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MORPHOLOGICAL AND MOTOR PREREQUISITES OF DIFFERENTIATED PHYSICAL EDUCATION OF SCHOOLCHILDREN

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The effort to improve the quality of teaching physical education at school should be based on taking into account the gender-age characteristics of the morphological and physical condition of the student youth. The purpose of the study was to substantiate the prerequisites for differentiated physical education of learners with different rates of physical development in physical education lessons. The study involved 1,192 girls aged 8–17 who studied in schools in Kyiv (Ukraine). The choice of schoolgirls is due to the fact that over 30 % of them already in elementary school have health problems. Materials and methods: pedagogical testing of physical abilities, anthropometry, physiological tests, sample statistical method. Results: It was found that in schoolgirls aged 8–17 with different rates of physical development, present statistically significant differences in the levels of manifestation of physical abilities and it observed in 41 % of cases. Such differences are most clearly visible during puberty (from 11 to 15 years old). The presence of these differences indicates the need for a differentiated approach in selecting means and methods of physical education, taking into account not only chronological age but also the pace (level) of physical development of schoolgirls.

Key words: physical education, girls 8–17 years old, pace of physical development, health.

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МОРФОЛОГІЧНІ ТА РУХОВІ ПЕРЕДУМОВИ ДИФЕРЕНЦІЙОВАНОГО ФІЗИЧНОГО ВИХОВАННЯ УЧНІВСЬКОЇ МОЛОДІ

Прагнення підвищити якість викладання фізичної культури в школі має ґрунтуватися на урахуванні статево-вікових особливостей морфологічного та фізичного стану учнівської молоді. Метою було обґрунтувати передумови диференційованого фізичного виховання учнів різного темпу фізичного розвитку на уроках фізичної культури. У дослідженні взяли участь 1192 дівчат 8–17 років, які навчалися у школах м. Київ (Україна). Вибір саме школярок зумовлений тим, що понад 30 % з них уже в початкових класах мають відхилення у стані здоров'я. Методи дослідження: педагогічне тестування фізичних здатностей, антропометрія, фізіологічні тести, вибірковий статистичний метод. Встановлено, що у школярок 8–17 років з різними темпами фізичного розвитку в 41 % випадків спостерігаються суттєві й статистично достовірні відмінності рівнів прояву фізичних можливостей. Найбільш чітко відмінності помітні в пубертатний період (з 11 до 15 років). Наявність цих відмінностей вказує на необхідність диференційованого підходу в доборі засобів і методів фізичного виховання з урахуванням не лише хронологічного віку, а й темпу (рівня) фізичного розвитку школярок.

Ключові слова: фізичне виховання, дівчата 8–17 років, темп фізичного розвитку, здоров'я.

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One of the modern directions for improving the teaching process of the subject "Physical Culture" is the differentiation of means and methods of physical education [1, 2]. The generalization of scientific and methodical sources regarding differentiated physical education shows that the effective solution of this problem depends on the research of the peculiarities of the manifestation of physical capabilities in groups of those who are engaged in homogeneous morphological and motor [3, 4]. Similar studies are important for student youth during the formation of their physical health [6, 9], as they enable each learner to exercise in the optimal mode and ensure the best health-improving effect.

In order to implement a differentiated approach in physical education lessons, various methods of dividing students of the same class and gender into homogeneous groups are proposed. It all depends on the criterion used to classify groups: morphological or physiological. In physical education, morphological is preferred as the most practical [10, 13].

One of the morphological methods of differentiation available to a physical education teacher is the pace (level) of physical development of learners. The peculiarities of the influence of the pace (level) of physical development of students on the level of manifestation of their physical abilities can be the basis for using this method during differentiated physical training of schoolchildren.

The purpose of the study was to substantiate the prerequisites for differentiated physical education of learners with different rates of physical development in physical education lessons.

Materials and methods. The research was conducted with the involvement of female learners of the main medical group of various schools in Kyiv (Ukraine). The age of the schoolgirls was between 8 and 17 years old, and their total amount was 1192. The choice of this contingent of students was due to the fact that among them, unlike boys, there are lower and below-average physical fitness indicators. It is schoolgirls who have significantly worse health indicators than schoolboys, but at the same time they are the most variable in terms of morphofunctional status. The study was conducted in 2023–2025. The results were processed at the Department of Theory and Methods of Physical Education of the Ukrainian State Dragomanov University and the Department of Public Health, Management and Medical Expertise of the Poltava State Medical University.

Research methods: determination of the level of manifestation of physical abilities was carried out using pedagogical tests that have passed the authenticity check (r=0.797–0.939). The level of muscle strength was determined by measuring the absolute strength of the flexor muscles of the hand (dynamometry); the level of flexibility was determined by measuring active mobility in the shoulder and hip joints, as well as in the spine mobility (goniometry); the level of speed was determined by assessing the results of the 30-meter run, and the level of agility was determined by measuring the results of the "shuttle" run. The assessment of the level of physical development (LPD) of schoolgirls was carried out in accordance with modern standards [14], which are based on calculations of indicators of total body dimensions using multiple correlation and regression. The assessment tables (standards) were developed based on a survey of learners living in the city of Kyiv (Ukraine). Here is an example of how to use assessment tables to determine the level of physical development of a schoolchild.

Example of assessment. It is necessary to assess the level of physical development of a student who was born on March 5, 2015, has a height (x) of 143 cm, a weight (W) of 35.6 kg, and a chest circumference (CCF) in the pause of 69.2 cm.

First, it is necessary to determine the child's age as of the date of the study: as of March 2025, the learner's age was determined as 10 years.

The numerical values of height, weight, and chest circumference can lay in one of five intervals: for example, if their values fall within the interval $x\pm0.67\sigma$, they are considered as average; if in the interval from $x+0.68\sigma$ to $x+1.5\sigma$, they are higher than average; from $x+1.6\sigma$ and more, they are high; from $x–0.68\sigma$ to $x–1.5\sigma$, they are lower than average; from $x–1.6\sigma$ and less, they are low.

Using the tables of modern standards [14], it is possible to determine to which of the above intervals the student's height belongs. The summary table [14] shows the mean height (x) and standard deviation (σ) for a statistical sample of 10-year-old boys: x=141.9 cm; σ=7.11 sm. For this student: $0.67\sigma=0.67\times7.11=4.76\approx4.8$ (cm); $x+0.67\sigma=141.9+4.8\approx146.7$ (cm); $x–0.67\sigma=141.9–4.8=137.1$ (cm). The value of the student's height belongs to the interval $x\pm0.67\sigma$: $143\in[137.1; 146.7]$, therefore, the height is average.

The necessary numerical values of the appropriate weight (with actual values of height 143 cm and CCF 69 cm) – 35.3 kg; appropriate CCF (with height 143 cm and weight 35.6 kg≈36 kg) – 69.0 cm; partial sigmal deviation for weight – $\sigma R\text{-}1=2.12$ and CCF – $\sigma R\text{-}2=1.95$ can be found in the corresponding tables [14]. For convenience, we present the found values in Table 1.

Table 1

Actual and appropriate values of the student's height, weight, and CCF

Actual values		Proper values	Sigma value
Height	x=143 cm	mean x=141.9 cm	σ=7.11 cm
Weight	W=35.6 kg	W_{proper}=35.3 kg	$\sigma_{R\text{-}1}$=2.12 kg
CCF	CCF =69.2 cm	CCF_{proper}=69.0 cm	$\sigma_{R\text{-}2}$=1.95 cm

Let's calculate the differences (Δ) between the actual values of weight and CCF and their proper values by using the algorithm:

Δ= actual value–proper value.

$\Delta W=35.6–35.3=0.3$ kg; $\Delta CCF=69.2–69.0=0.2$ cm.

We divide the found differences into the corresponding partial sigmas:

$\Delta W/\sigma(R\text{-}1)=0.3/2.12=0.14$; $\Delta CCF/\sigma(R\text{-}2)=0.2/1.95=0.10$.

If the obtained value is within $\pm0.67\sigma R$, then the corresponding indicator (weight or CCF) is considered average; if within $0.68\sigma R$ to $1.5\sigma R$, then the indicator is above average; if within $–1.5\sigma R$ to $–0.68\sigma R$, then the indicator is below average; if from $–1.6\sigma R$ and less, then it is low; if from $1.6\sigma R$ and more, then the indicator is high.

Let's check to which of the indicated intervals the value of the fraction $\Delta W/\sigma(R\text{-}1)$ belongs. Let's calculate: $\pm0.67\sigma R\text{-}1=\pm0.67\times2.12=\pm1.42$; $\Delta W/\sigma(R\text{-}1)=0.14\in[–1.42; 1.42]$, therefore, the student's weight is average.

Similarly, for CCF we calculate: ±0.67σR-2=±0.67×1.95=±1.31 and check whether the fraction ΔCCF/σ(R-2) belongs to this interval:

ΔCCF/σ(R-2)=0,10∈[–1,31; 1,31]. As it turned out, CCF also has an average value.

Using the value x±kx, according to the values of weight, height and CCF in various combinations, all school-age children can be divided into four groups according to the level of physical development, namely:

– schoolchildren with good (harmonious) physical development;

– schoolchildren with excessive physical development (high);

– schoolchildren with below-average physical development;

– schoolchildren with poor physical development (low).

The first group includes students with average, above average, high and below average growth indicators with average and above average indicators of weight and CCF. To the II group – with the same growth indicators as in the first group, but with high indicators of weight and CCF or one of them. Group III includes students with average, above average, and high height indicators with weight and CCF indicators (or one of them) below average. Group IV includes students from:

– high, higher than average and average growth indicators with low indicators of weight and CCF or one of them;

– below average height with below average weight and CCF (or one of them) and low;

– low growth rates.

Therefore, the student shown in the example has average height, weight, and CCF for his age, so his physical development is good (harmonious).

If one or both of the particles turn out to be outside the average interval, then it is necessary to calculate the final values of the intervals: ±0.67σR; ±0.68σR; ±1.5σR; ±1.6σR and check to which interval these values belong.

When determining how to classify a particular student by level of physical development, based on indicators of the total dimensions of his body, it is worth remembering that with low growth, the student already has a poor LPD, so the remaining indicators can be omitted.

The estimation of the general arithmetic means by the sample means and the reliability of the differences between them was determined using the Student's t-test. When assessing the reliability of the obtained data, a 5 % significance level was adopted ($p<0.05$). All statistical analyses were performed using IBM SPSS Statistics 21 software, adapted for medical and biological research. This study complies with the provisions of the Declaration of Helsinki of the World Medical Association. The research topic was approved by the Academic Council of Ukrainian State Dragomanov University (protocol No. 4 dated 04/12/2023). Informed consent was obtained from all schoolgirls who were involved in this study.

Results of the study and their discussion. Among the total number of schoolgirls aged 8–17 (1192 people), depending on age, it was found that: with a lower than average LPD from 10.2 to 25.0 %, with an average level – from 63.9 to 78.3 %, with a higher than average level – from 10.3 to 17.9 %. The indicated ratio of the surveyed students indicates that the process of morphofunctional development of the body of children and adolescents is characterized by significant individual fluctuations. 332 children (27.9 %) were identified with accelerated or slowed rates of morphological development.

For each age group, the average values of the development of their motor qualities were compared among the examined individuals according to the determined of physical development levels. As a result of comparing the levels of motor skills of schoolgirls with different levels of physical development, 49 significant differences out of 120 possible (40.8 %) were identified. The data presented in Table 2 indicate that the vast majority of significant differences (35) occur during the pubertal period of development of schoolgirls (from 11 to 15 years old). In junior and senior classes (8–10 and 16–17 years old), 14 reliable differences were found.

When comparing the levels of motor skills in schoolgirls with below-average and average LPD, a 100 % (14 out of 14) advantage was noted in favor of the latter, and the difference between these levels was mainly due to higher results in strength and speed ($p < 0.05$).

A similar situation takes place between LPD in schoolgirls with lower and higher than average levels. The predominance of schoolgirls with higher-than-average LPD was observed in 14 out of 17 cases. Significantly better results ($p<0.05$) were found in representatives of seven age groups in strength, four groups in speed, and three groups in agility. Only at the ages of 11, 14, and 15 do schoolgirls with above-average LPD lag behind their peers with below-average levels of physical development in flexibility.

Among girls with average and above average LPD, there was an advantage ($p<0.05$) in speed and flexibility in favor of average LPD (in 10 comparisons out of 18 reliable ones). According to the results of muscle strength, the indicators of girls with a higher-than-average LPD prevail.

It should be noted that studies conducted by other authors with involvements of boys did not reveal a similar contradiction. This may be due to the fact that the acceleration process is gender-dependent, as boys' sexual development is slower than girls' during adolescence [15]. However, this fact concerns the epochal acceleration of school-age children.

Table 2

Significant differences between indicators of motor qualities in schoolgirls of the same age with different LPD

Comparable LPD	Motor qualities	Age										n
		8	9	10	11	12	13	14	15	16	17	
Below average-average	power	-	-	-	M	-	M	M	M	M	M	6
	speed	-	-	-	M	M	M	M	-	-	-	4
	agility	-	-	-	-	M	M	-	-	-	-	2
	flexibility	-	-	-	-	-	M	-	-	M	-	2
n		0	0	0	2	2	4	2	1	2	1	14
Below average-above average	power	-	-	H	H	H	H	-	H	H	H	7
	speed	-	H	-	H	-	H	H	-	-	-	4
	agility	H	-	-	H	-	H	-	-	-	-	3
	flexibility	-	-	-	L	-	-	L	L	-	-	3
n		1	1	1	4	1	3	2	2	1	1	17
Average-above average	power	-	-	-	-	H	H	-	H	H	H	5
	speed	-	H	M	M	M	M	M	M	-	-	7
	agility	H	-	-	H	-	-	-	-	-	-	2
	flexibility	-	-	M	M	-	-	M	M	-	-	4
n		1	1	2	3	2	2	2	3	1	1	18
Total of 120 cases		2	2	3	9	5	9	6	6	4	3	49 from 120 (40.8 %)

Note: n – number of significant differences; M – mean advantage; H – above-average LPD advantage; L – below-average LPD advantage.

The obtained results allow us to talk about a similar trend with regard to the studied indicators of physical capabilities within the limits of intragroup acceleration.

Taking into account the facts presented, we can conclude that there is an objective need to develop methods of physical training for schoolgirls, taking into account the pace (level) of physical development of their body. This will be of particular importance during the prepubertal and pubertal periods.

The results of the dynamics of morphological and motor indicators of schoolgirls aged 8–17 confirm the age-related pattern of their formation. At the same time, in 40 % of cases, statistically significant differences in the levels of physical abilities were noted. This is about the manifestation of motor abilities of schoolgirls, taking into account their pace (level) of physical development. The most significant differences were recorded at the age of 11–15 years. In junior and senior classes, these differences are less pronounced.

The physical health of young students, according to research by many specialists [5, 11], has a steady tendency to deteriorate. This is due to the difficult socio-economic situation in the country; outdated approaches to the organization and methods of teaching physical education lessons, that is, without taking into account the pace (levels) of physical development of those who are engaged in.

New technologies are needed to achieve significant results in solving the problem of improving the physical health of schoolchildren through physical education. According to scientists [8], a differentiated approach should be used to optimize physical and motor activity. In their opinion, it allows each student to engage in optimal mode and at the same time provide the best health effect. First of all, this concerns the differentiation of methods of dosing physical activity [12]. The basis for these recommendations is the results of research on certain sex-age characteristics of the body's response to physical exertion of students of different morphofunctional conditions [7].

Nowadays, one of the criteria that can be used by a physical education teacher to divide a class into homogeneous groups according to morphological and motor indicators is the pace (level) of physical development [1, 3]. The basis of this criterion is the ratio of total body sizes [5, 11]. At the same time, in order to implement this criterion in the process of using physical exercises, it is first necessary to determine its impact on the manifestation of specific physical capabilities of schoolchildren. In our study, this

interaction was investigated in schoolgirls aged 8–17 years with different LPD in terms of muscle strength, agility, flexibility, and speed. The result of studying this interaction is the following judgment: if the pace (level) of physical development is maintained in the process of physical training of schoolgirls, then with such an organization it is possible to predictably achieve an improvement in physical health by 41 %.

Conclusion

In the age groups of schoolgirls 8–17 years old with different rates (levels) of physical development, in 40.8 % of cases, statistically significant differences in the level of manifestation of physical abilities (muscle strength, speed, agility, flexibility) are observed. The most pronounced differences in the levels of physical abilities are manifested in the prepubertal and pubertal periods of the formation of the body of schoolgirls (from 11 to 15 years old). These differences are less pronounced in elementary and high school. In the group of schoolgirls aged 11–15 with an above-average level of physical development, lower indicators of speed and flexibility are observed than in the group of schoolgirls with an average level of physical development ($p<0.05$). In the group of schoolgirls with a below-average level of physical development, the vast majority of cases (28 out of 31 reliable) indicators of motor qualities are lower than in the groups with an average and below-average level of physical development. The identified discrepancies indicate the need for a differentiated approach in the selection of methods and means of physical education, taking into account not only chronological age, but also the level of physical development of schoolgirls and individual characteristics of the manifestation of motor qualities.

Prospects for further research. It is intended to study the peculiarities of the influence of the level of physical development on the manifestation of boys' physical abilities.

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