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Differentiated approach to physical education of adolescents with different speed of biological development

ANDRII SITOVSKIY¹, BORYS MAKSYMCHUK², VASYL KUZMENKO³, YULIYA NOSKO⁴, ZORYANA KORYTKO⁵, OLGA BAHINSKA⁴, OKSANA MARCHENKO⁶, VALERII NIKOLAIENKO⁶, TETIANA MATVIICHUK⁵, VALERIY SOLOVYOV⁵, OKSANA KHURTENKO², NINA SLYUSARENKO⁷, IRYNA ZHOROVA³, IRYNA MAKSYMCHUK^{8,9}

¹Recreational Technology and Law Academy, Lutsk, UKRAINE

²Vinnitsia Mykhailo Kotsiubynskyi State Pedagogical University, Vinnitsia, UKRAINE

³Communal Higher Educational Establishment «Kherson Academy of Continuing Education» of Kherson Regional Council, UKRAINE

⁴Taras Shevchenko National University “Chernihiv Collegium”, UKRAINE

⁵Lviv State University of Physical Culture, UKRAINE

⁶National University of Physical Education and Sport of Ukraine, UKRAINE

⁷Kherson State University, UKRAINE

⁸Mariupol State University, Mariupol, UKRAINE

⁹Vinnitsia Cooperative Institute, Vinnitsia, UKRAINE

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Abstract

Aim: to justify and experimentally verify the methodology of differentiated approach to developing motor skills of seventh-graders depending on paces of their biological development. **Material:** 304 schoolchildren (148 boys and 156 girls), seventh-graders from the general education school No 20 in Lutsk, participated in the formative pedagogical experiment. The control group consisted of 99 boys and 105 girls and the experimental group – 49 boys and 51 girls, who were classified into the main medical group for health reasons and were not involved in sports sections. **Results:** It was found that schoolchildren with different levels of biological development within one age-sex group differ significantly in terms of the cardiorespiratory system capacity, physical performance and physical fitness. Therefore, the authors designed the methodology for allocating educational time to develop motor skills of seventh-graders during physical education lessons depending on paces of their biological development under the conditions of three physical education lessons per week. **Conclusions:** this methodology of differentiated approach to allocating educational time to develop motor skills of seventh-graders is an effective means for differentiated physical education of adolescents, which is reflected in the increase in the level of physical fitness and performance in seventh-graders during the pedagogical experiment.

Keywords: motor skills, quantitative estimation of biological age, differentiated physical training, differentiated assessment of physical fitness..

Introduction

According to the existing data, the body functioning during adolescence is determined by biological development rather than the calendar age. Individual acceleration and retardation of biological development is followed by significant variability of morphofunctional maturity, physical performance and fitness of adolescents. Different paces of adolescents' physical development during this period create a peculiar set of individual quantitative and qualitative features of development (Farber, 1988; Halaidiuk, & Maksymchuk, 2018). Individual features of adolescents' biological development are determined by different learning abilities (Ermakov, 1996; Hlazyrin, 1999; Nikityuk, Musagalieva, & Savchenko, 1990; Serhienko, 1993; Volkov, 2002). In relation to pubertal processes in the body of the adolescent, individual advances or deficiencies in biological, functional and motor development can reach on average up to 5 years (Bakhraev, & Dorokhov, 1991; Chyzyk, 1999; Maksimov, 1994; Shakhanova, 1997; Volkov, 1988).

Programmes for physical education in general education schools are aimed at average schoolchildren and do not take into account the characteristics of adolescence development (Andrieieva, 2002; Kuts, 1997; Mytchuk, 2002).

It is therefore of practical interest to design the methodology of differentiated physical education and assessment of adolescents' physical fitness based on the estimation of the biological age and individual paces of morphofunctional and motor development associated with it (Korobeinikov, Korobeinikova, Nenasheva, & Tsaiptuk, 2002; Krustevych, 2000a; 2000b; Pryimak, 2003; Serhienko, 1993; Volkov, 2002).

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Corresponding Author: BORYS MAKSYMCHUK, E-mail: 0674256781@ukr.net

The issue of differentiated physical education taking into account individual morphofunctional development and physical fitness was studied by many scholars (Hasiuk, 2003; Krustevych, 2000a; Leonova, & Kuts, 1996; Sidorova, 1998; Tsos, 1994). However, these studies did not take into account hormonally dependent development paces, in particular the paces of adolescents' biological development which are important in this period. The study on the differentiation of physical activity and assessment of adolescents' physical fitness taking into account paces of their biological development are normally aimed at individual age-sex groups of schoolchildren, in particular boys aged between 15 and 17 (Filchenkov, 1994; Hlazyrin, 2003), girls aged between 12 and 13 (Andrieieva, 2002; Krustevych, 2000b), adolescents aged between 13 and 14 (Maksimov, 1994). Some studies are dedicated to the differentiation of physical activity in sports (Shakhanova, 1997; Volkov, 2002).

Taking into account individual peculiarities of development and the body of every adolescent will make it possible to use adequate methods of physical education to enhance his/her motor skills. Inadequate ones can negatively affect adolescents' health, which will eventually slow down paces of their physical development and decrease their interest in physical education lessons (Apanasenko, & Popova, 1998; Blahii, & Cherniavskiy, 2005; Sukharev, 1991; Volkov, 2002).

L. Volkov (2002) distinguishes the following activity levels of motor skills development: high activity – the annual increase amounts to more than 3%; average activity – the annual increase ranges from 0 to 3%; low activity – one can observe some decreasing trends.

Therefore, it is necessary to develop organizational and methodological approaches to differentiated physical education of adolescents in modern schools.

Hypothesis. In adolescence, the level of physical development and the indicators of same-age adolescents' physical fitness largely differ and depend on paces of their biological development. Therefore, it is essential to justify the methodology of differentiated physical training taking into account biological development of seventh-graders, which will make it possible to specify the intensity of motor activity during physical education lessons.

Thus, *the current research attempts* to justify and experimentally verify the methodology of differentiated approach to developing motor skills of seventh-graders depending on paces of their biological development.

Materials and methods

Participants. The formative pedagogical experiment involved 304 schoolchildren (148 boys and 156 girls) aged between 12 and 13 from general education schools. The control group consisted of 99 boys and 105 girls and the experimental group – 49 boys and 51 girls, who were classified into the main medical group for health reasons and were not involved in sports sections.

Organization. The research was conducted in the laboratory of functional diagnostics at the Institute for Physical Culture and Health of Lesia Ukrainka Volyn State University and on the experimental site. The degree of puberty development in the schoolchildren was assessed by an andrologist and a gynecologist.

The degree of biological development was assessed by the level of puberty development. The scheme for a complex assessment of the biological age is composed based on creative processing of certain schemes (Krustevych, 2006; Chizhyk, Romanyuk, Sitovsky, & Chizhyk, 2002) using the regression analysis method.

The experiment involved four stages. Each of them solved a part of interrelated tasks determined in accordance with the general logic of the research design.

Physical education lessons in the control group (CG) and the experimental group (EG) were conducted three times a week (on Monday, Wednesday and Friday). The CG followed the general state programme. In the EG, educational time was distributed according to the changes in the development of the schoolchildren's motor skills during the school year and paces of their biological development. The training method mainly used in the EG was the group one. Group 1 included low-performing schoolchildren, who lag behind the biological age by one or more years compared to their peers. Group 2 included average schoolchildren with the average biological age for this sample (± 1 year). Group 3 included high-performing schoolchildren, who outpace their peers by one or more years in the biological age.

The current research suggests the following distribution of educational time allocated for developing motor skills in the schoolchildren aged between 12 and 13 in the structure of the annual plan and physical education lessons: 15% of the total time should be allocated to the development of those motor skills, which assume high activity level during the school year; 35% of the total time should be allocated to the development of those motor skills, which assume average activity level during the school year; 50% of the total time should be allocated to the development of those motor skills, which assume low activity level during the school year (see Table 1). More time should be allocated to the development of those motor skills, which tend to deteriorate during the school year and are characterized by a low pace of development.

It should be noted that there is practically no data on the dynamics of the cardiorespiratory system

capacity, physical capacity and physical fitness during the school year, especially in terms of paces of adolescents' biological development. Therefore, the effectiveness of the suggested methodology for differentiated approach to allocating educational time to develop motor skills of schoolchildren aged between 12 and 13 years in accordance with paces of their biological development was analyzed based on the relative increase in the indicators under study during the school year and was compared with that in the CG.

The cardiorespiratory system functional capacity was studied to monitor the adaptation to physical activity. The obtained indicators were compared between the schoolchildren in the CG and the EG, as well as with the data obtained by other researchers.

Table 1

Planning educational time for training certain motor skills in the schoolchildren aged between 12 and 13

Girls										
Group	Motor skills									Symbols
	Speed	Strength	Coordination	Endurance	Speed strength	*Dynamic strength endurance	**Dynamic strength endurance	Static strength endurance	Flexibility	
Relative educational time for training certain motor skills during the school year according to the suggested scheme of educational time distribution, tr, %										Σt_r
Low-performing schoolchildren	15	15	15	50	50	15	50	15	50	275
Average schoolchildren	35	15	35	50	50	15	50	50	50	350
High-performing schoolchildren	35	15	15	35	15	15	50	50	50	280
Adjusted relative educational time for training certain motor skills during the school year, t adj., %									$\Sigma t_{adj.}$	
Low-performing schoolchildren	5	5	5	18	18	5	18	5	18	100
Average schoolchildren	10	4	10	14	14	4	14	14	14	100
High-performing schoolchildren	13	5	5	13	5	5	18	18	18	100
Boys										
Relative educational time for training certain motor skills during the school year according to the suggested scheme of educational time distribution, tr, %										Σt_r
Low-performing schoolchildren	50	15	35	50	50	15	50	50	15	330
Average schoolchildren	35	15	15	50	15	15	50	15	35	245
High-performing schoolchildren	15	15	15	15	15	15	15	15	15	135
Adjusted relative educational time for training certain motor skills during the school year, t adj., %									$\Sigma t_{adj.}$	
Low-performing schoolchildren	15	5	11	15	15	5	15	15	5	100
Average schoolchildren	14	6	6	20	6	6	20	6	14	100
High-performing schoolchildren	11	11	11	11	11	11	11	11	11	100

Notes: * – dynamic strength endurance according to the test “Sit-ups”;
 ** – dynamic strength endurance according to the test “Chin-ups”.

Statistical analysis. The absolute time of physical activity is determined provided that the obtained relative values are adjusted depending on the number of motor skills, which are expected to be developed during the school year (or within the structure of one lesson), based on formulas 1 and 2:

$$t_{adj.} = \frac{t_r}{\sum t_r} \times 100. \quad (1)$$

where $t_{adj.}$ – adjusted time, t_r – relative educational time allocated for training certain motor skills determined by the suggested scheme for the distribution of physical activity duration; $\sum t_r$ – the amount of relative educational time allocated for each motor skill as defined by the annual plan (or by the objectives of one lesson).

In accordance with relative educational time allocated for training each motor skill, its absolute value can be determined in hours or minutes based on formula 2:

$$t_{absr.} = \frac{t_{adj.} \times t_{int.}}{100}. \quad (2)$$

where $t_{absr.}$ – time (hours) allocated for intentional impact on the development of certain motor skills during the school year; $t_{adj.}$ – adjusted time; $t_{int.}$ – the total time of intentional impact on the development of motor skills in the annual plan (or within one lesson).

In the same way, one can calculate educational time allocated for training certain motor skills in the structure of one lesson.

Thus, the lesson assumes intentional impact on the development of speed, strength, coordination skills and endurance. Accordingly, it is expedient to allocate 35% of the total time to the development of speed skills in girls with the average pace of biological development, another 35% of the total time – with the accelerated pace of biological development; 15% of the total time – with the slow pace of biological development. In relation to the development of strength skills, 15% of the total time should be allocated to their development in all three groups. As for coordination skills, it is important to allocate 35% of the total time to their development in children with the average pace of biological development, 15% of the total time – with the accelerated pace of biological development and another 15% – with the slow pace of biological development. Accordingly, 50% of the total time should be allocated to the development of endurance skills in children with the average pace of biological development, 50% of the total time – with the accelerated pace of biological development and another 50% – with the slow pace of biological development (see Table 2).

Table 2

Planning educational time for training certain motor skills in girls aged between 12 and 13 in the structure of one lesson

Group	Motor skills				Symbols
	Speed	Strength	Coordination	Total endurance	
Relative educational time for training certain motor skills in the structure of one lesson, t_r %					$\sum t_r$
Low-performing schoolchildren	15	15	15	50	95
Average schoolchildren	35	15	35	50	135
High-performing schoolchildren	35	15	15	35	100
Adjusted educational time for training certain motor skills in the structure of one lesson, $t_{adj.}$ %					$\sum t_{adj.}$
Low-performing schoolchildren	16	16	16	53	100
Average schoolchildren	26	11	26	37	100
High-performing schoolchildren	35	15	15	35	100
Educational time allocated for intentional impact on the development of certain motor skills in the structure of one lesson, $t_{int.}$ min					$\sum t_{int.}$ (min)
Low-performing schoolchildren	6	6	6	18	35
Average schoolchildren	9	4	9	13	35
High-performing schoolchildren	12	5	5	12	35

The total time needed to develop the four motor skills is allocated as follows: 95% – low-performing schoolchildren, 135% – average schoolchildren, 100% – high-performing schoolchildren. These values are adjusted based on the formulas 1 and 2. Consequently, it is possible to obtain the duration of intentional impact on the development of motor skills in the structure of one lesson in minutes.

Provided that the main part of the lesson is 35 minutes, 6 minutes is allocated to the development of speed, strength and coordination skills and 18 minutes – to endurance skills in the group with low-performing schoolchildren; 9 minutes is allocated to the development of speed and coordination skills, 4 minutes – to strength skills and 13 minutes – to endurance skills in the group with average schoolchildren; 12 minutes is allocated to the development of speed and endurance skills and 5 minutes – to strength and coordination skills in the group with high-performing schoolchildren.

Thus, the duration of intentional impact on the development of motor skills in the structure of the annual plan and physical education lessons largely depends on paces of schoolchildren's biological development.

It should be noted that low-performing schoolchildren have more time to develop motor skills than high-performing ones. Still, this approach is entirely justified, since the obtained results show that it is the low-performing boys and girls, whose functional capacity of the body at the beginning of the school year is most optimal. Indeed, they show markedly lower indicators of adaptive potential of blood flow, Robinson index, heart rate and higher indicators of birth-death ratio and physical activity than high-performing schoolchildren.

Therefore, the suggested scheme of educational time distribution makes it possible to develop motor skills in the schoolchildren aged between 12 and 13 taking into account the individual characteristics of motor skills development, especially paces of their biological development.

Nowadays, the methods and approaches to differentiating quantitative and qualitative parameters of assessment are insufficiently justified and do not meet modern requirements (Mudryk, Oliinyk, Prykhodko, & Ashanin, 2002). Some scholars indicate that regulatory requirements are calculated based on the average indicators and do not take into account the individual characteristics of schoolchildren, although the representatives of one age group are not homogeneous in terms of morphofunctional development, physical capacity and physical fitness (Blahii, & Cherniavskiy, 2005; Pryimak, 2003; Sitovskiy, 2005a; 2005b; 2005c; 2005d).

Therefore, it is necessary to take into account the individual characteristics of schoolchildren, which determine final results. It is suggested to assess physical fitness of children aged between 12 and 13 taking into account paces of their biological development (Sitovskiy, 2005a; 2005b; 2005c; 2005d). In order to assess the dynamics of motor skills development during the school year, tests should be conducted at the beginning and at the end of the school year. Physical fitness was assessed based on the 12-point system. Physical fitness standards based on the 12-point system were distributed in accordance with the results of percentile analysis by S. Glants.

Results

It is proved that the suggested methodology of differentiated approach to allocating educational time to develop motor skills of children aged between 12 and 13 is an effective means of differentiated physical education of adolescents, which is reflected in the increase in the level of physical fitness and physical performance in the schoolchildren aged between 12 and 13 during the pedagogical experiment (see Tables 3 and 4).

Table 3

Changes in physical fitness of boys aged between 12 and 13 during the pedagogical experiment depending on paces of their biological development, %

Motor skills, type of assessment	CG			EG		
	Low-performing schoolchildren	Average schoolchildren	High-performing schoolchildren	Low-performing schoolchildren	Average schoolchildren	High-performing schoolchildren
Strength skills, hand strength	+61,1***	+60,2***	+16,6**	+84,9***	+66,1***	+36,7***
Flexibility skills, seated forward bend	+6,3	+0,7	+29,4**	+12,1	+16,1	+35,9**
Speed strength skills, broad jump	-0,2	+5,0*	+8,4***	+11,7**	+7,8**	+9,7**
Dynamic strength endurance, sit-ups	+6,2	+21,2***	+44,4***	+11,3	+24,0***	+38,5***
Speed skills, 30-meter sprint	+4,8**	0	-7,2*	-4,9*	-5,7***	-8,9*
Total endurance, 6-minute sprint	-8,9**	-1,2	+21,3***	+13,7***	+8,1**	+22,1***
Coordination skills, shuttle run 4×9	-0,7	-4,6***	-9,4***	-6,8***	-5,3***	-9,7***
Physical performance	-14,3*	-6,7	+1,1	+7,6	+17,8**	+17,2**

Notes: * – $p < 0,05$; ** – $p < 0,01$; *** – $p < 0,001$.

It is found that strength skills have increased by 84.9% ($p < 0.001$) in low-performing boys, by 66.1% ($p < 0.001$) in average boys, by 36.7% ($p < 0.001$) in high-performing boys and respectively by 31.0% ($p < 0.01$), 37.0% ($p < 0.001$) and 30.5% ($p < 0.01$) in girls; flexibility skills – by 12.1%, 16.1% and 35.9% ($p < 0.01$) in boys

and by 4.9%, 7.9% and 9.9% in girls; speed strength skills – by 11.7% ($p < 0.01$), 7.8% ($p < 0.01$) and 9.7% ($p < 0.01$) in boys and by 4.4%, 4.6% and 6.9% in girls; coordination skills – by 6.8% ($p < 0.001$), 5.3% ($p < 0.001$) and 9.7% ($p < 0.001$) in boys and by 11.2% ($p < 0.001$), 4.8% ($p < 0.001$) and 8.0% ($p < 0.001$) in girls; speed skills – by 4.9%, 5.7% ($p < 0.01$) and 8.9% ($p < 0.001$) in boys and by 6.7% ($p < 0.05$), 7.1% ($p < 0.001$) and 7.9% ($p < 0.01$) in girls; endurance skills – by 13.7% ($p < 0.001$), 8.1% ($p < 0.01$) and 22.1% ($p < 0.001$) in boys and by 15.5% ($p < 0.05$), 19.4% ($p < 0.001$) and 15.5% ($p < 0.01$) in girls. The results obtained from the pedagogical experiment show that physical fitness of schoolchildren aged between 12 and 13 corresponds to high and average levels.

During the pedagogical experiment, relative physical performance of EG boys has improved in three groups (by 7.6%, 17.8% and 17.2% respectively). In relation to average and high-performing boys, however, the indicators are statistically significant. Relative physical performance of EG girls has improved by 15.0%, 7.1% and 8.3% respectively. Physical performance of CG boys has decreased during the school year, both in absolute ($p > 0.05$) and relative ($p < 0.05$) values. In relation to CG girls, one can observe a significant decrease in physical performance ($p < 0.001$).

Table 4

Changes in physical fitness of girls aged between 12 and 13 during the pedagogical experiment depending on paces of their biological development, %

Motor skills, type of assessment	CG			EG		
	Low-performing schoolchildren	Average schoolchildren	High-performing schoolchildren	Low-performing schoolchildren	Average schoolchildren	High-performing schoolchildren
1	2	3	4	5	6	7
Strength skills, hand strength	+22,2	+26,2***	+13,0*	+31,0**	+37,0***	+30,5**
Flexibility skills, seated forward bend	-15,0	-10,7*	-2,1	+4,9	+7,9	+9,9
Speed strength skills, broad jump	-2,4	-2,5	+4,2	+4,4	+4,6	+6,9
Dynamic strength endurance, sit-ups	+15,7**	+7,5	+27,7***	+13,4	+10,8	+29,3**
Speed skills, 30-meter sprint	-4,3	-2,7*	-0,5	-6,7*	-7,1**	-7,9**
Total endurance, 6-minute sprint	-5,4	-7,2***	+2,1	+15,5*	+19,4***	+15,5**
Coordination skills, shuttle run 4x9	-9,2***	-2,6**	-4,4***	-11,2***	-4,8**	-8,0***
Physical performance	-16,0*	-15,3***	-18,2**	+15,0***	+7,1**	+8,3***

Notes: * – $p < 0,05$; ** – $p < 0,01$; *** – $p < 0,001$.

In the context of speed and speed strength indicators, physical performance of EG schoolchildren is at appropriate level, whereas it is at rather low and average levels in the CG. The progress in physical fitness of EG boys is assessed as excellent in three groups. In relation to EG girls, it is assessed as good in low-performing and average girls and as excellent in high-performing girls. It should be noted that during the school year low- and high-performing EG boys have shifted from average to high level of physical fitness, average boys – from appropriate to high level of physical fitness. EG girls have shifted from average to appropriate level in all three groups. In the CG, the progress in physical fitness in girls from all three groups and low-performing and average boys is assessed as unsatisfactory.

It is proved that almost all indicators of somatic development in schoolchildren aged between 11 and 16 have significantly closer ($p < 0,05-0,001$) correlations with the biological age than with the chronological one. This dependence is also observed between individual parameters of the cardiorespiratory system capacity and the biological age. Almost all indicators of physical fitness in boys and girls reliably correlate with the biological age. However, this dependence is more pronounced in boys than in girls.

It is found that schoolchildren with different levels of biological development within one age group differ in terms of the cardiorespiratory system capacity, physical fitness and performance both at the beginning and at the end of the school year. Reliable ($p < 0,05-0,001$) differences were found between high- and low-performing boys in terms of heart rate, blood pressure, Robinson index, adaptive capacity of blood flow, systolic blood pressure and shock index, lung capacity, forced respiration, chest excursion, hand strength, deadlift strength, broad jumps, chin-ups.

Statistically significant difference ($p < 0.05-0.001$) was found between girls with extreme paces of biological development in terms of adaptive capacity of blood flow, systolic blood pressure and shock index, physical capacity, lung capacity, birth-death rate, forced respiration, chest excursion, hand strength, deadlift strength, seated forward bend, 30-meter sprint, shuttle run.

During the school year, one could observe significant heterochrony of the cardiorespiratory system capacity, physical fitness and performance in both boys and girls as a result of the paces of their biological development. The effectiveness of differentiated physical training for children aged between 12 and 13 is confirmed by the dynamics of physical performance during the pedagogical experiment. Physical performance increases by 7.6%, 17.8% ($p < 0.01$) and 17.2% ($p < 0.01$) in low-performing, average, high-performing boys in the EG and is lower by 20.4% ($p < 0.001$), 19.4% ($p < 0.001$) and 13.9% ($p < 0.001$) than that in the CG. In relation to girls, physical performance increases by 15.0%, 7.1% and 8.3% in the EG and is lower by 27.5% ($p < 0.001$), 20.5% ($p < 0.001$) and 28.5% ($p < 0.001$) respectively in the CG. During the school year, however, physical activity has decreased in CG boys ($p < 0.05$) and girls ($p < 0.001$).

Discussion

The results obtained from the pedagogical experiment show that physical fitness of schoolchildren aged between 12 and 13 corresponds to high and average levels in comparison with the data provided by some scholars (Hlazyrin, 2003; Krustevych, 2000a; Kuts, & Vynohradskyi, 2003). In particular, absolute and relative hand strength corresponded to high and average levels (Apanasenko, & Popova, 1998; Romanenko, 1999; 2005). According to T. Krutsevych (2006), strength index in EG boys and girls corresponds to average and appropriate levels of physical fitness. Flexibility skills of high-performing boys and girls corresponded to average (Kuts, & Vynohradskyi, 2003) and high levels (Romanenko, 1999; 2005).

Speed strength skills corresponded to average level in low-performing and average boys, to high level in high-performing boys (Romanenko, 1999; 2005), to higher average level in three groups (Hlazyrin, 2003); to average level in low-performing and average girls (Hlazyrin, 2003); to average level in girls in three groups (Kuts, & Vynohradskyi, 2003; Romanenko, 1999). According to T. Krutsevych (2006), speed strength index corresponds to average level in low-performing and average boys and to higher average level in high-performing boys in the EG and to average level in EG girls in three groups.

Coordination skills of boys corresponded to higher average level in three groups (Kuts, & Vynohradskyi, 2003) and to high level in three groups (Romanenko, 1999; 2005). Coordination skills of girls corresponded to high level in three groups (Krutsevych, 2006; Kuts, & Vynohradskyi, 2003; Romanenko, 2005).

Speed skills of boys and girls corresponded to average level (Hlazyrin, 2003; Romanenko, 1999; 2005). According to T. Krutsevych (2006), speed index corresponds to average level in high-performing and average boys and to higher average level in low-performing boys in the EG. In relation to EG girls, it corresponds to average level in three groups.

Endurance skills corresponded to average level in low-performing and average boys and to higher average level in high-performing boys (Hlazyrin, 2003), to average level in average boys and to high level in low- and high-performing boys (Romanenko, 1999; 2005). In relation to girls, they corresponded to higher average level in three groups (Hlazyrin, 2003), to higher level in average girls and to higher average level in high- and low-performing girls (Romanenko, 1999; 2005).

The obtained results can be divided into three groups: those confirmed by other studies; those complementing the already existing ones; novel results.

Therefore, the obtained results prove the views (Blahii, & Cherniavskyi, 2005; Krustevych, 2006; Pryimak, 2004) that functional development, physical performance and development of adolescents' motor skills are more dependent on the degree of biological development than on the calendar age. Schoolchildren with different levels of biological development within one age group are significantly different in terms of physical fitness, the cardiorespiratory system capacity and physical capacity. It is also confirmed that physical fitness standards are calculated based on average indicators and do not take into account the individual characteristics of schoolchildren (Mudryk, Oliinyk, Prykhodko, & Ashanin, 2002). In addition, the requirements for assessing these standards are overestimated.

Based on the view that the changes in the indicators of the cardiorespiratory system capacity, physical capacity and physical fitness are characterized by their significant heterochrony in both boys and girls, it is found that the heterochrony is caused by the paces of their biological development. In particular, one can observe some heterochrony during sensitive periods of the studied indicators of physical fitness in schoolchildren aged between 12 and 13 in the middle of age-sex groups with different levels of biological development. It is also proved that one can assess physical fitness of schoolchildren aged between 12 and 13 in accordance with their levels of biological development (Korobeinikov, Korobeinikova, Nenasheva, & Tsai piuk, 2002); one can assess the biological age by the method of its quantitative determination (Andrieieva, 2002); the periods of increase and decrease in the indicators of physical fitness, the cardiorespiratory system capacity and physical performance

during the school year can be determined by the paces of adolescents' biological development (Volkov, 2002; Sukharev, 1991). Novel results include development of differentiated approach to allocating educational time to develop motor skills of children aged between 12 and 13 depending on paces of their biological development and experimental verification of its efficiency.

Conclusions

Significant differences in paces of biological development of girls and boys and its individual characteristics lead to the situation, when classes can include children with different functional characteristics and adaptation skills. Therefore, it is necessary to employ differentiated approach, since one of the criteria for distributing schoolchildren to groups should be paces of their biological development.

Taking into account the dynamics of physical performance and physical fitness of schoolchildren aged between 12 and 13 during the school year, it is vital to plan developmental training of all the main motor skills with an emphasis on those that might deteriorate during the school year and have low growth rate. Indeed, 15% of the lesson time should be aimed at developing the motor skills, which improve by more than 3% during the school year; 35% of the lesson time should be aimed at developing the motor skills, which improve by 3% during the school year; 50% of the lesson time should be aimed at developing the motor skills, which deteriorate during the school year.

Physical fitness of children aged between 12 and 13 should be assessed in a differentiated way taking into account paces of their biological development and the initial level of physical fitness. In this case, the dynamics of motor skills should be assessed at the beginning and at the end of the school year.

The proposed distribution of educational time to develop motor skills of children aged between 12 and 13 taking into account paces of their biological development is an effective means of differentiated physical education for adolescents, which proves the increase in the level of physical fitness in the EG during the pedagogical experiment.

Further research may consist in introducing differentiated approach to distributing educational time to develop motor skills in physical education lessons depending on the pace of biological development in the practice of physical education of other age groups and conducting more studies on its effectiveness.

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