

FEATURES OF 14-15 YEARS' AGE BOYS' TRAINING TO PHYSICAL EXERCISES

Kapkan O.O.

Donbass State Machine-building Academy

Abstract. *Purpose:* to optimize modes of 14-15 years' age boys' training to physical exercises in educational process. *Material:* in experiment 14 years' age boys (n=24) and 15 years' old boys (n=24) participated. Plan of factorial experiment was used. *Results:* we detected influence of quantity of exercises' repetitions (X_1) and rest intervals (X_2) on effectiveness of physical exercises' training. Simultaneous varying of factors as per special program ensured studying of every of them in different conditions. It permitted to receive more reliable conclusions, suitable for changeable conditions. Results of dispersion analysis witness that for 14-15 years' age boys optimal modes of training are within 6-12 repetitions in one lesson with rest intervals 60-120 sec. In case of 14 years' age boys it is necessary to pay attention to quantity of exercises' repetitions in one lesson. Concerning 15 years age boys – attention should be paid to increase of rest intervals and consideration of interaction of these two factors. *Conclusions:* We have determined that increase of effectiveness of training process is possible on the base of analysis of regression models, calculation of optimal modes of physical exercises' fulfillment in process of their training.

Key words: simulation, regression models, physical exercises, modes of training.

Introduction

Analysis of scientific-methodic literature shows that it would be purposeful to concentrate attention at formation of motor function of secondary forms pupils [12, 13]. The works by O.V. Ivashchenko [1], O.M. Khudolii [6-8] are devoted to technologizing of learning process at school. Conceptual approaches to planning of experiment In researching of training process's effectiveness, working out of training models are substantiated in works by O.M. Khudolii, T.V. Karpunets [5], O.M. Khudolii, O.V. Ivashchenko [6], O.M. Khudolii [7]. In dissertation works of O.M. Khudolii, [10], O.V. Ivashchenko [2], V.I. Miroshnichenko [4] there are defined ways of training process's control. This control will be more effective, if orientation of training process is determined, considering modes of physical exercises' fulfillment. In our previous work we noted that increasing of training process is possible on the base of analysis of regression models, calculations of optimal modes of physical exercises' execution for 14-15 years' age girls at lessons of physical culture.

Thus, simulation of training process of secondary forms' pupils is rather important.

Purpose, tasks of the work, material and methods

The purpose of the works is to optimize modes of 14-15 years' age boys' training to physical exercises at physical culture lessons.

The methods and organization of the research: in this works we used analysis and generalization of scientific-methodic literature, pedagogic testing, methods of mathematical planning of experiment ($FFE 2^2$), pedagogic experiment; method of simulation.

Simulation in physical education is one of effective methods for searching and optimization of training process (S.S. Iermakov [1, 2, 3], O.M. Khudolii, S.S. Iermakov [13], O.M. Khudolii, O.V. Ivashchenko [7, 11, 12], O.M. Khudolii, [14]). Simulation of complex, holistic processes permits to better understand the studied phenomenon, cognate its content, determine correlations, mark out the most important components and so on. It is an effective mean of verifying validity and completeness of theoretical views about the researched object [11, 12, 16, 19, 20, 22, 23, 27, 28, 29, 30].

In the process of organization of our research we used conceptual approaches to planning of experiment, considering working out of training models. They were substantiated in works by O.M. Khudolii, O.V. Ivashchenko [7, 11, 12, 16, 18]. We determined certain ways for increasing of effectiveness of training process's control. It is possible with calculation of training modes through regression models, received as a result of full factorial experiment of $FFE 2^2$ type (see table 1). We studied modes of training of side roll, forward and backward rolls, forced headstand, throw of small ball, long jump from place.

The plan of factorial experiment permitted to study influence of quantity of repetitions (X_1) and rest intervals (X_2) on effectiveness of 14-15 years' old boys' training to physical exercises. Besides, we used complex approach to studying of objects, which admits simultaneous varying of several factors. Main target was to assess their influence and influence of their interactions. Simultaneous varying of factors by special program ensured studying of every of them in different conditions. It permitted to receive more reliable conclusions, suitable for changeable conditions.

Results of the research

For achievement of the best pedagogic effect in training of 14-15 years' age pupils to physical exercises we determined optimal correlations of quantity of repetitions (X_1) and rest intervals (X_2). In table 1 we present matrix of plan of full factorial experiment for studying of different modes of exercises' fulfillment influence on effectiveness of training. Lower and upper factors were received on the base of data of O.M. Khudolii, [5, 7] considering frames of lesson and requirements of Governmental program. Distinctions in methodic of lessons' conduct were determined by conditions of factorial experiment.

Table 1

Matrix of factorial experiment (type 2-²) for studying of influence of quantity of repetitions (X_1) and rest intervals (X_2) in one lesson on training of 14-15 years' age pupils.

№ of test	Elements of coded variables	
	X_1	X_2
1	6 –	60 –
2	12+	60 –
3	6–	120 +
4	12 +	120 +

As a result we detected regressive dependence of results of quantity of repetitions (X_1) and rest intervals (X_2) influence on training of 14-15 years' age boys to physical exercises in compliance with their age specificities (see table 2).

Table 2

Регресійна залежність результатів в процесі навчання фізичним вправам хлопців 14–15 років від впливу кількості повторів (X_1) та інтервалів відпочинку (X_2)

№	Description of exercises	Equation of regression for coded variables
14 years' age boys		
1	Side roll	$Y = 0.76 - 0.1 X_1$
2	Forward roll	$Y = 0.825 - 0.075 X_2$
3	Backward roll	$Y = 0.74 - 0.08 X_1 X_2$
4	Forced headstand	$Y = 0.77 - 0.08 X_1 + 0.09 X_1 X_2$
5	Throw of small ball	$Y = 0.865 + 0.075 X_1$
6	Long jump from the place	$Y = 0.775 - 0.065 X_1 + 0.065 X_1 X_2$
15 years' age boys		
1	Side roll	$Y = 0.845 - 0.065 X_2$
2	Forward roll	$Y = 0.765 - 0.045 X_1 + 0.045 X_2$
3	Backward roll	$Y = 0.79 - 0.06 X_1 X_2$
4	Forced headstand	$Y = 0.81 - 0.055 X_2$
5	Throw of small ball	$Y = 0.82 - 0.06 X_2 - 0.06 X_1 X_2$
6	Long jump from the place	$Y = 0.74 - 0.05 X_1 - 0.13 X_2$

Effectiveness of 14 years' age boys' training to "side roll" is influenced negatively by first factor (X_1), "forward roll" – by second factor (X_2), "backward roll" – by interaction of factors ($X_1 X_2$). Effectiveness of "forced headstand" training is negatively influenced by first factor (X_1) and positively influenced by interaction of factors ($X_1 X_2$). The fifth exercise "throw of small ball for distance" is positively influenced by first factor (X_1). The sixth exercise "long jump from place" is negatively influenced by first factor (X_1) and positively – by interaction of factors ($X_1 X_2$).

Thus, effectiveness of 14 years' age boys' training to physical exercises is influenced by quantity of repetitions in one lesson: increase of repetitions up to 12 times influences negatively on effectiveness of training process. Interaction

of quantity of repetitions and rest intervals influences positively on effectiveness of trainings. Level of exercise's mastering increases in case of reduction of quantity of repetitions to 6 times and increasing of rest interval to 120 sec. In training of "throw of small ball" quantity of repetitions shall be increased up to 12 times.

Training of 15 years' age boys to "side roll" is negatively influenced by second factor (X_2). Second exercise "forward roll" is negatively influenced by first factor (X_1) and positively – by second factor (X_2). Third exercise "backward roll" is negatively influenced by interaction of both factors (X_1X_2). Forth exercise "forced headstand" is negatively influenced by second factor (X_2). Fifth exercise "throw of small ball for distance" is negatively influenced by second factor (X_2) and by interaction of both factors (X_1X_2). Sixth exercise "long jump from place" is negatively influenced by first factor (X_1) and by second factor (X_2).

Thus, effectiveness of 15 years' age boys' training to physical exercises is influenced positively if quantity of repetitions in one lesson is reduced to 6 times. Interaction of quantity of repetitions and rest intervals influences on effectiveness of trainings. Level of mastering of exercises increases in case of repetitions' quantity reduction up to 6 times and rest interval increase up to 60 sec. ("backward roll", "throw of small ball")

Simultaneous varying of factors by special program permitted to assess influence of each of them in different conditions. Results of dispersion analysis of the used modes' influence on training of 14-15 years age boys are given in table 3.

Table 3

Results of dispersion analysis for FFE 2², concerning influence of quantity of repetitions (X_1) and rest intervals (X_2) on 14-15 years' age boys' training to physical exercises

Description of exercises	Relations of mean squares (%)		
	X_1	X_2	X_1X_2
14 years' age boys			
Side roll	98	0	0
Forward roll	3	86	9
Backward roll	1	27	71
Forced headstand	86	0	13
Throw of small ball	79	17	3
Long jump from place	42	2	54
15 years' age boys			
Side roll	0	94	5
Forward roll	79	10	10
Backward roll	0	20	80
Forced headstand	27	67	5
Throw of small ball	5	47	47
Long jump from place	0	2	97

In case of 14 years' age boys on effectiveness of training to "side roll" (98%), "forced headstand" (86%), "throw of small ball" (79%) priority influence is rendered by quantity of repetitions. Training of "forward roll" is mainly influenced by rest interval (86%). Effectiveness of "backward roll" (71%) and "long jump from place" (54%) is mainly influenced by quantity of repetitions and rest intervals.

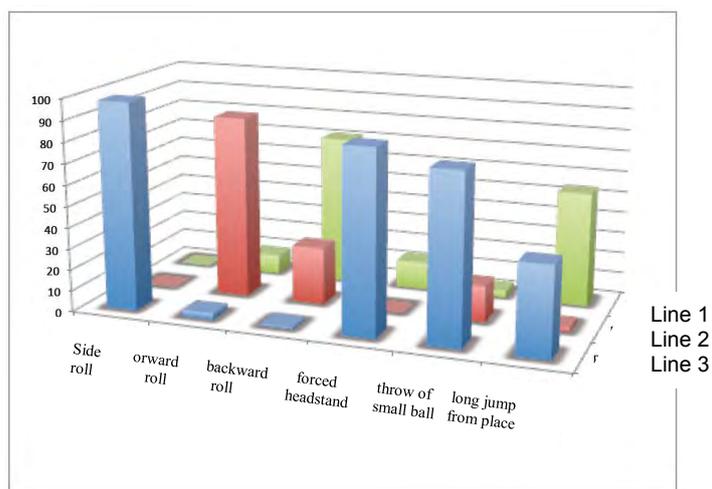


Fig.1. Diagram of relation of mean squares (%). 14 years' age boys: line1— X_1 (quantity of repetitions), line 2 — X_2 (rest interval), line 3 — X_1X_2 (interaction of quantity of repetitions and rest intervals)

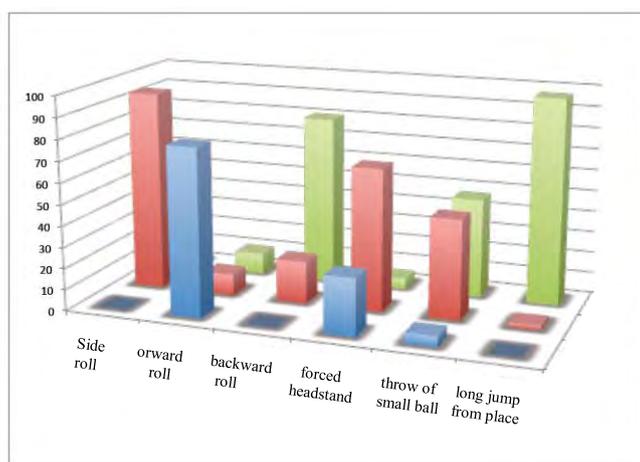


Fig.2. Diagram of relation of mean squares (%). 15 years' age boys: line1— X_1 (quantity of repetitions), line 2 — X_2 (rest interval), line 3 — X_1X_2 (interaction of quantity of repetitions and rest intervals)

In case of 15 years' age boys on effectiveness of training to "forward roll" depends on quantity of repetitions (79%); "side roll" (94%), "forced headstand" (67%), depends on rest interval; "backward rolls" (80%), long jump from place" (97%) depend on interaction of both factors.

Results of dispersion analysis witness that for 14-15 years age boys optimal modes of training are within 6-12 repetitions in one lesson with rest intervals of 60-120 sec. In case of 14-years' age it is necessary to pay attention to quantity of repetitions. In case of 15 years' age boys attention shall be paid to increase of rest intervals and consideration of both factors' interaction (see table 4).

Table 4

Comparative characteristic of the studied factors' influence on effectiveness of 14-15 years' boys' training

Description of exercises	Age	
	14 роки	15 роки
Side roll	X_1	X_2
Forward roll	X_2	X_1
Backward roll	X_1X_2	X_1X_2

Forced headstand	X_1	X_2
Throw of small ball	X_1	X_2
Long jump from place	X_1X_2	X_1X_2

Discussion

Results of the researches witness that in the offered matrix of factorial experiment's plan the chosen step of factors' varying is sufficient for studying of influence of different physical exercises' fulfillment modes on effectiveness of children's and adolescents' training (see table 1).

Our results widen and supplement the data of O.M. Khudolii and O.V. Ivashchenko [12, 16] about effectiveness of factorial experiments plans' application in researches of effectiveness of children's and adolescents' motor skills' training. In opinion of different authors [19, 36] usage of plans of factorial experiments in researches, involving children and adolescents facilitates increasing of quality of their indicators' assessment. Validity of full factorial 2^k type experiments' usage is confirmed by the data of Correa et.al. [20, 21].

The received data supplement information of different authors [22, 23, 26, 16] about increasing of effectiveness of training processes' control through regression models of training modes' determination.

Conclusions:

1. Experiment of 2^2 type permitted to study multi-factorial structure of 14-15 years' age pupils' training process; to specify optimal correlations of factors for their usage in period of physical exercises' training. They are objective tool of educational process's optimization.
2. In case of 14 years' age boys on effectiveness of training to "side roll" (98%), "forced headstand" (86%), "throw of small ball" (79%) priority influence is rendered by quantity of repetitions. Training of "forward roll" is mainly influenced by rest interval (86%). Effectiveness of "backward roll" (71%) and "long jump from place" (54%) is mainly influenced by quantity of repetitions and rest intervals.
3. In case of 15 years' age boys on effectiveness of training to "forward roll" depends on quantity of repetitions (79%); "side roll" (94%), "forced headstand" (67%), depends on rest interval; "backward rolls" (80%), long jump from place" (97%) depend on interaction of both factors.
4. Results of dispersion analysis witness that for 14-15 years age boys optimal modes of training are within 6-12 repetitions in one lesson with rest intervals of 60-120 sec. In case of 14-years' age it is necessary to pay attention to quantity of repetitions. In case of 15 years' age boys attention shall be paid to increase of rest intervals and consideration of both factors' interaction

The next task of our experimental researches is working out of methodic recommendations on organization and methodic of physical exercises' training at physical culture lessons for 14-15 years age pupils.

Acknowledgement

The research has been fulfilled in compliance with plan of scientific-research works of Ministry of education and science, youth and sports of Ukraine by topic 13.04 "Simulation of training process and development of children's and adolescents' motor skills" (2013-2014) (state registration number 0113U002102).

Conflict of interests

The author declares that there is no conflict of interests.

References:

1. Iermakov S. Modeli biomekhanicheskikh sistem v organizacii effektivnogo dejstviia sportsmena [Models of bio-mechanical systems in organization of sportsman's effective functioning]. *Pedagogics, psychology, medical-biological problems of physical training and sports* 2001;17:40-47. (in Russian)
2. Iermakov SS. Modeli rabochikh poz sportsmena kak faktor effektivnosti vypolneniia dvigatel'nykh dejstvij [Models of working postures as factor of effectiveness of motor actions' fulfillment]. *Fizicheskoe vospitanie studentov tvorcheskikh special'nostej* 2001;4:16-22. (in Russian)
3. Iermakov SS. Biomekhanichni modeli udarnikh rukhiv u sportivnikh igrakh u konteksti vdoskonalennia tekhnichnoi pidgotovki sportsmeniv [Bio-mechanical models of strike movements in context of perfection of sportsmen technical fitness]. *Teoriia ta praktika fizichnogo vikhovannia* 2010;4:11-18. (in Ukrainian)
4. Ivashchenko OV. Metodika navchannia gimnastichnim vpravam shkil'noi programi [Methodic of gymnastic exercises' training in school program]. *Teoriia ta praktika fizichnogo vikhovannia* 2001;1:26-31. <http://dx.doi.org/10.17309/tmfv.2001.1.7> (in Ukrainian)
5. Khudolii OM, Karpunec' TV. Planuvannia eksperimentu v doslidzhenni procesu pidgotovki iunikh gimnastiv [Planning of experiment in study of junior gymnasts' training]. *Teoriia ta metodika fizichnogo vikhovannia* 2002;4:2-8. <http://dx.doi.org/10.17309/tmfv.2002.4.73> (in Ukrainian)
6. Ivashchenko O. V. *Normativnye pokazateli trenirovochnykh nagruzok na nachal'nom etape podgotovki iunyh gimnastok 6-8 let. Cand. Diss.* [Normative indicators of training loads at initial stage of junior, 6-8 yrs., girl-gymnasts], Moscow; 1988. (in Russian)
7. Khudolii OM, Ivashchenko OV. Konceptual'ni pidkhodi do rozrobki programi naukovikh doslidzhen' u

- fizichnomu vikhovanni [Conceptual approaches to working out of program of scientific researches in physical education]. *Teoriia ta metodika fizichnogo vikhovannia* 2004;4:2—5. <http://dx.doi.org/10.17309/tmfv.2004.4.140> (in Ukrainian)
8. Khudolij OM. Navantazhennia u sportivnomu trenuvanni iunikh gimnastiv [Loads in sport training of junior gymnasts]. *Teoriia ta metodika fizichnogo vikhovannia* 2001;3:13-19. (in Ukrainian)
 9. Khudolij OM, Titarenko AA. Osoblivosti rozvitku rukhovikh zdibnostej u khlopchikiv molodshogo shkil'nogo viku [Peculiarities of motor abilities' development in junior school age boys]. *Teoriia ta metodika fizichnogo vikhovannia* 2010;8:3-12. <http://dx.doi.org/10.17309/tmfv.2010.8.644> (in Ukrainian)
 10. Khudolij OM. Zakonomirnosti rozvitku silovikh zdibnostej u fizichnomu vikhovanni i sporti. Povidomlennia II [Laws of strength training in physical education and sports. Report II]. *Teoriia ta metodika fizichnogo vikhovannia* 2011;2:19-34. <http://dx.doi.org/10.17309/tmfv.2011.2.690> (in Ukrainian)
 11. Khudolij OM, Ivashchenko OV. Informacijne zabezpechennia procesu navchannia i rozvitku rukhovikh zdibnostej ditej i pidlitkiv (na prikladi sportivnoi gimnastiki) [Informational provisioning of training process and development of children's and adolescents, motor skills (on example of calisthenics)]. *Teoriia ta metodika fizichnogo vikhovannia* 2013;4:3—18. <http://dx.doi.org/10.17309/tmfv.2013.4.1031> (in Ukrainian)
 12. Khudolij OM, Ivashchenko OV. Konceptual'ni pidkhodi do modeliuвання procesu navchannia i rozvitku rukhovikh zdibnostej u ditej i pidlitkiv [Conceptual approaches to simulation of training process and development of children's and adolescents' motor skills]. *Teoriia ta metodika fizichnogo vikhovannia* 2013;2:3—16. <http://dx.doi.org/10.17309/tmfv.2013.2.1012>(in Ukrainian)
 13. Khudolij OM, Iermakov SS. Zakonomirnosti procesu navchannia iunikh gimnastiv [Training process of junior gymnasts]. *Teoriia ta metodika fizichnogo vikhovannia* 2011;5:3—18. <http://dx.doi.org/10.17309/tmfv.2011.5.707> (in Ukrainian)
 14. Khudolij ON. Zakonomernosti formirovaniia dvigatel'nykh navykov u iunykh gimnastov [Regularities of motor skills' formation in junior gymnasts]. *Nauka v olimpijskom sporte* 2012;1:36—46 (in Russian)
 15. Khudolij OM, Ivashchenko OV, Chernenko SO. Chinniki, shcho vplivaiut' na efektyvnist' navchannia fizichnim vpravam khlopchikiv molodshikh klasiv [Factors, influencing on effectiveness of physical exercises' training of junior form boys]. *Teoriia ta metodika fizichnogo vikhovannia* 2013;1:21—26. <http://dx.doi.org/10.17309/tmfv.2013.1.1006>(in Ukrainian)
 16. Khudolij OM, Ivashchenko OV. *Modeliuвання procesu navchannia ta rozvitku rukhovikh zdibnostej u ditej i pidlitkiv* [Simulation of training process and development of children's and adolescents' motor skills], Kharkov: OVS, 2014. (in Ukrainian)
 17. Khudolij OM, Ivashchenko OV. *Teoriia ta metodika vikladannia gimnastiki* [Theory and methodic of gymnastic's training], Kharkov: OVS, 2014. (in Ukrainian)
 18. Khudolij OM, Ivashchenko OV. *Osnovi naukovo-doslidnoi roboti u fizichnomu vikhovanni i sporti* [Principles of scientific research work in physical education and sports], Kharkov: OVS, 2014. (in Ukrainian)
 19. García-Moya I, Moreno C, Jiménez-Iglesias A. Building a composite factorial score for the assessment of quality of parent-child relationships in adolescence. *European Journal of Developmental Psychology* 2012;10(5):642–648. <http://dx.doi.org/10.1080/17405629.2012.707781>
 20. Correa AA, Grima P, Tort-Martorell X. Experimentation order with good properties for 2k factorial designs. *Journal of Applied Statistics* 2009;36(7):743–754. <http://dx.doi.org/10.1080/02664760802499337>
 21. Correa AA, Grima P, Tort-Martorell X. Experimentation order in factorial designs: new findings. *Journal of Applied Statistics* 2012;39(7):1577–1591. <http://dx.doi.org/10.1080/02664763.2012.661706>
 22. Ivashchenko OV, Khudolij OM, Yermakova TS, Pilewska Wiesława, Muszkieta Radosław, Stankiewicz Błazej. Simulation as method of classification of 7-9th form boy pupils' motor fitness. *Journal of Physical Education and Sport (JPES)* 2015;15(1):142-147. <http://dx.doi.org/10.7752/jpes.2015.01023>
 23. Ivashchenko OV, Yermakova TS, Cieślicka M, Zukowska H. Discriminant analysis in classification of motor fitness of 9-11 forms' juniors. *Journal of Physical Education and Sport (JPES)* 2015;15(2):238 – 244. <http://dx.doi.org/10.7752/jpes.2015.02037>
 24. Milić M, Milavić B, Grgantov Z. Relations between sport involvement, selfesteem, sport motivation and types of computer usage in adolescents. *Anthropological Aspects of Sport, Physical Education and Recreation. Proceedings of 3rd International Scientific Congress*. Banja Luka: University of Banja Luka; 2011. p. 151-156.
 25. Gert-Jan de Bruijn and Benjamin Gardner. Active Commuting and Habit Strength: An Interactive and Discriminant Analyses Approach. *American Journal of Health Promotion* 2011;25(3):e27-e36. <http://dx.doi.org/10.4278/ajhp.090521-QUAN-170>
 26. Khudolij OM, Iermakov SS, Prusik K. Classification of motor fitness of 7-9 years old boys. *Journal of Physical Education and Sport (JPES)* 2015;15(2): 245 - 253. <http://dx.doi.org/10.7752/jpes.2015.02038>
 27. Lulzim I. Discriminant analysis of morphologic and motor parameters of athlete and non athlete girl pupils of primary school on age 14 to 15 years. *Research in Kinesiology* 2013;40(2):185-190.
 28. Meng FH, Li QL. Application of Data Mining in the Guidance of Sports Training. *Advanced Materials Research* 2013;765:1518-1523. <http://dx.doi.org/10.4028/www.scientific.net/AMR.765-767.1518>
 29. Merala R, Piziali RL. *Water ski binding release loads: Test method and results. Skiing Trauma and Safety*, Tenth

- Volume, ASTM STP 1266, Mote CD Jr, Johnson RL, Hauser W, Schaff PS (eds), American Society for Testing and Materials, Philadelphia, PA; 1996. p. 361–379.
30. Kirk D. Physical Culture, Physical Education and Relational Analysis. *Sport, Education and Society* 1999;4(1):63–73.
 31. Hongliang W. Data analysis for sports training based on information technology. *Information Technology and Industrial Engineering* 2013;48:411.
 32. Wu L. The Application of Basketball Coach’s Assistant Decision Support System. *Journal of Theoretical and Applied Information Technology* 2013;49(3)120-125.
 33. Dorita Du Toit, Anita E, Pienaar & Leani Truter. Relationship between physical fitness and academic performance in south african children. *SAJR SPER* 2011;33(3):23-35.
 34. Geoffrey D, Broadhead And Gabie E Church. Discriminant analysis of gross and fine motor proficiency data. *Perceptual and Motor Skills*: 1982;55:547-552. doi: <http://dx.doi.org/10.2466/pms.1982.55.2.547>
 35. Rink Judith. Teacher perceptions of a physical education statewide assessment program. *Research quarterly for exercise and sport* 2007;78(3):204-215.
 36. Wang A, Karns JT, Meredith W. Motivation, Stress, Self-Control Ability, and Self-Control Behavior of Preschool Children in China. *Journal of Research in Childhood Education* 2003;17(2):175–187. <http://dx.doi.org/10.1080/02568540309595008>
 37. Wright Steven. A compatative view of teaching practice in Physical Education. *International Sports Studies* 1999;21(1):55-68.

Information about the author:
Kapkan O.O.; http://orcid.org/0000-0003-4320-4276 ; tmfv@tmfv.com.ua; Donbass State Machine-building Academy; st. Shkadinova, 72, Kramatorsk, Donetsk region, 84313, Ukraine.
Cite this article as: Kapkan O.O. Features of 14-15 years’ age boys’ training to physical exercises. <i>Pedagogics, psychology, medical-biological problems of physical training and sports</i> , 2015;9:26-32. http://dx.doi.org/10.15561/18189172.2015.0904
The electronic version of this article is the complete one and can be found online at: http://www.sportpedagogy.org.ua/html/arhive-e.html
This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (http://creativecommons.org/licenses/by/3.0/deed.en).
Received: 26.06.2015 Accepted: 18.07.2015; Published: 20.07.2015