence on the tested indicators, Dynamic of changes of control tests' results (roll with turn) and Romberg's, Yarotskiy's tests, tests "Shuttle run" and "Running around poles" showed statistically significant (P<0.05) improvement of the tested parameters. It again proves effectiveness of the worked out by us methodic of CA training in junior boxers with application of complex-coordination loads and increased impact on sensor-informational and motor systems of movements.

Discussion

Analysis of literature and author's own researches' results showed that this work confirms researches of specialists [15-18] in field of coordination training of junior boxers. At present there is a few scientific researches in the field of variation of means and methods of coordination orientation in boxing. With it, many authors [15-18] touch on development of separate parameters of boxers' coordination training and do not regard process of junior boxers' training from the point of complex character of variation approach. Up to the present research variation approach in coordination training of junior boxers has been being regarded only as a specific question [19-21], without creation of theoretical essence, principles, algorithms and specific methods of training's optimization. From this point of view our research is a new one and is significant for theory and practice of sport training in boxing and other kinds of sports, That is why this work is a new direction, in which principle of variation approach transforms into system with own structure and algorithm.

We have confirmed the data of specialists [15-20] about the fact that in age range from 11 to 13 years, there exists high development of sensor-informational and motor components of CA under influence of purposeful coordination exercises of different variation orientation. This phenomenon is conditioned by the fact that in this age inhibitive influences of cortex and sub-cortex structures increase, close to adult type cortex – sub cortex relations form with leading role of cortex [22]. Accordingly, interconnection between different cortex centers increases, mainly at the account of neurons' branches growth in horizontal direction. It creates morphological functional basis for brain functions' development and installation of inter-systems' connections.

According to a number of researches [15-21], permanent creation of new inter-system links in neuro-physiological mechanisms of junior boxers' organisms ensures variation of complex processes of movements' coordination. In its turn, it conditions high tension of functions of central nervous system in general as well as motor apparatus. In this connection, presence of high level coordination is determined by different correlation of inherited features, physiological construction and highly developed psycho-physiological qualities, which are sustained by special coordination training.

Conclusions:

1. Coordination training in boxing shall include specialized means and methods of variable orientation, which would permit to form the basis of motor conditions and skills. Thus additional reserves are created for further growth of coordination abilities.

2. In the age of 11-13 years old junior boxers manifest intensive development of informational and motor components of coordination abilities: ability for according and co-submission of separate movements in single, holistic complex-coordinated motor functioning. The detected age peculiarities of CA substantiate main approaches to training of above named abilities and permit to effectively and rationally control training process at initial stage of junior boxers' training.

3. In programs with coordination orientation it is necessary to rationally combine variety of trainings' construction and control over load. It permits to ensure higher level of development of coordination potentials' components of junior boxers. In this connection the necessary conditions of CA development in junior boxers are: establishing of optimal structural-functional connections between training and competition functioning; application of special exercises in varied conditions (probable and sudden situations); simulation of situations with alternate indefiniteness, connected with demand in varying of responsive actions; shortening of time for solution of psycho-motor task in certain sequence (situation – attack- defense – plot of boxing duel – the solved task). Just such approach will permit for junior boxers to realize effectively technical-tactic actions in boxing duel.

Thus, the data of experiment permitted to determine that under influence of system of special motor-coordination tasks there happen improvement of synchronizing of organism's motor, physiological and vegetative functions (achievement of their optimal concordance). It results in mobilization of reserve potentials and finds additional ways for further improvement of training methodic for junior boxers.

The prospects of further researches imply working out and implementation of exercises of conjugated orientation: motor coordination tasks accented on boxers' technical tactic actions.

Conflict of interests

Author declares absence of any conflict of interests.

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DAILY DYNAMIC OF INDICATORS OF GIRL-STUDENTS' BLOOD MICRO-CIRCULATION

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Abstract. *Purpose:* study daily dynamic of indicators of girl-students' blood micro-circulation. *Material:* 340 girls of 17-19 years old age were examined. The method of laser Doppler's flow metering was used. *Results:* The state of tissue blood circulation was determined. Character of micro-circulation's changes under influence of daily bio-rhythms was detected. In first half of day tension of mechanisms of micro-circulation's regulation takes place. Partially it reduces by 4 p.m. at the account of strengthening of metabolic components of vasomotor rhythm. In evening period there is observed compensatory increasing of breathing and pulse modulations. It is connected with weakening of sympathetic and strengthening of parasympathetic impacts on tissue blood circulation. Also we registered changes in correlation of rhythmic components of tissue blood circulation's oscillations at the accounts of weakening of vasomotor rhythm. It witnesses about tension of regulatory mechanisms. *Conclusions:* it is recommended to use the received data as normative indicators of laser Doppler's flow metering when studying pathological processes.
Key words: blood micro-circulation, daily dynamic, laser Doppler's flow metering, bio-rhythms, girl students.

Introduction

One of important modern problems is health of population. Environment and heredity influence on all structures of human organism [11]. Complex examination of girl students' health, as far as they are a social group with increased risk of organism's functional disorders, is especially important. Their age is the most optimal for realization of reproductive function [13, 15, 16].

In diagnostic of different diseases one of leading places is engaged by problem of study of blood micro-circulation. In this case micro-circular link is regarded as sub-system of all vessels' system, in which main function is realized: ensuring of trans-capillary exchange and its response to environmental and internal factors [6]. It is evident that changes in blood microcirculation's system are in close correlation with shifts in central haemo-dynamic. It permits to use parameters of micro-circulation as criteria in assessment of examined persons' health 11, 17, 19].

At present one of main methods of micro-circulation studying is laser Doppler's flow metering (LDF). LDF is method of integral non-invasive assessment of micro-circulation haemo-dynamic in tissues. LDF is also a proved method of diagnostic of micro-circulation disorders [1, 2, 8, 9, 10, 18]. That is why demand in working out and substantiation of new methodic techniques, based on LDF, is evident. However, at present reliable criteria for application of laser Doppler's flow metering of healthy persons are absent.

Thus, detection of interconnection between blood micro-circulation indicators and daily dynamic of girl-students is rather urgent.

Purpose, tasks of the work, material and methods

The purpose of the work: to study daily dynamic of micro-circulation of girl-students.

The tested contingent consisted of 340 girl-students of Melitopol State Pedagogical university, who related to junior age group (from 17 to 19 years old). In ethnic aspect most of the tested girls were Ukrainian and Russian, who lived in South-East of Ukraine.

The methods and organization of the research:

In order to study functional state and specific features of micro-circulation in women's organism we used method of laser Doppler's flow metering (LDF). This method permits to added tissue blood circulation and detect the signs of micro-circulation changes under influence of daily bio-rhythms.

LDF was conducted with the help of Laser analyzer of blood flow "LAKK-01" «ЛАКК-01» (production of НПП «Лазма», SIA "Lasma", Russia) with laser source of light at wave length of 0.63 mcm. Laser analyzer was connected with computer. The curve of LDF recording is depicted on monitor in real time. The girls were tested in sitting position. The head of optical probe (sensor of the instrument) was fixed in ventral surface of 4th finger of left hand; the hand was located wt level of heart, Standard recording lasted 3 minutes [7, 14].

Computer program for processing of LDF records permits to determine the following characteristics of micro-circulation: PM – parameter of micro-circulation; MSD – mean square deviation of registered Doppler signals from mean value; Cv – coefficient of variation, measured in %. Results of LDF testing were registered in relative perfusion units *(perfusion units – perf. un.*), which reflect: degree of perfusion by mainly erythrocyte fraction; units of tissue volume per unit of time. Important stage of LDF metering is analysis of amplitude-frequency variety of blood flow components – *(AFV)* of tissue blood flow oscillations' haemo-dynamic rhythms: VLF – metabolic oscillations, LF – vasomotor oscillations, HF –breath oscillations, CF –pulse waves.

For every tested indicator of micro-circulation we calculated mean arithmetic M, error of mean value m, mean square deviation δ . Evaluation of confidence was carried out with the help of Sjudent's t-criterion for sample with

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unequal quantity of observations. Statistical processing of results was fulfilled in Microsoft Excel. The received data were processed with the help of basic package of programs for statistical processing of data.

Results of the research

It is known that during day human workability changes as well as degree of tension of different regulatory mechanisms in human vegetative sphere [3, 4, 12]. In this connection we made LDF records of girls with standard type of daily micro-circulation. For this purpose we made record at 8:00 a.m., 12:00 a.m., 4 p.m., 7 p.m. and 11 p.m. In fig. 1-5 daily monitoring of LDF record of one girl is depicted.

Minimal value of micro-circulation parameter (PM) was registered at 12 a.m. – 16.9±0.5 perfusion units (perf. un.). Mean square deviation (MSD) of girls was the following: at 8 a.m. – 1.34±0.07 perf. un.; at 12 a.m. it reduced by 13.5% and was 1.16±0.06 perf. un. At 4 p.m. mean square deviation (MSD) increased by 21.5% from previous value and became equal to 1.41±0.07 perf. un. At 7 p.m. mean square deviation (MSD) continued to increase and reached 1.74±0.09 perf. un. (increment 23.4%). Maximal MSD value of girls was registered at 11 p.m.– 1.92±0.13 perf. un. (dynamic from previous indicator +10,3%).

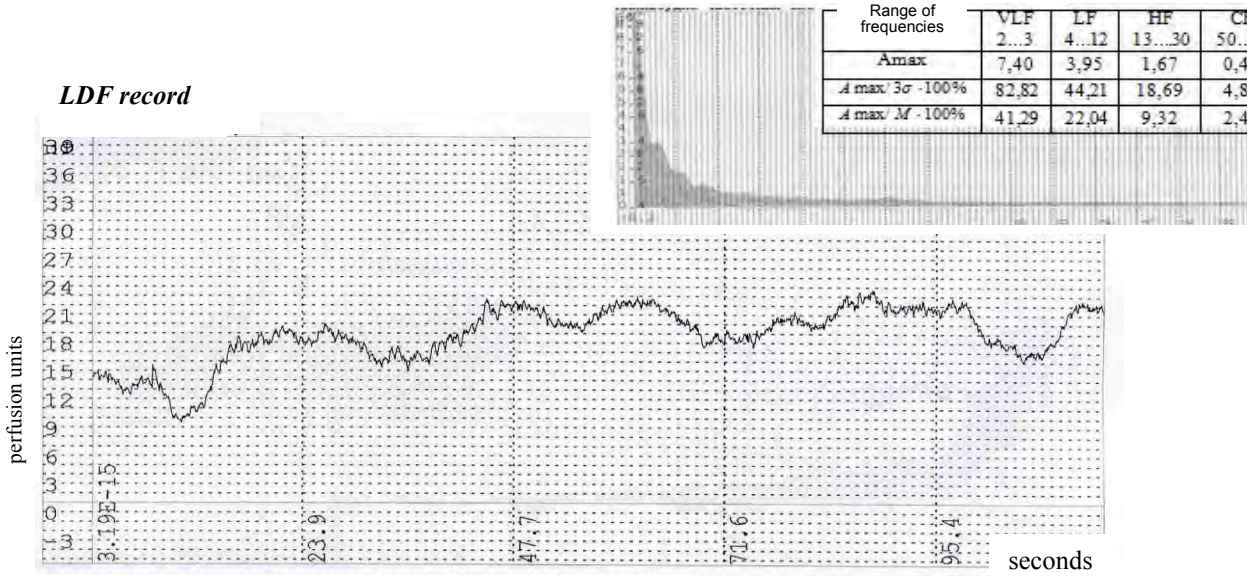


Fig.1. Daily monitoring of LDF record of 17 years old girl with standard type of micro-circulation at 8 a.m.

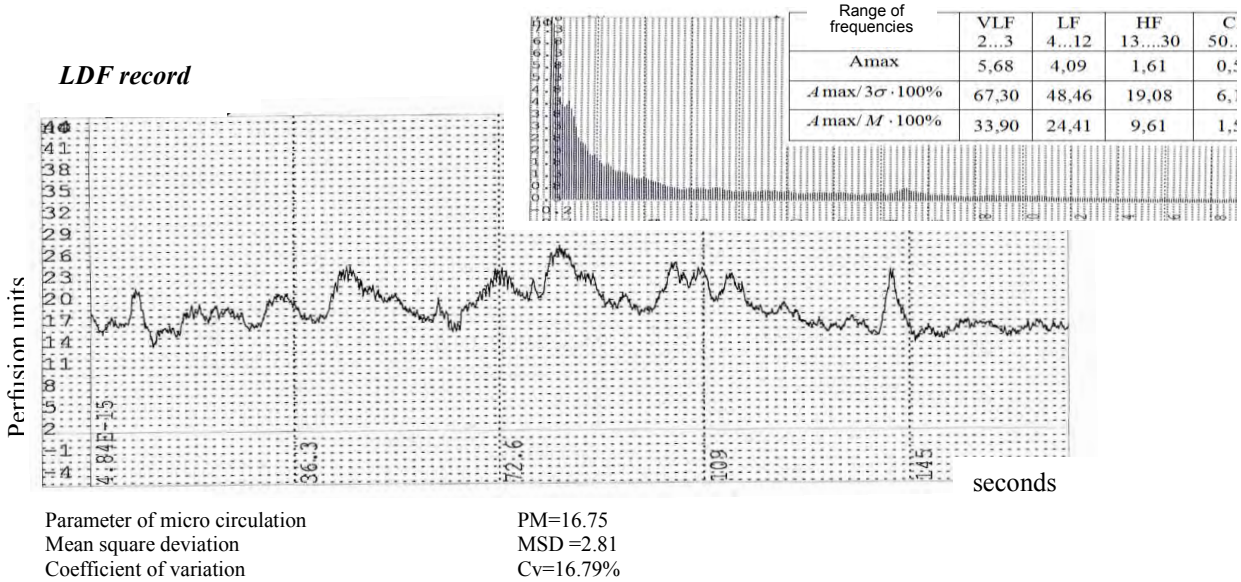
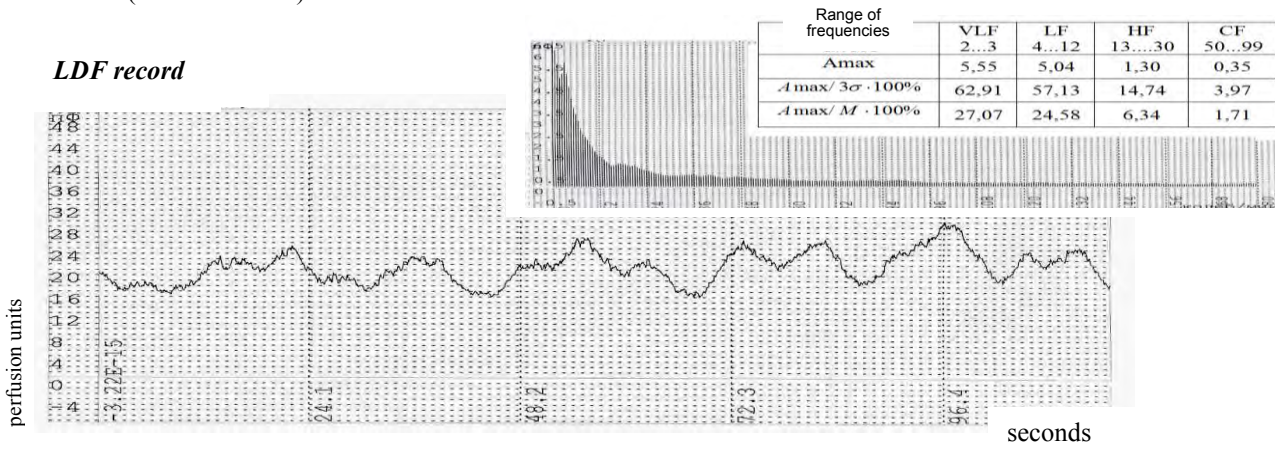


Fig.2. Daily monitoring of LDF record of 17 years old girl with standard type of micro-circulation at 12 a.m.

The received data witness that during day LDF record with a-periodically high amplitude oscillations of tissue blood flow, which are characteristic for standard type, preserves. By 12:00 we registered reduction of micro-circulation parameters and level of mean square deviation. Variation coefficient also reduces. Analysis of amplitude-frequency variations (AFV showed increase of vasomotor oscillations' amplitude (LF oscillations), breathing oscillations (HF) and pulse waves (CF oscillations).



Range of frequencies	VLF 2...3	LF 4...12	HF 13....30	CF 50...99
Amax	5,55	5,04	1,30	0,35
$A\max/3\sigma\cdot100\%$	62,91	57,13	14,74	3,97
$A\max/M\cdot100\%$	27,07	24,58	6,34	1,71

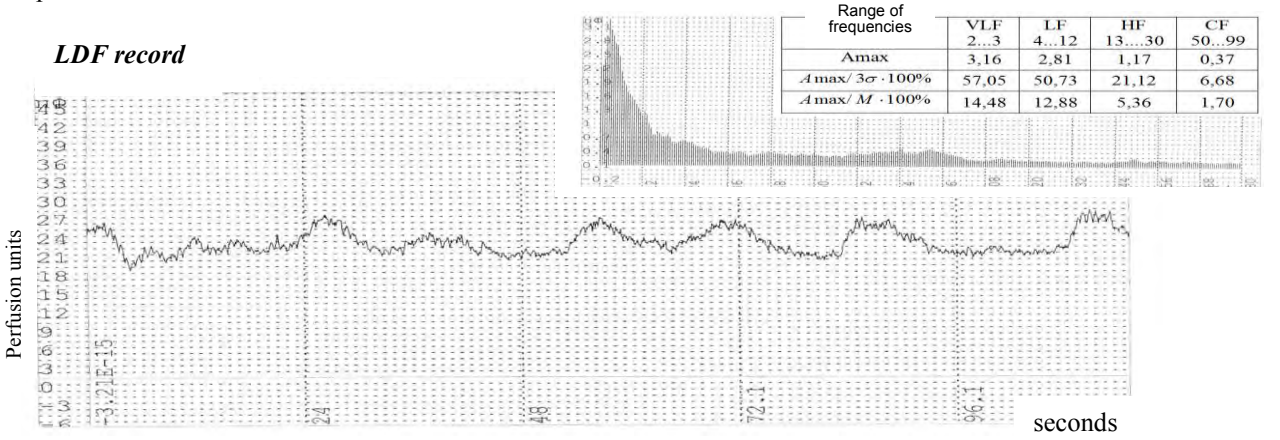
Parameters of micro-circulations PM=20.11
Mean square deviation MSD = 2.94
Коэффициент вариации Kv=14,34%

Fig.3. Daily monitoring of LDF record of 17 years old girl with standard type of micro-circulation at 4 p.m.

By 4 p.m. PM and MSD increase. In AFV metabolic component of vasomotor oscillations (VLF rhythm) substantially increases. At evening period PM reduces and MSD (characterizing flux level) significantly rises. Against such background contribution of vasomotor rhythm, breath and pulse oscillations of blood flow increase.

In analysis of rhythmic components of LDF amplitude-frequency spectrum of girl-students we received the following data (see table 1).

Indicators of contribution of metabolic oscillations (VLF-oscillations), vasomotor oscillations) breathe oscillations (HF) and pulse waves (CF oscillations) at 8 and 12 a.m. witness about tension of breathing and pulse components of tissue blood flow's modulations.



Range of frequencies	VLF 2...3	LF 4...12	HF 13....30	CF 50...99
Amax	3,16	2,81	1,17	0,37
$A\max/3\sigma\cdot100\%$	57,05	50,73	21,12	6,68
$A\max/M\cdot100\%$	14,48	12,88	5,36	1,70

Parameter of micro-circulation PM=21.19
Mean square deviation MSD =1.85
Coefficient of variation Cv=8.46

Fig.4. Daily monitoring of LDF record of 17 years old girl with standard type of micro-circulation at 7 p.m.

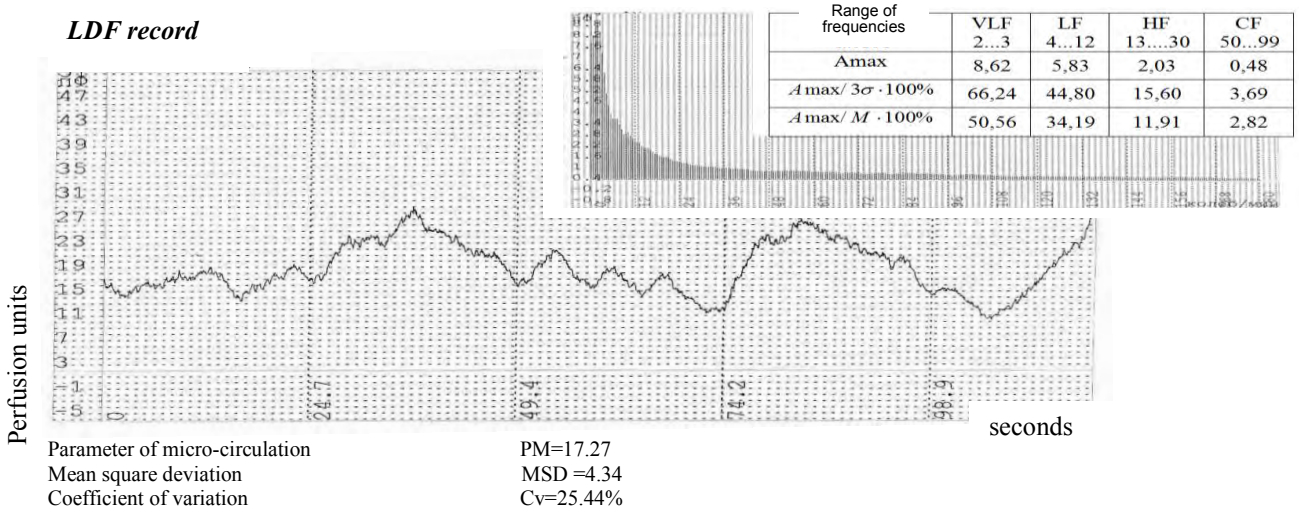


Fig.5. Daily monitoring of LDF record of 17 years old girl with standard type of micro-circulation at 11 p.m.

At 4 p.m. metabolic component of vasomotor activity plays substantial role in modulation of tissue flow's oscillations. At 7 p.m. contribution of LF oscillations reduces. Contribution of HF oscillations increases. Here we see clear compensatory increasing of breathing rhythm, which plays passive role in modulations of tissue blood flow. As 11 p.m. contribution of VLF-oscillations, LF- and HF- oscillations corresponded to values of 8 a.m. In comparison with morning hours it is higher by 50%.

Table 1.

Girls' daily dynamic of contribution of different rhythmic components in tissue blood flow's modulation

AFV parameters	***Time of day***								
	8:00	12:00		16:00		19:00		23:00	
	Contribution in power of spectrum, %	Contribution in power of spectrum,%	Change from previous value, %	Contribution in power of spectrum,%	Change from previous value, %	Contribution in power of spectrum, %	Change from previous value, %	Contribution in power of spectrum, %	Change from previous value, %
VLF-oscillatios	56.7± 1.2	47.2± 0.9*	-6.8	55.3± 0.9*	+16.6	57.4± 1.2	+3.8	56.8± 0.1	-1.1
LF-oscillations	35.4± 1.0	44.3± 0.9	+25.0	37.7± 0.6*	-14.9	27.8± 1.5*	-26.3	35.5± 0.8*	+27.6
HF-oscillations	6.9± 0.6	7.3± 0.5	+6.6	6.0± 0.4	-16.8	7.6± 0.8	+26.7	6.4± 0.6	-16.2
CF-oscillations	0.8± 0.1	1.1± 0.1*	+35.8	0.9± 0.1	-10.3	0.9± 0.1	-4.1	1.2± 0.2	+27.6

Notes: VLF – metabolic oscillation, LF – vasomotor oscillations, HF – breath oscillations, CF – pulse oscillations; statistically confident between indicators of contribution of different rhythmic components in tissue blood flow's modulation* – $p < 0{,}001$

Discussion

As on to day the problem of individual-typological characteristics of blood micro-circulation process is rather urgent as far as any change in organism results in disorder of trans-capillary metabolism. World practice of study of blood micro circulation is based on researches of micro-circulation with pathologies in clinic conditions. Such scientists like Friese R.S., Edwards K.M. [19] research blood micro-circulation with hyper-tension. Mills P.J., Heller M.J.,

Lefkowitz R.B., Schmid-Schönbein G.W. [20, 21] study ferment fractions of blood. Shoucri B.M., Edwards K.M. [23] regard hereditary – determinate parameters of micro-circulation stream.

Blood microcirculation of healthy persons in process of ontogeny is widely studied by Russian scientists: V.I. Kozlov, F.B. Litvin, M.V. Morozov et al. [3, 6, 7, 8]. Their work contain fundamental study of individual-typological characteristics of children's micro-circulation in process of ontogeny; peculiarities of capillary blood flow's reserves of sportsmen, when conducting different functional tests.

In Ukraine researches of myogenic activity of micro-vessel stream of healthy person's skin under influence of low intensive electromagnetic radiation of high frequency, with the help of laser Doppler's flow metering were conducted by N.S. Tribrat, Ye.N. Chuyan [17].

At present one of main methods of micro-circulation study is laser Doppler's flow metering (LDF), which is a method of integral, non invasive assessment of micro-circulation haemo-dynamic in tissues and is a reliable method of micro-circulation disorders' diagnostic.

G. Schmid-Schonbein works out conception, according to which owcillations of tissue blood flow are result of superposition of active and "passive" modulations of flux-motions. Disappearing of some or another rhythmic components of flux-motions is interpreted as "spectral narrowing" of LDF record and can serve as diagnostic criterion of disordering of micro-circulation regulation mechanisms [22].

In spite of high interest and urgency of studying of blood micro-circulation processes, as on to day there is no normative indicators of parameters of health persons' tissue blood plow parameters, received with the help of laser Doppler's flow metering (LDF). That is why the purpose of our work was studying of blood micro-circulation parameters of healthy girls in connection with daily bio-rhythms. The observed daily dynamic of micro-circulation indicators in women's organism witnesses about increase of LDF record's indicators in second half of day. Some changes in correlation of rhythmic components of tissue blood flow at the account of weakening of vasomotor rhythm were registered. According to conception of myogenic mechanism (worked out by B. Folkow) spontaneous rhythmic contractions of smooth myocytes are conditioned by increasing of transmural pressure [18]. It witnesses about tension of regulatory mechanisms. The received by us data are in accordance with ideas about changes in vegetative sphere and workability of human organism during day.

Thus, the received data about peculiarities of blood micro-circulation of certain ager group girls can be used as normative indicators of LDF metering when studying of pathological processes in medicine.

Conclusions:

1. Studying of daily dynamic of girls' micro-circulation showed increase of LDF record's indicators (PM and MSD) in second half of day. Besides, there were registered changes in correlation of rhythmic components of tissue blood flow oscillation at the account of weakening of vasomotor rhythm. It witnesses about tension of regulatory mechanisms in them.

2. In first half of day there is observed tension of micro-circulation regulatory mechanisms, which partially reduces by 4 p.m. at the account of strengthening of metabolic components of vasomotor rhythm.

3. In evening period we observed compensatory strengthening of breath and pulse modulations of tissue blood flow, which were mainly connected with weakening of sympathetic and strengthening of parasympathetic impacts on tissue blood flow.

In the prospect we plan to carry out researches in the field of organism's reserve potentials of girls' daily blood micro-circulation with the help of thermal and cold tests.

Conflict of interests

Authors declare that there is no conflict of interests.

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DYNAMIC OF VERTICAL STABILITY INDICATORS OF JUNIOR SCHOOLCHILDREN, WHO HAVE WEAKENED HEARING, UNDER INFLUENCE OF PHYSICAL EDUCATION MEANS

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Abstract
Purpose: study of physical education means' influence on vertical stability indicators of junior school age children with weakened hearing. *Material:* in experiment 26 pupils of 7-8 yrs. age with different hearing problems participated. *Results:* it was found that effectiveness criteria of physical education means' influence on child's balance function are: reduction of amplitude of general body mass center's oscillations (eyes opened) in main stance on immobile support; reduction of general body mass center's oscillations in Romberg's test; increasing of posture's keeping time in Bondarevskii's test. *Conclusions:* it was determined that application of technology of body vertical balance formation in junior schoolchildren with weakened hearing conditions positive dynamic of main indicators of body vertical balance.
Key words: dynamic, balance, indicators, stability, effectiveness, shifts.

Introduction

Children with health problems need care and attention of pedagogues and physical education specialists much more than any other population strata [8, 14, 15]. Indeed, practicing of physical exercises facilitate not only strengthening of their motor skills, which, due to a number of reasons, are weaker than in practically healthy children, but also help social adaptation, overcoming of self –uncertainty, develop ability to work in team. That is why problems, connected with compensation of infracted or lost children's functions, attract great interest of specialists.

Scientific works in field of physical education of children with weakened hearing witness that it is possible to influence on psycho-physiological qualities of children with weakened hearing, by developing their motor skills [9].

Besides, scientists make efforts in studying of psycho-motor functions of children of the mentioned nosology. For example, at present L.S. Gartseva offered and tested correction methodic for psycho-motor function of 8-10 yrs. Age children with weakened hearing. Its basis is exercises, oriented on development of space and space-time orientation, speed, balance, coordination. With it among methodic techniques means, based on strengthening of requirements to visual, vestibular and tactile analyzers, prevailed [4, pg. 9]. At the same time A.A. Ivakhnenko suggests to solve problem of development of such children's psycho-motor functions in process of specially organized game functioning. It conditions demand in working out of games, considering specificities of physical and psychic condition of children with weakened hearing [6, c. 68].

Methodic of physical education of children with weakened hearing, based on fit-ball gymnastic, "little" acrobatic and articulation gymnastic, worked out by V.V. Verbina [3, pg. 45] is also interesting. Positive shifts in physical fitness indicators are achieved at the account of interchangeability of exercises, which are components of systems "Exercise", "Game", "Word" [3, pg. 47].

I.V. Khmelnitskaya offered to apply computer monitoring of motor functioning in programming of physical culture lessons [11, 12]. The author proves that there are interconnections between coordination abilities and psycho-motor characteristics in junior schoolchildren with hearing deprivation.

As per already conducted researches children with weakened hearing have weak ability to keep balance [13]. In this case calisthenics means are recommended [7, pg. 47].

Among specialists' recommendations the most interesting are methodic of development of vertical stability of disabled children. Effectiveness of methodic of vertical stability development of children with intellectual deficit was proved; it was based on principle of increasing of coordination difficulty of exercises, applied for development of static and dynamic balance [5, pg. 228].

Nevertheless, among scientific works [9, 16, 18] there were no papers, in which effectiveness of process of development of children's with weakened hearing functions would have been proved with the help of quantitative, space and time analysis of body stability.

Purpose, tasks of the work, material and methods

The purpose of the work is assessment of dynamic of vertical stability indicators of junior schoolchildren with weakened hearing under influence of selected beforehand means of physical education and specially created pedagogic conditions for their usage in the process of adaptive physical education (APE).

In the course of our research we conducted forming experiment in control (CG) and experimental (EG) groups (13 tested in every group). Dynamic of abilities to keep static balance was assessed with the help of Ye.Ya. Bondarevskii's test [2]. Besides, in order to determine amplitude-frequency characteristics of GMC we used method of stabilography [1]. For this purpose we used platform Kistler. The researches were conducted on the base of laboratory of bio-mechanical technologies in physical education and Olympic sports of SRI of National University of Physical Education and Sport of Ukraine.

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We used two tests: main stance on stationary support with closed and open eyes and Romberg's test on stationary support with closed and open eyes [17]. Methods of mathematical statistic permitted to process empiric data and to find out certain regularities and make reasonable conclusions.

Results of the researches

By results of our researches we worked out technology of correction of vertical body stability of 7-10 yrs. age children with weakened hearing [10].

Assessment of the offered technology's effectiveness was carried out with the help of determined criteria: reduction of child's body GMC oscillations in main stance on stationary support with open eyes; amplitude of body GMS oscillations in Romberg's test; Increase of times of posture's keeping in Bondarevskii's test.

In process of physical education in EG we used the offered technology of correction of vertical body stability's disorders [10]. CG was trained by traditional program.

Analysis of rate of increment of vertical body stability indicators in CG permitted to detect:

- Time of posture keeping in Bondarevskii's test increased by 2.55%;
- Amplitude of body GMC oscillations in main stance reduced by 0.97%;
- Amplitude of body GMC oscillations in Romberg's test reduced by 0.58% (see table 1).

Table 1

Amplitude of body GMC of children with hearing deprivations before and after experiment, (n=26)

Description of test	Control group, (n=13)				Experimental group, (n=13)			
	Before		After		Before		After	
	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S	$\bar{x}$	S
Main stance, mm	10.6	0.6	10.5	0.6	10.4	0.6	10.0*	0.4
Romberg's test, mm	13.7	0.5	13.6	0.5	13.6	0.5	13.2*	0.5
Bondarevskii's test, sec.	14.3	4.2	14.5	3.6	15.0	4.2	17.5*	3.2

Notes: confidence of differences by t-criterion of Stjudent; **p<0.05 (p**<0.01) comparing of indicators before and after experiment*

The determined shifts of indicators of vertical stability in CG turned out to be statistically not confident ($p>0.05$).

The observed dynamic of vertical stability indicators in EG was as follows:

- Time of posture keeping in Bondarevskii's test increased by 15.56%;
- Amplitude of body GMC oscillations in main stance reduced by 3.57%;
- Amplitude of body GMC oscillations in Romberg's test reduced by 3.09%.

As we can see in EG changes of the tested indicators are more expressed, comparing with CG pupils. Especially it was noticeable in indicator, characterizing posture keeping time.

Comparative analysis of the received data permitted to determine that indicators of vertical stability in EG statistically confidently improved in all tested parameters ($p<0.05$). In CG we did not observe any substantial changes of the tested indicators.

The conducted research showed that before experiment initial and middle levels of static stability was characteristic for 38.5% (n=5) of CG children and 46.2% (n=6) of EG children. With it 30.8% (n=4) of CG and 38.5% (n=5) of EG members demonstrated high level of the mentioned parameter. As we can see differences between groups were insignificant. However, after experiment situation principally changed: if in CG among children with initial and middle levels of static balance we found 30.8% (n=4), than in EG – only 7.7% (n=1). Such changes in EG happened at account of increase of quantity of children with high static stability up to 69.2% (n=9) (see fig. 1).

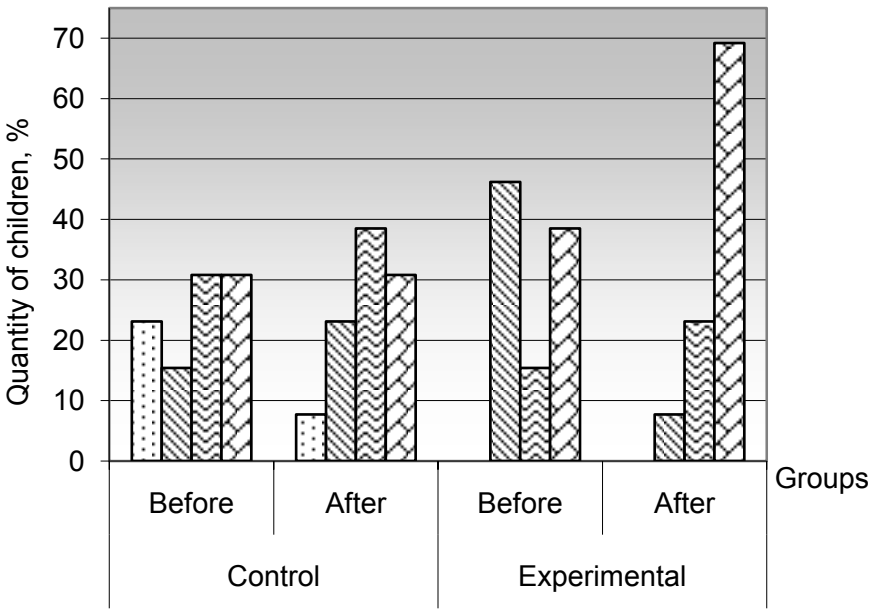

Fig. 1. Distribution of the tested by level of static balance before and after experiment (n=26), %
-high; - sufficient; -middle; - initial

The obtained results witness about positive influence of the offered by us technology of vertical stability formation of 7-10 yrs. age children with weakened hearing on vertical stability of disabled junior schoolchildren.

Discussion

In the course of our research we proved and supplemented data, which were rendered by other specialists. For example we proved information about deprivations of balance function in junior schoolchildren with weakened hearing [3, 4, 5].

At the same time we supplemented data of specialists about usage of stabilography method for determination of body vertical stability's indicators. With it we registered that reduction of GMC oscillations' amplitude witnesses about improvement of body vertical stability [2, 19, 20]. It should also be noted that junior schoolchildren with weakened hearing do not demonstrate statistically significant increase of GMC oscillations under influence of physical education means.

Usage of stabilography method ensures quantitative assessment of vertical body stability's indicators. Such approach to determination of effectiveness of pedagogic influences on children's balance function increase reliability and accuracy of measurements, comparing with assessment with the help of motor tests.

Conclusions

In spite of specialists' interest to perfection of motor skills of children with hearing deprivations, by present time problems of vertical body stability of junior schoolchildren with weakened hearing under influence of physical education means have not been solved completely.

Criteria of effectiveness of vertical body stability's correction for children with hearing deprivations are positive changes of indicators, which characterize the following:

- Reduction of GMC oscillations' amplitude in main stance on stationary support with open eyes;
- Reduction of GMC oscillations' amplitude in Romberg's test;
- Increase of time of posture's keeping in Bondarevskii's test.

It has been proved that in EG there happened statistically significant improvements of GMC oscillations' indicators (in main stance and in Romberg's test). The same was in Bondarevskii's test ($p<0.05$). With it in CG there have been registered no statistically significant changes of the tested indicators ($p>0.05$).

After experiment in EG quantity of children with high static balance level increased by 30.7%. It happened at the account of reduction of quantity of children with initially middle level of static balance. At the same in CG we did not observe such shift.

In general the worked out by us technology of vertical stability correction for 7-10 yrs. age children with weakened hearing is effective and it is purposeful to apply it in physical education of children of such nosology.

He further researches will be oriented on assessment of changes in junior school age children's postures (children with weakened hearing) under influence of the offered by us technology of vertical body stability's formation for 7-10 yrs. age children.

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Conflict of interests

Author declares absence of no conflict of interests.

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CONTROL OVER TRAINING PROCESS AS THE BASIS OF SUCCESSFUL REALIZATION OF ELITE HANDBALL TEAMS' TRAINING

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Abstract. *Purpose:* substantiation of control over elite handball players' training functioning with the help of special tests. *Material:* experiment covered 85 elite handball players of 18-32 yrs. old age (teams of Supreme League of Ukrainian championship). *Results:* effectiveness of different means and methods of control over sportsmen's fitness have been studied. The following tests have been offered: vertical jump, test-balance, shuttle run, test for accuracy of throws, «T-test», «Beep-тест». Model characteristics of indicators of qualified sportsmen's fitness have been determined. A list of test exercises, which are rather effective for control over handball training, has been recommended. *Conclusions:* testing of special workability of qualified handball players permitted to assess current condition of sportsmen, their functional potentials; it also allowed to determine symptoms of de-adaptation and to differentiate correction of training program.
Key words: handball, test, model, training, control.

Introduction

One of requirements to perfection of elite sportsmen's training system is optimizing of training process. Control over it permits to determine level of fitness, to detect presence of deviations and demand in corrections. It is of common knowledge that in training process level of fitness, functional condition and scope of loads are controlled [7,9]. At the same time, handball players' training is oriented on development of motor skills in compliance with requirements of competition functioning. Accordingly, quantity of different manifestations of different motor skills is rather great. That is why perfection of each of them requires differentiated methodic and control. It is well known that in training process coach shall promptly receive information about results of pedagogic influence. In this aspect the most significant is assessment of every player's fitness and the whole team in general as well as determination of training process's correctness. Concerning indicators of control they shall be in minimal quantity. But they shall carry effective information for correction of training process and game itself [5, 12].

Control of training process of elite players requires exact knowledge about their condition at certain stages of training on the base of methodically substantiated complex control over the whole process. There have been published some works, devoted to different kinds of handball players' training [3, 7]. Specificity of handball is in variable intensity of game, in quick and nearly continuous responding to varied situations. That is why it sets high requirements to control over speed power abilities of handball players [9]. In this game there appears a problem of instant responding to sudden actions in conditions of acute time deficit, of demonstration of high quickness, while fulfilling certain techniques, feints, complex group interactions with partners and opponents.

At the same time analysis of scientific-methodic literature witnesses that physical characteristics of players in handball have been studied [2, 6], as well as normative of special and physical fitness [9, 14] and some problems of technique and tactic[4, 11]. Works by T.A. Alizar, Ye.O. Nadezhdina, V.A. Tsapenko were devoted to special fitness of goalkeepers [1, 12, 15]. Kushniriuk S.G. presented results of practical work on organization of control over perfection of elite handball players' training in different stages of year training cycle [8]. However, formation and control over optimal informative tests for determination of elite handball players' fitness practically have not been studied. It justified urgency of our researches.

Purpose, tasks of the work, material and methods

The purpose of the research is substantiation of control over qualified handball players' training functioning with the help of special tests. *The methods of the research:* analysis and generalization of domestic and foreign scientific-methodic literature, pedagogic observations, generalization of handball coaches' advanced pedagogic experience, methods of mathematical statistics. Experimental researches were carried out on base of handball teams of Supreme League of Ukrainian championship "Motor", "ZRT", "ZNTU-ZAD", "Olympus-85". Experiment covered 85 sportsmen of 18-32 yrs. age in grades from CMS to IMS of Ukraine.

Results of the researches

With the help of well known procedure of determination of accuracy of physical qualities and abilities' phenol-typical demonstration with authentic tests (calculation of correlation coefficients between tests' results and indicators of fitness and competition functioning) we composed a set of tests for control of qualified handball players' training functioning:

Test №1. The height of jump is a critically important component for increasing of efficiency in many kinds of sports. It is realized under different conditions in different forms: by one leg and two legs' push, from run or from the spot. For determination which factors of influence on vertical increment of efficiency we conducted research. Results were analyzed with deterministic model. This analysis showed that successful vertical increment of efficiency is a result

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of reactive force, concentric actions, power of legs' flight, flexors of thighs, shoulders, body position, body mass. As a result we found normative marks [23].

Legs' power and strength are connected with ability for vertical jumps, which is an important parameter for some game roles. The purpose of the test is to jump vertically from immobile position, pushing by two legs (see fig.1). Reliability coefficient of this test is $r_{tt} = 0,92$.

Fig.1. Schema of test 1 fulfillment

Test №2. Ability to keep balance, coordination is very important in handball. Test-balance determines strength, balance and stability of sportsman's body. The exercise was fulfilled with the help of balance semi-sphere (boss). The test is started from right leg. Then it is necessary to turn back to left leg from number 12. Then, repeat it 3 times to each side. In case of mistake - add 3 seconds.

Fig.2. Schema of fulfillment of test-balance

Besides, instability of platform (boss) in some planes helps to develop pro-prioreceptive, kinesthetic links. Reliability coefficient of this test is $r_{tt} = 0,88$.

Test №3. During one game handball player changes rhythm about 190 times, 279 times – direction. Thus, in total he fulfills 485 movements of high intensity during 60 seconds (in average 8 movements per minutes) [16]. Character of competition actions requires from players: ability to quickly fulfill different by tension efforts; ability to fulfill many times "start" accelerations at short segments of distance; at first requirement of situation to change direction and speed of run and enter fight for ball in due time. That is why we offered and proved this test (reliability coefficient $r_{tt} = 0,97$).

During test acceleration by 15 meters is fulfilled (first time), then turn and finish in 5 meters (second time). Measurement is fulfilled with the help of two photo-finish devices and electric chronometers with accuracy up to 0.01sec.

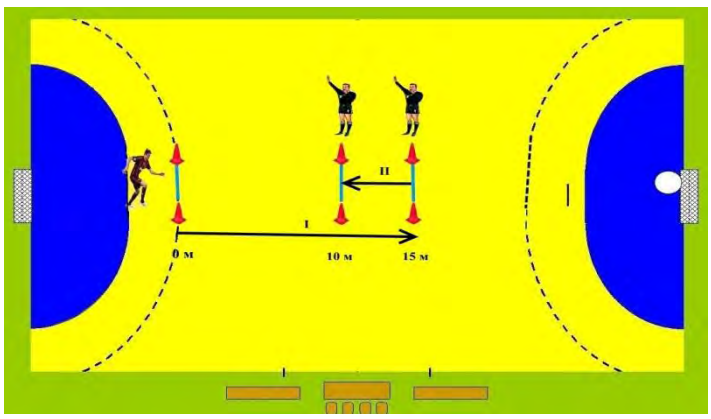

Fig.3. Schema of test №3 fulfillment

Test №4. Shuttle run 30 meters x 10 repetitions with maximal speed was intended for determination of lactate (hlycolitic) characteristics of sportsman. Analysis of received data witnessed confident interdependence between quickness and indicators of psycho motor abilities and adaptation potentials. Reliability coefficient of this test is r_{tt} = 0,96.

Test №5. Quickness is a determining factor in outdoor games. Quickness can be of movement (cyclic run, acyclic with throw, feint and jump in movement), complex quickness of responsiveness, speed endurance. It belongs to complex ability to realize technical-tactic actions in certain situation effectively and accurately in optimal time with certain intensity (see fig. 4). Reliability coefficient of this test is r_{tt} = **0,94.**

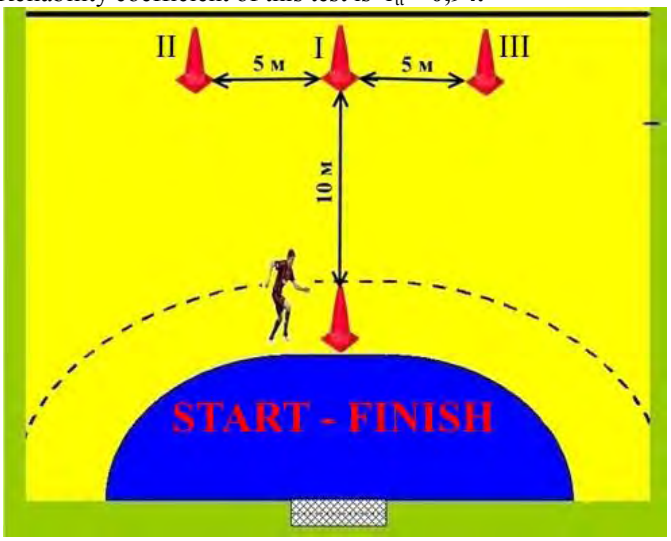

Fig.4. Schema of test №5 fulfillment

Sportsman shall run to mark 1 at maximal speed and touch it with right hand. Then he moves to mark 2 and touches it with left hand. Then – to mark 3 and touch it with right hand. After this – return to mark 1, touch it and accelerate at start-finish in reverse direction. With the help of criteria special fitness of sportsmen is determined.

Test №6. Test for accuracy of throws. Site is divided into six sectors. Zones 1, 2, 5, 6 shall be equal by size. Zones 3, 4 also shall be equal but be two times larger than zones 1, 2, 5, 6. Goal is divided in three sectors. Every sector is of 1 meter length. Handball player fulfills 12 throws (two throws from every zone) to line of free throws (9-meters' line). Three scores are gained if player hits the nearest to stand sector. One score – for hitting central sector. Maximal quantity of gained scores is 36. If sportsman oversteps with throw – no score is gained. Throws are fulfilled exactly in goal or with one jump from floor (see fig.5).

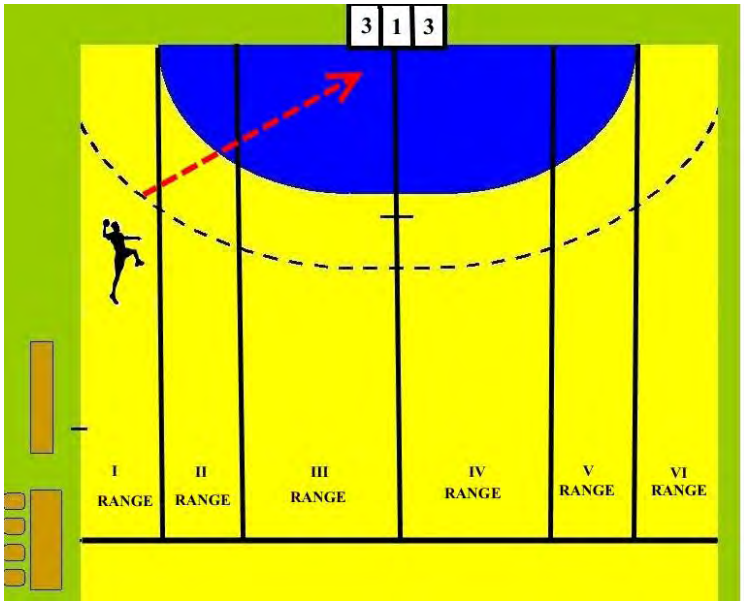

Fig.5. Schema of test №6 fulfillment

Test №7. Handball is a game, which is characterized by intermittent sprints of high intensity and very short rests. Player shall fulfill repeated intermittent accelerations. That is why special endurance is very important in match. One of maincomponents of handball players' fitness is high level of aerobic abilities. As on to day, traditionally one of

the most frequently used tests is multi-stage shuttle run test for 20 meters distance with sound signal («Beep-тест») by methodic of Leger. Time betweensignals for covering 20 meters segment gradually shortens. Reliability coefficient of this test is $r_{tt} = 0,95$.

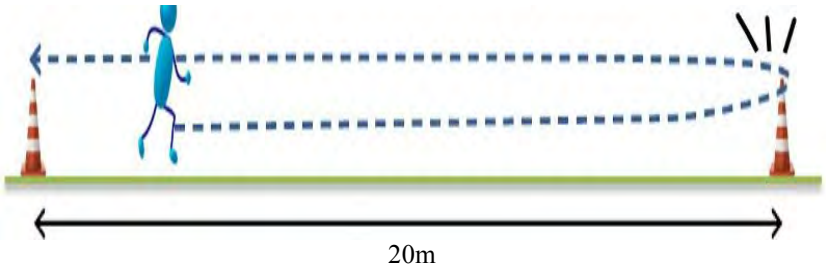

Fig.6. Schema of "Beep test" fulfillment

Test finishes when handball player can not sustain following increase of temp of run or can not run to control line two times turn by turn (see fig.7).

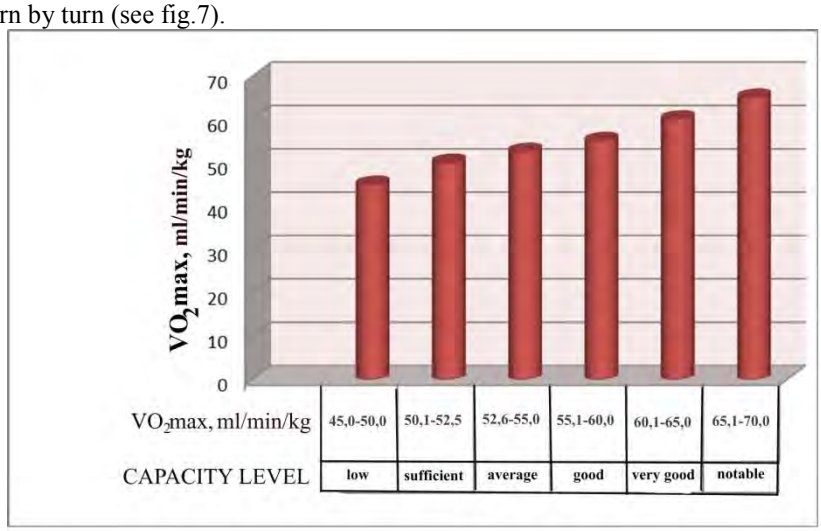

Fig.7. Workability levels of qualified handball players in "Beep test"

Discussion

The data, received in our research, agree with results of other authors. Leger and Lambert offered multi stage "Beep test" for measuring of aerobic endurance [20]. Later, it was changed a little [21] and proved [22]. Our researches proved informative potential of this test for qualified handball players. We assessed workability by calculated $V0_2max$, which is equivalent to overcoming of distance.

Besides we supplemented the data, determining correlations between dexterity of movements and physical fitness of junior handball players: explosive power of lower limbs, speed power, high jumps, sprint abilities with the help of T-test [19]. Movements' dexterity is correlated with most of special qualities, which determine competition functioning. It can be used as assessment of specific potential of sportsman's physical potentials.

Offered by Buchheit M. et al. intermittent fitness test for players of team kinds of sports is an alternate classic continuous testing of speed endurance. It is an exact assessment of $V0_2max$, but it causes parasympathetic innervations [17]. The testing, conducted by us, proved these data and permitted to determine functional potentials and assess current condition of qualified handball players.

Effectiveness of training process of elite handball teams is based on application of models of physical and special fitness. It is known that successful realization is possible only under objectification of qualitative and quantitative information about peculiarities of sportsmen's motor functioning. It permits to plan control of their qualitative sides, ensure and base its rationality. Thus, assessment of control over elite handball players' training functioning shall be regarded as purpose of complex control. Analysis of accumulated material permitted to work out model characteristics of control over qualified handball players' training functioning (see table 1).

Table 1

Model characteristics of indicators of control over qualified handball players' training functioning

INDICATORS	LEVELS		
	MIDDLE	GOOD	EXCELLENT
	TEST 1		
Distance, cm	50-55	55-60	> 60
	TEST 2		
Time, min.	> 3	1.31 – 2.14	< 1.30
Time, sec.	TEST 3		
15 m	2.6	2.4	< 2.4
15+5 m	3.7	3.5	< 3.5
	TEST 4		
Time, min.	2.10-2.25	2.00-2.10	< 2.00
Time, sec.	TEST 5		
	56-58	53-55	< 53
	TEST 6		
Quantity, times	29-31	32-34	>34

Conclusions

Testing of special workability of qualified handball players permitted to assess current condition of sportsmen, their functional potentials, determine symptoms of de-adaptation and differentiate correction of training programs.

The conducted researches do not cover all sides of analyzed problem. It proves demand in great attention to further theoretical-methodic studies and in perfection of implementation of innovative system of control in training of elite handball teams. The main purpose of further usage of this information is to determine its potentials and correspondence to requirements and correction of training process.

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IL-6 RESPONSES TO GLYCAEMIC INDEX DURING RECOVERY FROM EXERCISE

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Abstract. *Purpose:* This study examined the effect of meal with different glycaemic index (GI) on plasma IL-6 concentration and glucose metabolism after maximal lengthening contractions of the knee extensors. Using a cross-over design, *Material*: 10 healthy males completed 5 sets of 10 lengthening (eccentric) contractions at 120% 1 repetition-maximum. Subjects were randomized to consume the GI beverage (high-GI, low-GI (15% weight per volume; 3 g/kg BM) or placebo in three times within 10 min following exercise, and again at 50 and 110 min during recovery time. Blood samples were collected before exercise and after 0.60, 180 min and 24 h of recovery. *Result:* Concentration of plasma IL-6 in HGI group was less than LGI and Pla groups. IL-6 tended to significantly increase after exercise in recovery time in 3 groups (all $P < 0.05$), except for 24 hours ($P = 1.00$), furthermore there was significant difference for IL-6 between placebo and high glycemic groups in 3hours after exercise ($P=.016$). Concentration of serum CK in HGI group was less than LGI and Pla groups, CK was significantly elevated at all times points during recovery in 3 groups (all $P < 0.05$), except for 1 hour after exercise in HGI group ($P = 0.31$), but there was no significant difference for CK between groups. *Conclusion:* In summary, consuming HGI carbohydrate during recovery from exercise attenuate plasma IL-6 concentration.
Key words: Exercise, Glycaemic, index, carbohydrate, plasma.

Introduction

Eccentric skeletal muscle contractions induce inflammation and damage within muscle directly (Beaton et al., 2002), whereas indirect markers include loss of muscular strength and increased release of myocellular proteins (creatine kinase) into the circulation (Hirose et al., 2004; Paulsen et al., 2005; Peake et al., 2006). In response to exercise-induced muscle damage, neutrophils and macrophages are mobilized into the circulation (Paulsen et al., 2005; Pea et al., 2006), and subsequently infiltrate damaged muscle tissue (Beaton et al., 2002; Raastad et al., 2003). The systemic concentrations of cytokines (IL-6) also increase following muscle injury (Smith et al., 2000; Nieman et al., 2004; Paulsen et al., 2005; Peake et al., 2006). Eccentric exercise is associated with an increase in IL-6 (Steensberg et al., 2002) and can be used as a model to induce muscle damage and inflammation.

Carbohydrate (CHO) metabolism is a key factor that could influence on immune responses during exercise (Nieman et al., 2006). During endurance running and cycling, carbohydrate ingestion reduces circulating post-exercise leukocyte counts, and the plasma concentrations of IL-6 (Nieman et al., 1998, 2003, 2005). Within skeletal muscle, CHO suppresses IL-6 and IL-8 mRNA expression after endurance running (Nieman et al., 2003), but not in response to endurance cycling (Febbraio et al., 2003; Nieman et al., 2005).Consumption of CHO before and during 2 h intense resistance training reduces circulating neutrophil counts (Nieman et al., 2005). The immune response to CHO ingestion during the early recovery period following intense resistance exercise is currently unknown. These findings indicate that glucose exerts anti-inflammatory effects during exercise, when metabolic demands are high. Glucose may influence inflammatory responses within blood and skeletal muscle differently when CHO is consumed in the recovery period following muscle injury, when metabolic stress is lower and inflammation is higher (Louis et al., 2007). Evidence exists that large doses of glucose can induce inflammation and oxidative stress at rest in normal healthy individuals (Mohanty et al., 2000; Dhindsa et al., 2004; Aljada et al., 2006; Dasu et al., 2007; Dickinson et al., 2008).

Glycemic index (GI) describes the difference by ranking CHO according to their effect on blood glucose levels(Jenkins et al., 1981). Different type of CHO and exercise may have various effects on immune function (Kirwan et al., 2001). Resistance training with high-force eccentric contraction causes more micro-tears in muscle and more inflammatory responses than concentric contraction (Miles et al., 2010), also one of the most important aspects of recovery from resistance exercise, that can be influenced by nutrition is the synthesis of muscle glycogen to replace stores lost during exercise and thus can be used as a model to study the influence of diet on the inflammation process. The inflammation might be increase with a high amount of CHO diet following a high-force eccentric contraction (Miles et al., 2010). On the other hand some study indicate that CHO sources with a moderate to high GI may enhance post exercise recovery (Burke et al., 2004).

We can infer that over-release of the inflammatory cell during recovery after exercise may be an expression of decrease of body immune function. Evidence exists that large amount of glucose can decrease inflammation and oxidative stress at rest in normal healthy individuals (Dickinson et al., 2008). On the other hand a high GI diet following a high-force eccentric arm exercise increased insulin resistance and inflammation (Miles et al., 2010). The IL-6 response to carbohydrate ingestion during the early recovery period following intense resistance exercise is currently unclear. Therefore, knowing about that which type of CHO be able to reduce inflammatory responses during recovery in resistance exercise, could guide the athletes for choosing beneficial nutrition to reduce their damage. Few studies, if

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any, have investigated the influence of a GI beverage on IL-6 response during recovery from resistance exercise. We also examined the effect of a post-exercise beverage with different GI on IL-6 responses to intense resistance exercise. The aim of this study was to determine whether there are differences in plasma IL-6 concentration between low and high GI during recovery from resistance exercise.

Materials and Methods

Subjects

Ten weight lifter males (age 22±2 years; body mass 83±10 kg; high 177±5 cm; fat percentage (%) 12±2; 1RM 235±42/kg and training experience 4±1years) were volunteers to participate in the study. volunteered to participate in this study which was approved by the Ethical Committee of Qom University of medical science. Written informed consent was obtained from all subjects. They were also required to complete a general health questionnaire and were excluded if any medication had been taken during the 6 weeks prior to the study and if symptoms of upper respiratory infection had been experienced in the 4 weeks prior to the study. Moreover, at the time of the study, all subjects were involved in normal training (2–3 times per week). Subjects were asked to refrain from alcohol consumption 24 hours prior to sample collection.

Preliminary testing

1RM assessment

At least 1 week prior to main trial all subjects reported to the laboratory to assess leg strength. Maximal dynamic strength 1RM was determined using a 60° incline heavy duty leg press. Following a 5-min warm up on a stationary bicycle, each subject was given 6 lifting attempts in order to achieve their 1RM. A valid repetition involved lowering the weight to the point of 75° of knee flexion (the load-lowering point) as measured by a Jarma goniometer (Therapeutic Equipment, Clifton, NJ), and then extending to full leg extension. Subjects were instructed to rest for 2–5 min between repetitions to ensure a true maximal lift was achieved. After each successful lift, the load was increased by 2.5–5 kg until failure to complete one repetition. Subjects were given a maximum of 2 attempts to lift the weight; the greatest amount lifted successfully was recorded.

Exercise familiarization.

Subjects were familiarized with the resistance exercise protocol, in which they were required to resist the downward movement of the weights. This movement involved lengthening (eccentric) contractions of the knee extensor muscles. A hand winch (5:1 ratio; model number: F10217; line pull capacity: 700 kg; Jarrett Synergy, SA, Australia) was fitted to the frame of the leg press, so that when the weight was lowered to the load-lowering point, the winch was used to lift the weight and reset it for the next repetition. In this fashion, the subjects only completed lengthening muscle contractions, with no shortening (concentric) contractions. Before the main trials, participant kept a 3-day diary of their dietary intake before the main trial and energy intake and dietary composition were subsequently analyzed (The Food Processor 10.0, Esha).They were required to repeat the same diet before each main trial to minimize the variation in muscle and liver glycogen concentrations.

Experimental procedure

This study is a counterbalanced cross-over design and the order of the three trials will be randomized, separated by at least14 days. Subjects were randomized to consume the GI beverage : High-GI (GI = 83) glucose drink 15% weight per volume; 3 g/kg body mass GI = 83), Low-GI (GI = 36) fructose drink 15% weight per volume; 3 g/kg body mass GI = 36) or placebo(an equal volume of flavor- and color-matched artificially sweetened placebo)(Ross et al., 2010), in three time within 10 min following exercise, and again at 50 and 110 min during recovery time.

On the day of the main trial, between four and seven days after the first visit the subjects were brought to the laboratory at about 8:00 am after an overnight fast of 12 h. After collection of the baseline blood samples the subjects were repeated the standardized warm-up on a stationary bicycle. The resistance exercise protocol consist of 5 sets of 10 lengthening contractions (5 sets, 10 repetition in each set) at a workload of 120% 1RM) legs press. Each set was separated by a 2-min rest interval. Subjects were instructed to lower the load in a controlled fashion to a 75° angle at the knee joint over 5 s (digital stopwatch, Cal. SO56, Seiko, Australia). During recovery from resistance exercise, subjects were consumed either the GI beverage : High-GI (GI = 83) glucose drink 15% weight per volume; 3 g/kg body mass GI = 83), Low-GI (GI = 36) fructose drink 15% weight per volume; 3 g/kg body mass GI = 36) or placebo(an equal volume of flavor- and color-matched artificially sweetened placebo)(Ross et al., 2010), in three time within 10 min following exercise, and again at 50 and 110 min . All of the trials were performed under similar conditions of barometric pressure, temperature, and relative humidity. No extra food was allowed until after the final blood sample was been taken.

Blood analyses

10 ml venous blood will be drawn from an antecubital vein in the forearm at each time point: 1- Fast blood sample (F.B.S) , 2- Immediately post-exercise, 3- 1 hour 4- 3 hours after exercise 5-24 hour after exercise during recovery period, into two different evacuated collection tubes (Vacutainer; Becton Dickinson, Mountain View, CA). The first (5 ml) venous blood sample was drawn into a vacuum tube with clot activator and serum separator for collection of serum to analyze glucose by BIOSEN C (EKF Diagnostic GmbH, West Germany) and CK by SYNCHRON® System(s) (Beckman Coulter, Inc.USA). The second (5 ml) venous blood sample was taken in to K3 EDTA vacutainers .5ml blood sample was spun at 1500 g for 10 min at 4°C to obtain plasma which was immediately stored at -70 °C before being analyzed for IL-6 . IL-6 was determined with the use of quantitative sandwich type enzyme-linked immunosorbant assay (ELISA) kits from R&D systems (Minneapolis, MN). All standards and solutions

were prepared, and procedures were followed according to the kit specifications. Samples were diluted when necessary to ensure that the measurement fell within the range of the standard curve.

Data analysis

All collected data will be presented as mean and standard deviation (Mean ± SD). Repeated measures 5 × 3 (time × groups) ANOVAs was used to assess metabolic and immune differences between groups. Any significant F ratios shown were assessed using Bonferroni correction test. Assumptions of homogeneity and sphericity in the data were checked. Statistical significance was accepted at $p < 0.05$. The data was analyzed by using the statistical package SPSS, PC program, version 19.0 (SPSS Inc., USA).

Results:

10 Subjects completed 3 sessions of resistance exercise (Table .1) .The protocol consist of 5 sets of 10 lengthening contractions (5 sets, 10 repetition in each set) at a workload of 120% 1RM) legs press.

Table 1.

Individual characteristic: N = 10.Values = mean ± SD. 1RM = Maximal dynamic strength

Characteristics	***M± SD***
Age (yrs)	22±2
Height (cm)	177±6
Body mass (kg)	83±10
Fat percentage (%)	12±2
1RM (kg)	235±42
Training experience (yrs)	4±1

Markers of inflammation

Plasma IL-6 concentration and CK were measured as indicators of inflammation as a result of muscle damage. For IL-6 at the baseline, there was no significant difference between trials. Concentration of plasma IL-6 in HGI group was less than LGI and Pla groups. IL-6 tended to significantly increase after exercise in recovery time in 3 groups (all $P < 0.05$), except for 24 hours ($P = 1.00$), furthermore there was significant difference for IL-6 between placebo and high glycemic groups in 3hours after exercise (P=.016) (Fig.1). At the baseline, there was no significant difference for CK between trials. Concentration of serum CK in HGI group was less than LGI and Pla groups, CK was significantly elevated above baseline values at all time points during recovery in 3 groups (all $P < 0.05$), except for 1 hour after exercise in HGI group ($P = 0.31$), but there was no significant difference for CK between 3 groups (Fig.2).

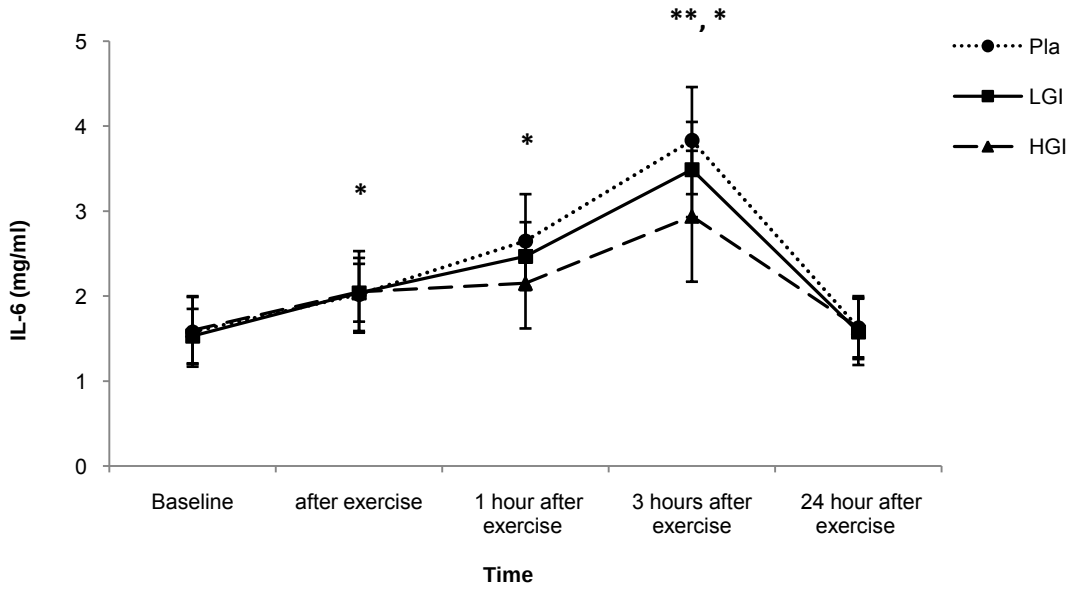

Fig. 1. Mean concentration of plasma IL-6 for Pla, LGI and HGI diet groups at the various time points.
Significant differences between Pla and HGI (treatment effect) are indicated with (**) where $P < 0.05$ Significant differences from baseline (time effect) are denoted by (*) where $P < 0.05$. Solid black bar represents resistance exercise bout; Pla = placebo, LGI = Low glycemic index, HGI = High glycemic index. Values are mean ± SE.

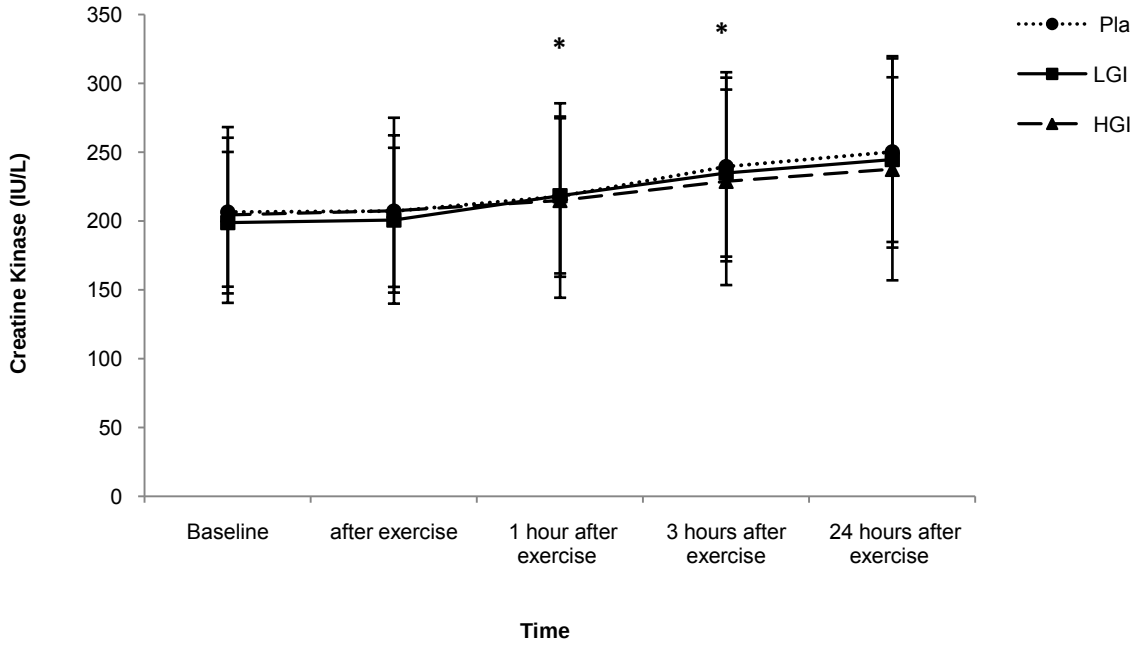

Fig.2. Mean concentration of serum CK for Pla, LGI and HGI diet groups at the various time points. Values are mean ± SE. Pla = placebo, LGI = Low glycemic index, HGI = High glycemic index.

Blood glucose:

The serum concentration of glucose was measured to identify differences in the diets between conditions. At the baseline, there was no significant difference for glucose between trials. Glucose increased significantly following carbohydrate ingestion. Concentration of glucose in HGI group was more than LGI and Pla groups, glucose was elevated above baseline values at 1h after exercise in HGI and LGI groups (all $P < 0.05$). There was significant difference for glucose between placebo with low glycemic groups (P=0.00) and placebo with high glycemic (P = 0.00), also high glycemic with low glycemic groups (P = 0.00) in 1h after exercise. Furthermore there was significant difference for glucose between placebo with high glycemic (P=0.00) and also high glycemic with low glycemic group (P = 0.00) in 3h after exercise (Fig.3).

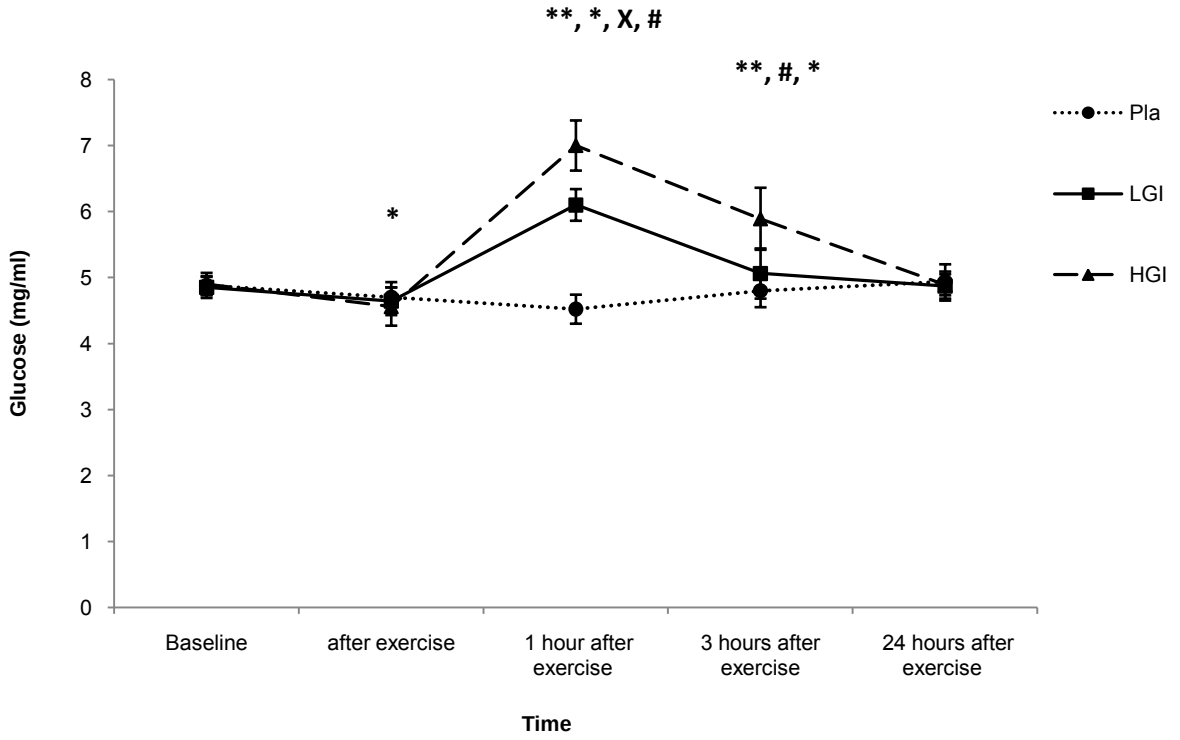

Fig.3. Mean concentration of serum glucose for Pla, LGI and HGI diet groups at the various time points. Significant differences between Pla and LGI (treatment effect) are indicated with (X) where P <0.05; Significant differences between Pla and HGI (treatment effect) are indicated with (**) where P < 0.05; Significant differences between LGI and HGI (treatment effect) are indicated with (#) where P < 0.05; Significant differences from baseline (time effect) are denoted by (*) where P < 0.05. Solid black bar represents resistance exercise bout; Pla = placebo, LGI = Low glycemic index, HGI = High glycemic index. Values are mean ± SE.

Discussion:

The aim of this study was to determine whether there are differences in plasma IL-6 concentration between low and high GI beverage during recovery from maximal lengthening contractions of the knee extensors. The key finding of present study was that plasma IL-6 concentration decrease significantly in HGI group to compare with LGI and Pla groups at least during the early post-exercise recovery period.

We selected an exercise model that would induce moderate muscle damage with relatively little metabolic stress in skeletal muscle. Generally, eccentric exercise elicits an inflammatory response for repair and adaptation, leading to increases in IL-1 and IL-6, while anti-inflammatory cytokines appear to be down regulated and inhibited (Peake et al., 2005). In current study IL-6 significantly increased after exercise in three groups which was expected, as exercising skeletal muscle is a powerful stimulator of IL-6 (Petersen et al., 2005). No previous research has investigated cytokine responses during the early phase of recovery from eccentric contractions in different glycemic trials. The glycemic index is a scale that indicates how rapidly different foods influence blood glucose levels. The purpose of elevating blood glucose to the point of hyperglycemia in the high carbohydrate condition was because previous studies indicate that hyperglycemia can induce and or augment inflammation (Esposito et al., 2002; Gonzales et al., 2006). The present data demonstrate that concentration of IL-6 in HGI group was significantly less than LGI and Pla groups. Inflammation following muscle injury is important for tissue regeneration, but excess inflammation may delay tissue regeneration. The HGI diet could have resulted in a quicker glucose response, and therefore, a faster spike in insulin. HGI ingestion immediately following exercise is useful for the replenishment of muscle glycogen, resulting in limited breakdown and increased repair of the muscle protein structure (Cockburn et al., 2012). HGI diet versus the LGI diet after exercise induces greater increase in insulin. Insulin is a powerful promoter of protein synthesis (Cockburn et al., 2010). Muscle injury combined with hyperglycemia attenuated plasma IL-6 concentrations. (Stevenson et al., 2005). Depner and colleagues (2009) lend tentative support for these findings. They reported that consuming a high-carbohydrate meal after 60 maximal lengthening contractions of the elbow flexors tended to raise the plasma concentrations of IL-6 compared with consuming a high-protein/fat meal.

Creatine kinasis is indicative of loss of muscle integrity, and researchers have suggested that muscle integrity is most compromised in high force eccentric contractions (Eston et al., 1995). We also measured the serum concentrations of CK in recovery time after exercise; we observed that the serum concentrations of CK increased after exercise during recovery period. These findings complement data from other studies indicating that plasma/serum cytokine concentrations generally increase beyond 3 h after resistance exercise (Smith et al., 2000), and lengthening contractions

of the leg muscles (MacIntyre et al., 2001; Paulsen et al., 2005) and arm muscles (Hirose et al., 2004; Miles et al., 2007). According to our finding CK in HGI group was less than LGI and Pla groups, but not significantly. This increase in CK peaked at 24 hours post-exercise for the HGI group, which is consistent with previous research on downhill running (Eston et al., 1995).

CK can be elevated for several days in individuals (Miles et al. 2010). The exercise protocol in our study included only 50 single-leg contractions, whereas other studies have used upper and lower body exercises (Smith et al., 2000), and 200 single-leg contractions (MacIntyre et al., 2001; Paulsen et al., 2005). The smaller muscle mass and lower number of contractions used during exercise may also account for the lack of any substantial systemic inflammatory response after exercise.

Conclusions

We can conclude that there is consuming of HGI carbohydrate during recovery from exercise attenuate plasma IL-6 concentration. Future research could investigate the effects of consuming carbohydrate with different glycemic index during recovery from other forms of exercise such as prolonged and interval, which induces greater muscle injury, that require higher intake of carbohydrate to restore muscle glycogen content. Interferences aimed at diminishing excess inflammation may promote faster muscle repair and recovery of muscle function.

Conflict interests

The authors declare they have no conflict interests.

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PROGNOSIS OF TRAINING EFFECTS BASED ON SOMATIC CHARACTERISTICS AND SPORT RESULT

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Abstract. *Purpose*: Researchers and coaches continue to look for the solutions that would contribute to creation of somatic and mobility condition patterns, allowing the players to obtain sport achievements at the highest level. Therefore, the aim of the study was to trace the sport results' impact in the pole vault and the selected somatic parameters of the vaulters of different ages and comparing them with the results of the players reaching the results at the highest level. *Material:* The study covered 29 vaulters of 17-19 years old age, engaged in the pole vault at "Zawisza Bydgoszcz", "Gwardia" Pila, "Sląsk" Wrocław, TS "Olimpia" Poznan sports clubs, the Centre of the Pole Vault in Gdańsk, as well as 4 top vaulters - two from Germany, one from the UK and one from Poland. The study was carried out in the training and sports competitions conditions in 2005-2009. In the work teaching observation method was used. The research tools were: assessment of physical development and sports outcome, which were carried out within the start period. The statistical methods were used for analysis of the study results. *Results*: Indicators of physical development were specified, as well as correlated with sport result for each group. The highest (the only statistically significant) indicator with the pole vault at 0.69 level was reported in the sample - the volume thoracic, exhaling (19-year-old vaulters). *Conclusions*: The group of vaulters, belonging to the "world's finest" is characterized by a higher rate of shoulders than the other studied groups. There seems to be a large influence on sport technique and result in the pole vault belonging to the proportions of the individual somatic parameters and here the relevant connections can be seen.
Keywords: physical development, comparison, pole vault, somatic.

Introduction

The researchers and coaches continue to look for solutions that would contribute to creation of somatic and mobility condition patterns, allowing the players to obtain sport achievements at the highest level. Of course, these achievements are possible with a parallel adjustment and optimizing of means and training methods to individual psychophysical predispositions of a vaulter, properly trained body wellness, as well as control of its responses[1, 2, 3, 4].

Individual sport disciplines are closely associated with specific requirements, for example somatic (basketball player, swimmers, gymnasts, strongmen, vaulters), which can be used to achieve sports outcome at the highest level.

The pole vault belongs to a very interesting competition in athletics, but execution of the pole vault is associated with a number of complex sequences of movements. They include - optimal speed of running start and transfer of kinetic energy to pole in order to use it to move the body on the flexible pole vault up and take the bar suspended as high as possible [5]. Only athletes with special skills such as: orientation in time and space, body balance, proper psychomotor and somatic conditions, can meet these criteria [6, 7, 8].

On the basis of carried out control of suitability, we receive the necessary message regarding their current level, which will serve for planning of training loads and sport result [5, 9, 10].

Analysis of specialized literature permits to conclude that type of body of every person is his/her biological characteristic of large genetic determinants of significant stability during its ontogeny [11, 12, 13]. Therefore, the choice of individual sports disciplines for certain somatic built plays important role, and in the future it will allow to take part in competitions at the highest level. According to the researchers the somatic built, especially some of its proportions, have a specific track of its development, particularly important in the pole vault [11, 14]. Unfortunately, at present it is difficult to determine, which of the parameters of somatic built can serve as a criterion for sportsmen of all ages, training the pole vault.

Therefore, the aim of the study was to trace the impact of the sport result on pole vault and the selected somatic parameters of different age vaulters as well as comparing them with the results of sportsmen, who already reached the highest results.

Material and methods

The study was carried out in training conditions and sports competitions in 2005-2009. It involved 29 sportsmen of 17, 18 and 19 years old age, engaged in the pole vault at "Zawisza" Bydgoszcz, "Gwardia" Piła, "Śląsk" Wrocław, TS "Olimpia" Poznań sports clubs, the Centre of the Pole Vaulter Gdańsk, as well as four athletes, two from Germany, one from the UK and one from Poland, whose best result in pole vault varied from 571 to 600 cm (later herein this group of four vaulters is specified as "Group A").

17, 18, 19-year-old athletes attended club training courses, 5-7 times a week. The training unit was 60-120 min., while at school they were taught by the program of physical education in terms of 3-4 classes a week, focused on development of overall physical fitness. While the players of "Group A" trained from 6 to 11 times a week. The training unit was 120 min.

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In our work we used the following methods and research tools:

- assessment of physical development,
- registration of athletic result,
- statistical methods.

In order to carry out assessment of physical development, the measurements of somatic built were conducted, with registration of the following indicators:

- body height (basis-vertex),
- body weight,
- torso length (suprasternale-symphysiom),
- lower limb length (basis-symphysion),
- upper limb length (acromion-daktylion III),
- shoulder width (acromion-acromion),
- pelvis width (iliocristale-iriocristale),
- thigh circumference,
- shank circumference,
- arm circumference,
- volume of the chest during inspiration,
- volume of the chest during exhalation,
- chest breadth (the difference of the chest volume during inhaling and exhaling).

With these parameters the somatic built ratio was calculated according to Rohrer, by determination of the ratio of body weight and height.

$$\text{weight it its height} = \frac{\text{body weight (g)} \times 100}{\text{body height (cm)}\ 3}$$

$$\text{- indicator of bars} = \frac{\text{width of bars}}{\text{length of the torso}} \times 100$$

$$\text{- indicator of the pelvis} = \frac{\text{width of the pelvis}}{\text{width of bars}} \times 100$$

Large bow compass, medical weight and metric tape were used to carry out the study.

For the analysis of athletic result the protocols of official competitions were taken into account. The collected material was statistically analysed using the values of minimum, maximum and average variance of the studied parameters, and Pearson correlation coefficients was found to be statistically significant at $p<0.05$.

Analysis of the studied results

The carried out analysis of physical development of 17-19-year-old vaulters showed fluctuations in the value of the standard deviation of each parameter of 1.04 cm (arm circumference of 18-year-old participants) to 6.10 cm (length of the lower limb of 19-year-old participants) (Table 1).

The average height of 19 years old participants was 186.78 cm. The highest vaulter was characterised by the body height of 191 cm, while the lowest was 175 cm. The average body mass of 17-year-old trainees was about 69.97 kg, in this group the greatest dispersion of results can be noted as well (standard deviation of 5.39).

Mean value of the shoulder width, e.g. in the group of 17-year-old vaulters, was 39.95 cm, hip width - 30.5 (18-years' age). The most significant difference between the smallest and the largest values of the shoulder and hip width in each group was respectively 7.2 cm (17-years' age) and 8.0 cm (19-year-old vaulters).

While mean values of lower and upper limbs' length, for example, in group of 18-year-old athletes was 91.16 cm and 78.97 cm.

The measurements of thighs' circumference, lower leg and arm were also interesting. Mean values of these parameters of e.g. 17-year-old vaulters were respectively 50.4 cm, 36,08 cm and 27,85 cm. The largest difference in standard deviation occurred was in circumference of the thigh of 19-year-old (4.59); maximum value of this indicator was 61 cm and minimum - 45 cm.

The measurement of the volume of the chest when at inhale/exhale and size of chest, e.g. in group of 18-years'-old, showed the average value respectively at level of 96.89 cm, 88.61 cm and 8.28 cm.

Average torso length, e.g. of 17-years'-old, was 54.78 cm; the difference between maximum and minimum values was 5.8 cm.

On the basis of this analysis of the somatic parameters of the vaulters, the dependencies were revealed, which derived from their natural biological development and the process of organism's adaptation under the influence incentives (load training).

Table1.

Parameters of the somatic built of 17-19 years' old vaulters (source, Klimczyk, 2012).

Parametres	Statistical quantities	17 years old (n-11)	18 years old (n-9)	19 years old (n-9)
body height (cm)	M	182,73	183,00	186,78
	SD	5,14	6,04	4,94
	Min	174,00	174,00	175,00
	Max	190,00	189,00	191,00
body weight (kg)	M	69,97	71,90	76,58
	SD	5,39	5,30	4,46
	Min	60,00	60,00	69,00
	Max	76,00	77,50	84,00
shoulder width (cm)	M	39,95	40,42	42,34
	SD	2,24	1,99	1,77
	Min	36,70	36,70	39,60
	Max	43,90	43,10	45,00
pelvis width (cm)	M	29,37	30,50	30,66
	SD	1,48	2,51	2,61
	Min	27,70	27,70	26,00
	Max	32,50	34,20	34,00
lower limb length (cm)	M	92,57	91,16	95,02
	SD	3,32	5,86	6,10
	Min	84,00	83,40	84,00
	Max	96,50	98,00	101,00
upper limb length (cm)	M	80,21	78,97	81,28
	SD	2,86	4,02	3,56
	Min	75,00	73,00	74,00
	Max	84,20	84,00	85,00
thigh circumference (cm)	M	50,40	50,94	54,11
	SD	4,20	3,91	4,59
	Min	45,30	43,00	45,00
	Max	58,00	56,00	61,00
Shin circumference (cm)	M	36,08	35,61	37,83
	SD	2,31	1,88	1,30
	Min	33,00	33,00	36,50
	Max	40,00	38,00	40,50
arm circumference (cm)	M	27,85	28,06	29,78
	SD	1,99	1,04	1,68
	Min	25,50	27,00	27,50
	Max	32,00	29,50	32,50
volume of chest after inhalation (cm)	M	95,77	96,89	101,94
	SD	4,22	4,57	4,98
	Min	90,00	90,00	95,50
	Max	101,50	103,00	112,00
volume of chest after exhalation (cm)	M	87,59	88,61	92,33
	SD	4,01	4,53	3,87
	Min	80,00	80,00	88,00
	Max	93,50	92,50	101,00
chest breadth (cm)	M	8,29	8,28	8,83
	SD	1,97	1,95	1,77
	Min	7,00	5,00	6,00
	Max	11,00	11,00	11,00
torso length (cm)	M	54,78	55,18	56,50
	SD	1,93	2,48	2,15
	Min	51,30	51,00	55,00

	Max	57,10	60,20	62,00

Correlation analysis demonstrated relationship between different parameters of the somatic built and showed significant interdependencies. In all age groups with the highest coefficients of dependence were between height and weight (0.52 to 0.90). Very high dependence was found between volume of chest at inhale/exhale (correlation coefficient of 0.80 to 0.96). In the age group of 17-19 years old, the significant differences, concerning correlation, were not found. The higher range (0.63-0.96) was detected only between few parameters. Below the correlation of somatic dimensions, e.g. 19-year-old vaulters, is shown.

Table 2

Correlation matrix of somatic dimensions of 19-year-old vaulters.

Studied parameters	**Lp.**												
body height (cm)	**1.**												
body weight (kg)	**2.**	0,52											
shoulder width (cm)	**3.**	-0,04	0,42										
pelvis width (cm)	**4.**	-0,44	0,29	0,09									
lower limb length (cm)	**5.**	**0,88**	0,22	-0,01	-0,62								
upper limb length (cm)	**6.**	0,60	0,10	**-0,74**	-0,24	0,50							
thigh circumference (cm)	**7.**	0,05	**0,72**	0,59	0,41	-0,22	-0,47						
Shin circumference (cm)	**8.**	-0,06	0,58	0,30	0,22	-0,19	-0,02	0,42					
arm circumference (cm)	**9.**	0,29	**0,86**	0,10	0,43	-0,09	0,24	0,66	**0,68**				
volume of chest - at inhalation (cm)	**10.**	0,29	**0,73**	0,31	0,29	0,17	0,25	0,24	**0,77**	**0,68**			
volume of the chest - at exhalation (cm)	**11.**	-0,03	0,54	0,08	0,44	-0,19	0,21	0,17	**0,73**	**0,68**	**0,80**		
chest breadth (cm)	**12.**	-0,06	0,34	-0,16	0,49	-0,08	0,25	0,17	0,49	0,52	0,50	**0,71**	
torso length (cm)	**13.**	-0,13	0,30	0,11	0,31	-0,53	-0,24	0,57	0,12	0,46	-0,08	-0,05	-0,34
	variable	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**

$p<0.05$ specified in bold.

On the basis of the carried out analysis of the slenderness of the body of the vaulters at the age of 17, 18 and 19 years old, referred to Rohrer index (which in comparison to previous studies of the author concerning the vaulters at a younger age showed its growth [15]), it was found that it reached up respectively the values of 1.15, 1.17 and 1.18 (see tab. 3). Similarly, increase in the indicator of shoulders was observed in the range from 72.95 (17-year-old) to 75.02 in athletes of 19 years' old age. While largest value of pelvis indicator for 18-year-old was 75.48.

Table 3

Average rate of body building of the vaulters.

No.	Types of indicators by Wanky	The studied age		
		17-year-old (n-11)	18-year-old (n-9)	19-year-old (n-9)
1.	Roher index	1.15	1.17	1.18
2.	Shoulder indicator,%	72.96	73.34	75.02
3.	Pelvis indicator	73.66	75.48	72.48

Analysis of the results of examined vaulters showed very high range of individual age groups' results, where standard deviation ranged from 44.38 (18-year-old) to 56.04 (17-year-old) (tab. 4). The largest difference between the

lowest and the best result in pole vault was in a group of 19-year-old vaulters (151 cm), and in this group one of the vaulters reached the best effect (551 cm).

Table 4

Result of pole vault of examined vaulters.

Efficiency tests	Statistical quantities	17 years old (n-11)	18 years old (n-9)	19 years old (n-9)
Pole vault result (cm)	M	398,64	407,78	463,60
	SD	56,04	44,38	52,89
	Min.	340,00	360,00	400,00
	Max	480,00	490,00	551,00

Table 5 shows the dependence of individual somatic features on the result of the pole vault. Statistically significant correlation of pole vault outcome takes place only between the volume of the chest – at exhale (/ 0.69 / of 19-year-old). There is interesting correlation between the height of the body (0.60) and the length of the lower limb (0.55) in group of 17-year-old vaulters. However, the highest quantity of correlations were with medium and low dependence.

Table 5

Analysis of somatic features of pole vault results (source, Klimczyk, 2012).

Lp.	Examined features	Pole vault result		
		17 years old	18 years old	19 years old
1.	Body height (cm)	0,60	0,33	0,15
2.	Body weight (kg)	0,13	0,37	0,33
3.	Shoulder width (cm)	-0,07	0,52	-0,20
4.	Pelvis width (cm)	0,04	0,17	0,43
5.	Lower limb length (cm)	0,55	0,52	0,02
6.	Upper limb length (cm)	0,26	0,41	0,40
7.	Thigh circumference (cm)	-0,07	0,13	-0,14
8.	Shank circumference (cm)	-0,12	-0,15	0,10
9.	Arm circumference (cm)	-0,40	-0,19	0,33
10.	Chest volume at inhale (cm)	0,19	0,59	0,44
11.	Chest volume at exhale (cm)	0,22	0,52	**0,69**
12.	Chest breadth (cm)	-0,35	0,17	0,47
13.	Torso length (cm	0,05	-0,31	-0,17

$p < 0.05$ in bold

Analysis of "Group A" somatic parameters (the vaulters, whose sport achievements are at leading positions in the world rankings) showed that this group has similar somatic conditions proved by dispersion of results around the standard deviation ranging from 0.9 (hip width) to 3.54 (volume of the chest at exhaling) (tab. 6). Average height and weight were respectively 191 cm and 82.3 kg (tab. 6). Difference between the extreme parameters of height and body weight of this group vaulters amounted to respectively 2 cm, 6 kg, while the widths of the shoulder and hips were respectively 4 cm and 2 cm. Other parameters are presented in table 6.

Table 6

The parameters of the somatic built of the vaulters.

Lp.	Examined parameters	Examined vaulters				Statistical quantities	
		L. M.	M.M.	D.E.	S.L.		
1	body height (cm)	190	192	192	190	M	191
						SD	1,15
						Min	190
						Max	192
2	body weight (kg)	85	79	83	82	M	82,3
						SD	2,5
						Min	79
						Max	85
3	shoulder width (cm)	40,6	36,8	40,8	38,8	M	39,26
						SD	1,86
						Min	36,8

						Max	40,8
4	pelvis width (cm)	24,8	24,9	26,5	24,5	M SD Min Max	25,2 0,9 24,5 26,5
5	lower limb length (cm)	96,7	96,4	99,4	99,8	M SD Min Max	98,1 1,77 96,4 99,8
6	upper limb length (cm)	83,3	83,8	87	85,2	M SD Min Max	84,8 1,66 83,3 87
7	thigh circumference (cm)	50,7	48	51	54	M SD Min Max	50,9 2,45 48 54
8	Shin circumference (cm)	40	37,5	36,5	36,7	M SD Min Max	37,6 1,61 36,5 40
9	arm circumference (cm)	32	30,7	33	36	M SD Min Max	32,9 2,26 30,7 36
10	volume of chest at inhale (cm)	109	102	105	109,5	M SD Min Max	106,4 3,54 102 109,5
11	volume of chest at exhale (cm)	98	95	97	100	M SD Min Max	97,5 2,08 95 100
12	chest breadth (cm)	11	7	8	9,5	M SD Min Max	8,9 1,75 7 11
13	torso length (cm)	50,8	53,1	52,4	49,8	M SD Min Max	51.5 1,5 49,8 53,1

Slenderness of the body established on the basis of Rohrer index showed that the greatest value has Ł.M. (1.24), while the lowest is for M.M. (1.12) (tab. 7). The average value of this index of the studied group is 1.18, while the average rate of the shoulders and the pelvis is respectively 76.25 and 64.2.

Table 7

Average rate of body building of the vaulters.

No.	Types of indicators by Wanky	Examined vaulters				Statistical quantities	
		L. M.	M.M.	D.E.	S.L.		
1.	Pointer Roher	1.24	1.12	1.17	1.19	M	1.18
2.	index shoulder, %	79.92	69.3	77.86	77.91	M	76.25
3.	indicator pelvis	61.08	67.66	64.95	63.14	M	64.2

The results of four vaulters' analysis showed the diversity of individual achievements (the standard deviation is 12.87). The best result belonged to D.E. 600 cm, and the lowest was by 29 cm lower (Ł.M.) (tab. 8).

Table 8

Pole vault results of "Group B" members.

No.	Performance test	Examined vaulters				Statistical quantities	
		Ł. M.	M.M.	D.E.	S.L.		
1	outcome of pole vault (cm)	571	580	600	575	M	581.5
						SD	12.87
						Min	571
						Max	600

Discussion

Interdependence of certain characteristics of somatic built with any parameter in determination of motor efficiency or with results of pole vault sets some differences, which took place in the studied group, as well as between certain vaulters. The researchers define this issue as rather complex one, eliminating the uniqueness of the individual dependence. [16]

By comparison, the height of body of the studied vaulters with the results of the studies of M. Napierała (2008), carried out in the area of the Kujawsko-Pomorskie Voivodeship, it appears that the studied vaulters at the age of 18 years are taller than their peers (M. Napierała: 18.5 years, 178,69cm). In addition, the comparison of body weight of the vaulters with the results of M. Napierała (2008), carried out in the area of the Kujawsko-Pomorskie Voivodeship, contributed to the finding that the studied vaulters have higher value of mean body weight. In the studies of M. Napierała (2008) it is as follows: M. Napierała 18.5 years 71.89 kg. It is interesting that height and weight of the vaulters obtaining the best results at the world level is very different, e.g. height of the body varies from 170 cm to 200 cm.

By comparing the results of the study of body slenderness, referred to Rohrer index of 17, 18, 19-year-old athletes, it can be noted that this index increases from the value of 1.15 (17-year-old) to 1.18 (19-year-old). The smooth growth of this index can occur under influence biological development period as well as under used training loads. It also affects growth of their muscle mass as well as width of hips, shoulders and volume parameters (e.g.: the circumference of thighs, drumsticks, arm). It is also associated with significantly slowed down increase of height of the body.

According to experts [5, 11], regularity in somatic built plays special role in terms of the efficiency of complex motor sequences (e.g., for pole vault), it is associated with their implementation, coordination and biomechanics of movement. The world's finest vaulters demonstrate this regularity.

Conclusions

- Analysis of the study results of the somatic built (17-19-year-old vaulters) showed large diversity, but much less it was seen in "Group A".
- "Group A" vaulters exceed 19-years'-old ones in average height and weight (up to 3.22 cm and 5.72 kg). In the widths of hips and shoulders the vaulters of 19 years' old age dominate. Other parameters, with the exception of the circumference of thighs, drumsticks and length of the torso, have higher values and belong to the vaulters of "Group A".
- "Group A" vaulters have better average results in pole vault (by 117.4 cm) than 19-years'-old vaulters.
- By comparing Rohrer index, indicating body slenderness of 17-18-19-year-old vaulters, fluent increase was noticed.
- The same average value of Rohrer index belonged to 19 years old vaulters and four vaulters of "Group A".
- Vaulters' group belonging to the "world's finest" was characterized by higher rate of shoulders than members of other studied groups.
- Vaulters of 17, 18 and 19 years old age have average score of pelvis higher than the Group of four vaulters (Ł.M., M.M., D.E., S.L.).
- It was found that results of pole vault indeed statistically correlate with only one sample (19-year-old vaulters /0.69/ - the volume of the chest, breathing out).
- Due to (inter alia) insufficient quantity of the studied persons the relationship between the somatic built and the result in the pole vault cannot be definitely stated.

There seems to be significant influence on sport technique and results in pole vault belonging to the proportions of the individual somatic features and here the relevant connections can be seen.

Conflict interests

The authors declare they have no conflict interests.

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DYSPRAXIA AS A PSYCHOMOTOR DISORDER OF SCHOOL AGE CHILDREN

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Abstract. *Purpose:* The purpose of the study was to define the epidemiology of dyspraxia among children from 6 to10 years' age, attending grades I-III of primary schools in Wrocław, Poland. *Material:* the study was conducted among pupils of primary schools in Wrocław, Poland. The studied groups included 48 girls and 52 boys. The study employed Polish version of Questionnaire for the screening assessment of dyspraxia's occurrence among children from 5 to 15 years' age (DCDQ-PL), as well as the Coordination Test for Children (KTK). *Results.* After assessing the occurrence of dyspraxia among studied children, it was found out that this disorder is present in the studied group. The prevalence of dyspraxia depends on studied children's gender; however, it is not related to their age. The results of tests, conducted with the DCDQ-PL and the KTK are consistent and confirm the observed inter-dependencies. *Conclusions.* Dyspraxia is a widespread psychomotor disorder, which can be diagnosed among children in the early school years. A diagnosis of a child's development with respect to this disorder should constitute a constant element of work for teachers and educationists dealing with children at this stage of education.
Key words: dyspraxia, psychomotor disabilities, diagnosis, education.

Introduction

Dyspraxia also called the *Developmental Coordination Disorder (DCD)* is a pervasive disorder. Dyspraxia cases are relatively widespread, affecting ca. 6-10%% of children (APA, 2000). In the majority of cases, this disorder is diagnosed for children at the school age, since at that time differences in a child's performance are the most noticeable in comparison to the peer group (Polatajko, Cantin, 2006).

DCD manifests with irregularities with respect to the development and motor functions of a child from the early age, which persist until adulthood (Kirby, Peters, 2010; Portwood 2000). Despite having an IQ within the accepted standards, a DCD child performs the majority of actions slower and worse than other children of the same age group, which frequently leads to irregularities in the emotional and social aspects of life, which in turn manifests itself in low self-respect, anxieties, difficulties in establishing relationships, improper interpersonal contacts, or avoidance of physical functioning, and - as a result – obesity and other somatic diseases. Researches define such consequences as the secondary dyspraxia impairments, which are as serious as the primary symptoms of this disorder (Cantell, Smyth, Ahonen,1994; Mandich, Polatajko, Rodger 2003).

It is not easy to diagnose dyspraxia due to the heterogenic character of its symptoms. Frequently, it is recommended that the diagnosis of the disorder should be done with the use of motor tests (Polatajko, Cantin, 2006). The most recommended are the Bruininks-Oseretsky Test of Motor Proficiency – Second Edition (BOT-2) and the Movement Assessment Battery for Children (MABC), whose sensitivity and specificity have been confirmed in numerous analyses (Bruninks, Bruininks, 2006; Henderson, Sudgen, 1992).

Due to the fact that the DCD symptoms include disorders observable in the daily performance of a child, researchers also deem it justified to apply screening tools for dyspraxia diagnosing (Wilson et al., 2000; Green et al., 2005; Schoemaker et al., 2006). They believe that such type of a diagnosis allows for colleting crucial information about the performance of a child observed in various daily situations, which is particularly important in the case of dyspraxia (Portwood, 2000).

For the purpose of making such a diagnosis, several questionnaires have been developed, of which the *Developmental Coordination Disorder Questionnaire (*DCDQ) is the most popular. It has already been used in many countries as an accurate and reliable instrument to diagnose dyspraxia. Currently, the study on the Polish cultural adaptation has been completed. The procedure has been successful, and the Polish results confirm the high validity and reliability of the analysis instrument.

The purpose of the study was to determine the epidemiology of dyspraxia among children from 6 to10 years of age, attending grades I-III of primary schools in Wrocław, Poland.

Material and Method

The study group comprised 100 parents of children from grades I-III of primary schools in Wrocław, Poland.

The study included all parents of pupils from randomly selected classes. Studied pupils were healthy and they had never been diagnosed with respect to any psychomotor development disorders. In the case of those children, parents and teachers did not observe any specific symptoms, which might indicate dyspraxia, although not all parents assessed highly the daily performance of their children. During discussions, some parents used phrases that their children were *clumsy, slow, avoid movement* or *do not have a feel for things.*

The study was conducted in two stages. In the first stage, parents filled in the DCDQ-PL. Parents received the questionnaire from class tutors and within two weeks they returned completed copies.

The second stage of the study was to test the children with the KTK test. This took place on three occasions, during the physical education classes. The examination was conducted by a person prepared to diagnose with the use of

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the KTK test.

The study employed the DCDQ-PL. The questionnaire includes 15 questions concerning the every day performance of the observed child. The questions are answered by parents, who fill in the Questionnaire. The child's performance is defined in the context of the performance of the child's peers. In each question, a parent may chose a score from 0 to 5, where 0 signifies "*not at all like my child",* and 5 signifies "*extremely like my child"*. The total score of the Questionnaire corresponds to the result of the child in the study and, according to its values, it may suggest a suspected dyspraxia or normal development of a child. The authors of the Questionnaire recommend that children with the lowest score should be subjected to a more detailed diagnosis to either exclude or confirm the developmental disorders.

The C*oordination Test for Kinder* (KTK) is a measure developed in 1974 by E. Kipharda and F. Schilling. High values of psychometric parameters of this test were confirmed in the research conducted by the authors in 2007, as well as by other researchers in the following years [15-19]. This test is designed for children from 5 to 15 years of age. It comprises four items: one-legged hopping, moving sideways on wooden boards, walking backwards along balance beam, and two-legged jumping from side to side.

The raw performance score is converted depending on the age and (in the case of two items) gender of the child. The assessment of the general motor coordination of the tested child is given in five categories, starting from the high-range to the impaired development.

Results

48 girls and 52 boys participated in the study. Mean age was 8.66 (SD 1.59); the age of girls (mean 8.7 SD 19.8) was not statistically significantly different from the age of boys (mean 8.62 SD 18.5) (Table 1).

Table 1.

Group size with mean ages and standard deviations (SD) (N=100)

	DCD		**non-DCD**		**Total**	
	Number	**Age**	**Number**	**Age**	**Number**	**Age**
Boys	12	8.75 (1.25)	14	8.58 (0.629)	52	6.49 (0.89)
Girls	7	9.10 (0.84)	15	8.62 (0.819)	48	6.78 (0.81)
Total	19	8.89 (1,36)	29	8.06 (0.72)	100	6,62 (1.59)

The score diversification is big and gender-related. Girls achieve statistically significant higher score than boys, which is shown in Table 2. According to the observations, in the girls' group, the number of children with the lowest score indicating suspected dyspraxia was smaller (n=7). In the studied girls' group the mean score was (67.7 points).

Table 2.

Mean DCDQ-Pl Scores by DCD, Age and Gender (n=100)

	With DCD				**Non DCD**			
	DCDQ-PL Total M(SD)	**Control during movement M (SD)**	**Fine motor/hand writing M (SD)**	**Gross motor M (SD)**	**DCDQ-PL Total M (SD)**	**Control during movement M (SD)**	**Fine motor/hand writing M (SD)**	**Gross motor M (SD)**
Boys n=48	46.2 (7.93)	14.45 (3.87)	15.6 (3.71)	16.4 (2.74)	65.39 (6.88)	21.23 (3.27)	22.03 (2.42)	21.77 (2.99)
Girls n= 52	48.91 (5.83)	15.84 (1.9)	17.23 (2.16)	16.23 (3.08)	67.7 (5.49)	21.25 (2.94)	23.05 (1.96)	22.99 (2.11)
Total n=100	47.27 (7.21)	15.0 (3.27)	16.24 (3.25)	16.33 (2.83)	66.59 (6.31)	21.24 3.08)	22.54 (2.25)	22.36 2.64)

Additionally, to verify the validity of the diagnosis made with the use of the DCDQ-PL among the girls, the group was subjected to the KTK, which is used in numerous studies as a valid and reliable test for diagnosing dyspraxia in children.

In the KTK, the majority of girls with the lowest score in the Questionnaire also scored the lowest results. Only in the case of three girls, the study with the use of the Questionnaire did not confirm the developmental disorders diagnosed with the KTK (Table 3).

In the Questionnaire test, the boys' group achieved a lower score than the girls (Table 2). The mean score of this group was 65.39 points and was statistically significantly different from the score achieved by the girls.

Also the number of boys with the lowest score, suggesting a risk of dyspraxia in their development, turned out to be higher than in the corresponding group of girls and amounted to 12 boys.

In the case of studied boys, the results of the additional KTK showed a larger number of boys with irregular

development that it was defined according to the Questionnaire (Table 3). In the case of 5 boys, the Questionnaire did not reveal any disorders.

Table 3.

Classification of DCD with the KTK compared to the DCDQ-PL

DCDQ	KTK		
	DCD	**Non DCD**	**Total**
DCD	24	0	24
Non DCD	8	68	76
Total	32	68	100

Discussion

A significant conclusion from the performed study is the difference in the development level of boys and girls. According to the observations, the development of boys in the early school years is slower in comparison to the development of girls, which was also shown in other studies [11, 14]. This regularity was also described by Kiphard and Schilling, who in the case of two items of their test applied different standards for boys and girls respectively [20].

The gender-related difference in the development level can be also observed in the group of children with diagnosed dyspraxia, where boys constitute the majority (n=12), achieving significantly lower scores that girls. An additional conclusion from the study is also the fact that dyspraxia is more frequent among boys, than among girls. This conclusion is in line with the research conducted by Portwood, who also observes higher epidemiology of dyspraxia among boys [6]. Also according to APA, the observed regularity is described as a peculiar characteristic of dyspraxia [1].

Differences in the psychomotor development of tested children were also confirmed with the KTK, where girls also achieved higher scores. The comparison of scores in both tests showed their high convergence, however the KTK has proven to be more sensitive. The high value of this parameter is typical for diagnostic tests, while it is not typical of screening tests, which allow to identify the most typical and intense symptoms of a specific disorder [12, 14].

However, the most important conclusion from the conducted research is the fact that now in Poland it is possible to apply the screening diagnosing for children with respect to the regularity of their development. In the past, such diagnosis was not possible due to the lack of diagnosing tools. As a result, many children with developmental disorders were not diagnosed and were not subjected to proper preventive or therapeutic measures. An important consequence of a lack of such a diagnosis is also a lack of information on the epidemiology of dyspraxia in Poland. Therefore, the problem was underestimated and frequently overlooked as a reason for school difficulties or failures. According to the study results, it is possible to see such opportunities with the application of the DCDQ-PL.

Conclusions

According to the conducted research, it was deemed to perform screening tests to diagnose children's dyspraxia in Polish schools. Such studies will help in economical, valid and reliable manner to identify children at risk with the disorder within the tested group, and as a result, to undertake deliberate and specialized actions related to a proper diagnosis and consequently a relevant therapy for such children. Researchers stress the fundamental importance of the child' age, when the discussed disorder is diagnosed, underlying the fact that the sooner it is diagnosed, the greater is the chance for a successful therapy addressing the preliminary symptoms of the disorder.

The results of conducted research clearly confirm that the screening assessment of a child's development is possible, which creates an opportunity to identify any irregularities.

In the studied group, as much as 19% of children subjected to the screening diagnosis were assessed as being at risk of dyspraxia. It is a significant percentage value, which confirms the importance of the analysed problem.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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MORPHOLOGICAL DIFFERENTIATION AND SPORT RESULTS OF MALE AND FEMALE WEIGHTLIFTERS

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Abstract. *Purpose* of this study was to analyze the types of body structure of elite Polish weightlifters of both genders, depending on their sports' achievements. *Material:* Somatic measurements of weightlifters were fulfilled during individual Junior and Senior National Championships. Overall, a total of 127 male athletes (66 juniors and 61 seniors) were examined, along with 63 female athletes (32 juniors and 31 seniors). The levels of endomorphism, mesomorphism, and ectomorphism were determined and compared to the reference values of adolescents and young adults who did not engage in any sports discipline. The scores achieved during the National Championships were converted into Sinclair scale points, and each athlete was classified into one of three categories of sports outcome (superior, intermediate, or poor). *Results:* The athletes were characterized by higher level of endomorphism and mesomorphism and lower level of ectomorphism than non-training individuals. This suggests that the level of body adiposity is not considered during the qualification and selection of examined weightlifters. Male seniors were the only group with lower adiposity than the reference group. Analysis of body structure in relation to sports results revealed a tendency towards increased mesomorphism and decreased ectomorphism associated with higher level of skills and training experience in studied men and women. This reflects the appropriateness of the training process. However, not all differences between analyzed groups proved statistically significant. *Conclusions:* Training methods and diet should be verified to reduce adiposity in athletes as aside from male seniors, this parameter proved higher than in the respective reference groups, and there was no tendency towards a decrease in this parameter in concert with age or sports level.
Key words: somatic type, weightlifting, ectomorphism, endomorphism, mesomorphism.

Introduction

High level of sport competition is associated with higher requirements faced by athletes and their coaching teams. Therefore, only a few athletes can achieve outstanding results in contemporary sports; this group includes individuals with superior motor skills, who are very well prepared with regards to fitness, technique, mentality, and theory, and are characterized by proper somatic predispositions. However, each sports discipline should possess a well-documented "model of champion", especially regarding body structure [13], as the same body weight can be associated with different percentage of muscle, adipose, and skeletal tissue. The fraction of various tissue components in the overall body weight plays an important role in athlete's body structure. Therefore, the aim of ongoing studies is to define the somatic predisposition of athletes who achieve outstanding results in various sports disciplines [4,8,9,16]. The review of literature dealing with the somatic characteristics of weightlifters [5,10,12,14,19,20] suggests that such athletes should be characterized by a proper proportion of body height and weight. Linear measurements, such as body height, are of lesser importance in the case of "weight" sports discipline. Consequently, individuals with lower values of linear measurements should be selected to lower weight categories, and the linear measurements should increase in concert with weight category. As regards the internal relationships pertaining to body structure, the most important features of weightlifters include large mass of active tissue manifested by outstanding endurance of the skeleton and well-developed muscular system (high mesomorphism), along with small adipose tissue content (low endomorphism). Therefore, the aim of this study was to analyze the types of body structure of superior Polish weightlifters of both genders depending on their sports achievements. The results of our study could be used as reference values during qualification and selection of candidates to this sports discipline.

Materials and Methods

Somatic measurements of weightlifters were fulfilled during individual Junior (up to 20 years of age) and Senior (above 20 years) National Championships. The best Polish athletes, including the members of the National Team, took part in this competition. Overall, a total of 127 male athletes were examined in 2005, among them 66 juniors and 61 seniors. The female athletes, 32 juniors and 31 seniors, were studied in 2006. The study included measurements required to estimate the type of body structure with Heath and Carter method [6]. The level of endomorphism was determined on the basis of the skin fold thickness on the arm, below the scapula, and over the hip. The level of mesomorphism was calculated from the elbow and knee width, arm and crural circumference, and the thickness of arm and crural skin folds. The analysis of ectomorphism was based on body height and weight, which were used to calculate the slenderness index. All measurements were taken prior to the warm-up on the day of the competition. This study also used the scores achieved during the competition, which were converted into Sinclair scale points [18], enabling the analysis of sports outcomes regardless of weight category. The characteristics of Sinclair points in each age category were presented as arithmetic means and standard deviations. Subsequently, each athlete was classified into one of three groups defined on the basis of arithmetic mean ± 0.5 standard deviation. This enabled us to identify three groups of athletes: group I characterized by the superior results in each age category (mean + at least 0.5 deviation (SD) from the Sinclair scale points), group II with intermediate results (mean – 0.5 SD to mean + 0.5 SD from the Sinclair scale

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points), and group III with the poorest results (mean – 0.5 SD from the Sinclair scale points). The number of athletes analyzed in various age categories is presented in Table 1, along with their biological age and sports results.

Table 1

Number of analyzed athletes in various age categories and their results expressed in Sinclair scale

Group of athletes	Total	Group I		Group II		Group III	
		n	points	n	points	n	points
Female juniors	32	10	from 155.35	14	from 135.06 to155.34	8	to 135.05
Male juniors	65	22	from 305.1	22	from 267.45 to 305.0	21	to 267.44
Female seniors	31	8	from 198.98	16	from 169.12 to 198.97	7	to 169.11
Male seniors	61	22	from 366.5	21	from 324.74 to 366.4	18	to 324.73
Total	189	62		73		54	

The statistical characteristics of groups defined on the basis of biological age and sports results were presented as arithmetic means and standard deviations. The results of this study were compared with the data obtained in non-training individuals. The results of male and female junior athletes were compared to the data of adolescents from Wroclaw [3], and the results of male and female senior athletes to the data of students from Zielona Gora University [1]. The statistical significance of differences between the body components of two groups was determined with the Student's t-test for independent variables, and the significance of differences between the structural body indices of three groups defined depending on age and sports result was analyzed with univariate ANOVA and the Newmann-Keuls test.

Results

The distribution of somatotypes amongst female and male weightlifters and non-training adolescents was presented on a somatogram (Figure 1). On the basis of this data, we concluded that our athletes were characterized by mesomorphic type of body structure. This corresponds to good development of musculature and high endurance of skeletal system. Female juniors were the only group which presented with structural endomesomorphy, indicating relatively high adiposity. The somatotypes of individuals from the reference groups placed within the central part of the somathogram, which is typical for similar values of all three analyzed structural components.

To perform detailed analysis of the body structure of weightlifters in relation to non-training adolescents, the values of endomorphism, mesomorphism, and ectomorphism were studied separately. The statistical characteristics of analyzed groups are presented in Table 2. Junior male weightlifters were characterized by the lowest level of mesomorphism, 2.69 on average, and were followed by male seniors (2.83). Women showed significantly higher average levels of this parameter, 4.44 and 4.89 in senior and junior athletes, respectively. Both in men and women, the levels of mesomorphism increased with age. Higher values of this parameter were observed in male senior athletes (6.05) as compared to juniors (5.26); similarly, female seniors scored better than the juniors with regards to the level of mesomorphism (5.21 vs. 4.93). Analysis of the latter parameter, i.e. ectomorphism, revealed that both male (2.09) and female juniors (1.81) were more slender than male (1.30) and female (1.61) senior weightlifters. The results of these comparisons suggest that athletes of all age and gender categories were characterized by higher levels of endomorphism and mesomorphism, and lower levels of ectomorphism as compared to relevant reference groups. With the exception of endomorphism in male juniors, which only slightly differed from that in non-training peers, the differences in all analyzed structural components proved significant at $p<0.01$.

The distribution of somatotypes of female and male weightlifters depending on their age category and sports results is presented in Figure 2. Female junior athletes achieving the worst sports results were the only group characterized by structural endomorphism, whereas their peers with intermediate achievements and the worst senior athletes represented structural endomesomorphism. The predominance of mesomorphism was observed in the remaining female athletes and all groups of male athletes. The details of the differences between various groups were revealed during further analysis of structural components.

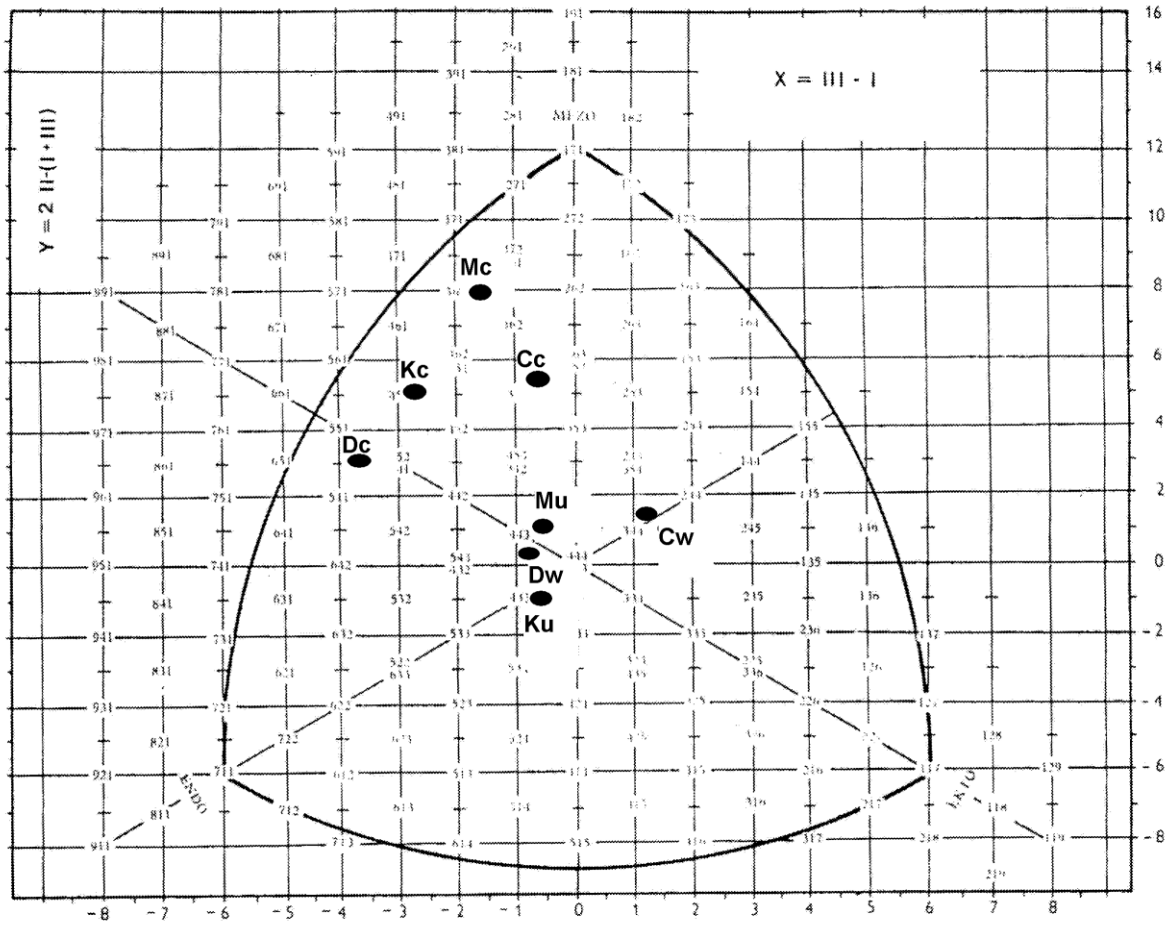

Fig. 1. Distribution of somatotypes amongst female and male weightlifters, adolescents from Wroclaw, and male and female students from Zielona Gora University. Kc – female seniors, Dc – female juniors, Mc – male seniors, Cc – male juniors, Ku – female students from Zielona Gora University, Dw – girls from Wroclaw, Mu – male students from Zielona Gora University, Cw – boys from Wroclaw.

Table 2

Type of body structure in female and male weightlifters depending on their biological age and in relation to non-training individuals

Parameter	Athletes			Reference group			t-value
	n	mean	SD	n	mean	SD	
	Female juniors			Women from Wroclaw			
Endomorphism	32	4.89	1.77	91	3.3	0.71	7.13*
Mesomorphism	32	4.93	1.48	91	2.94	0.89	9.03*
Ectomorphism	32	1.81	1.06	91	3.57	0.99	7.25*
	Male juniors			Men from Wroclaw			
Endomorphism	65	2.69	0.75	130	2.63	0.83	0.49
Mesomorphism	65	5.26	1.35	130	3.91	1.02	7.83*
Ectomorphism	65	2.09	0.95	130	3.74	1.02	10.95*
	Female seniors			Female students from Zielona Gora			
Endomorphism	31	4.44	1.74	95	3.64	0.84	3.44*
Mesomorphism	31	5.21	1.10	95	3.12	0.66	12.80*
Ectomorphism	31	1.61	0.98	95	3.08	1.23	6.05*
	Male seniors			Male students from Zielona Gora			
Endomorphism	61	2.83	1.35	43	3.53	0.76	3.07*
Mesomorphism	61	6.05	1.85	43	3.57	0.58	8.49*
Ectomorphism	61	1.30	0.59	43	3.00	1.11	10.12*

*$p<0.01$

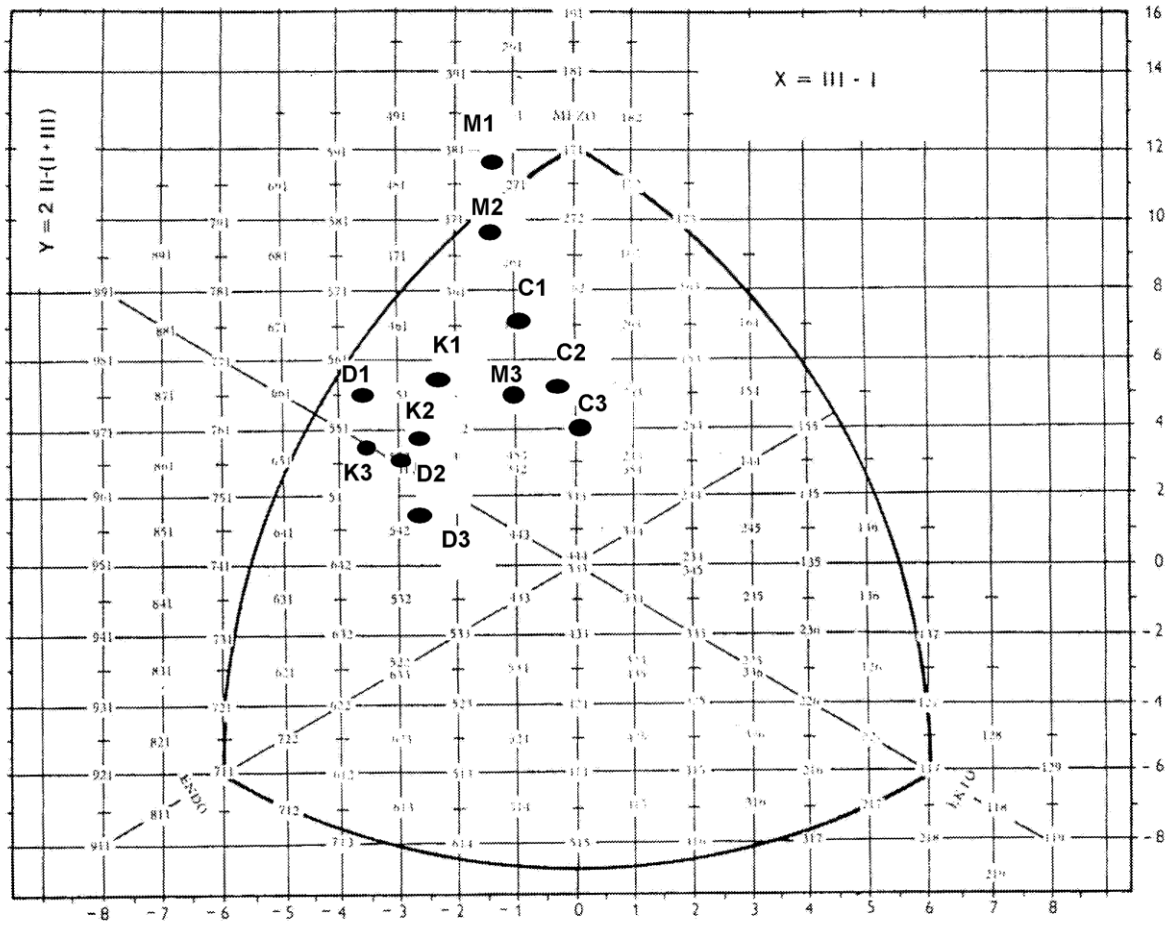

Fig. 2. Distribution of somatotypes amongst female and male weightlifters depending on their age category and sports results. K1 – group I female seniors, K2 – group II female seniors, K3 – group III female seniors, D1 – group I female juniors, D2 – group II female juniors, D3 – group III female juniors, M1 – groups I male seniors, M2 – group II male seniors, M3 – group III male seniors, C1 – group I male juniors, C2 – group II male juniors, C3 – group III male juniors.

Athletes with worst sports results were characterized by highest level of endomorphism, whereas the lowest values of this parameter were documented in outstanding senior athletes of both genders, as well as in male and female juniors presenting with moderate sports levels (Table 3). In all age categories, the level of mesomorphism was directly proportional to sport result. Therefore, the highest skeletal endurance and muscle mass were observed in outstanding athletes, while the worst athletes were characterized by the lowest level of mesomorphism. The lowest values of the latter analyzed parameter, i.e. ectomorphism, were documented in male and female athletes who received the highest scores in the Sinclair scale; the level of ectomorphism increased proportionally to the decrease in the result achieved during the National Championships. Female seniors representing sport group I and III were the only categories characterized by similar level of height to weight ratio.

Table 3

Types of body structure along with the statistical significance of differences in weightlifters depending on their sports results

Parameter	Group I	Group II	Group III	ANOVA	I-II	I-III	II-III
	Mean ± SD	Mean ± SD	Mean ± SD				
Female juniors							
Endomorphism	5.00±2.19	4.75±1.53	5.00±1.81	0.07	0.47	0.00	0.44
Mesomorphism	5.58±1.96	4.85±0.83	4.51±1.58	1.33	1.72	2.20	0.75
Ectomorphism	1.50±0.97	1.82±0.87	2.19±1.44	0.94	1.03	1.93	1.11
Male juniors							
Endomorphism	2.74±0.60	2.52±0.69	2.81±0.84	1.00	1.46	1.90	0.45
Mesomorphism	5.71±1.51	4.97±1.20	4.78±1.26	2.98	2.64	3.24	0.67
Ectomorphism	1.74±0.94	2.06±0.80	2.78±1.06	6.95*	1.62	5.15*	3.61*
Female seniors							
Endomorphism	3.69±2.19	4.63±1.51	4.86±1.68	1.04	1.77	1.84	0.41

Parameter	Group I	Group II	Group III	ANOVA	I-II	I-III	II-III
	Mean ± SD	Mean ± SD	Mean ± SD				
Mesomorphism	5.39±1.23	5.25±1.21	5.09±0.77	0.13	0.40	0.72	0.44
Ectomorphism	1.44±0.82	1.78±1.03	1.43±1.10	0.46	1.11	0.03	1.09
Male seniors							
Endomorphism	2.24±2.32	2.57±1.11	2.83±1.25	0.62	0.91	1.56	0.68
Mesomorphism	7.50±1.79	6.66±1.54	4.89±1.95	11.15*	2.21	6.60*	4.43*
Ectomorphism	0.93±0.59	1.21±0.63	2.06±0.90	13.35*	1.84	7.11*	5.29*

*statistically significant differences at the level of $p \leq 0.05$

The differences between analyzed structural components rarely proved significant on statistical analysis. The statistically significant differences were documented in the case of mesomorphism and ectomorphism of male seniors and ectomorphism of male juniors.

Discussion

The findings of our study can be employed during qualification and selection of candidates to weightlifting as well as during further training work. It should be remembered that weightlifting constitutes a discipline in which athletes compete in various "weight" categories. Therefore, both too slim silhouette and excessive obesity limit the amount of muscle mass; this proved to be the most important determinant of outstanding sport achievement amongst all other tissue components [2,7,11,20].

It should be emphasized that both men and women participating in our study were characterized by significantly higher endomorphism and mesomorphism, and significantly lower level of ectomorphism, as compared to the corresponding groups of peers who did not engage in any sports discipline. The only exception pertained to males of senior category, who showed lower adiposity than the reference group. The level of structural endomorphism documented in our athletes suggests that they still possess some reserve; it can be used for increasing muscle mass by reducing obesity or for preparing for competition in lower weight category due to the decrease in adipose tissue content. The results of previous studies by Saczuk et al. [17] suggest that in most female weightlifters reducing the adipose tissue content to the average level observed in non-training peers, would enable competing one (or even two) weight categories lower. High adiposity of examined athletes suggests that little attention was paid to this parameter during the sport selection process; moreover, it was not significantly modified during training. The content of adipose tissue could be reduced by physical exercise and proper, adjusted to energetic requirements, diet. These conclusions were further supported by the fact that the level of structural mesomorphism of examined athletes increased with age category, and the observation that the higher it was, the better were the results of male and female weightlifters. The increase in this structural component was not associated with a decrease in adipose tissue content, as suggested by the lack of statistically significant differences in this latter parameter. It should be emphasized that variable sport training enables obtaining proper body height to body weight ratio along with desired body composition, both predisposing athletes to outstanding achievements in a given sports discipline [2,11,15, 20].

Conclusion

The following conclusions and observations can be made on the basis of our findings.

1. The participants of National Weightlifting Championships were characterized by higher level of endomorphism and mesomorphism and lower level of ectomorphism than non-training individuals. This suggests that the level of body adiposity is not considered during the qualification and selection of examined athletes. Male seniors were the only group with lower adiposity than the reference group.
2. Analysis of body structure in relation to sports results revealed a tendency towards increased mesomorphism and decreased ectomorphism associated with higher level of skills and training experience in studied men and women. This reflects the appropriateness of the training process. However, not all differences between analyzed groups proved statistically significant.
3. Training methods and diet should be verified to reduce adiposity in athletes as aside from male seniors, this parameter proved higher than in the respective reference groups, and there was no tendency towards a decrease in this parameter in concert with age or sports level.

Conflict interests

The authors declare they have no conflict interests.

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