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Contents

Mykhailo Kharkovshchenko	
Didactics: Peculiarities of Programmed Teaching of the Cartwheel to Girls Aged 14	5-10
Inna Mugurdinova and Sergii Iermakov	
Pattern Recognition: Effectiveness of Teaching Boys Aged 14 the Press Headstand and Handstand	11-17
Kyrylo Siedykh, Olha Ivashchenko, Pavol Bartik and Viktoria Veremeenko	
Pattern Recognition: Effectiveness of Teaching Boys Aged 15 the Press Headstand and Handstand	18-24
Herdian and Euis Rahayu	
“I Don’t want to commit academic dishonesty”: the Role of Grit and Growth Mindset in Reducing Academic Dishonesty	25-33
Eduard Doroshenko, Olexandr Solovey and Mykhaylo Melnyk	
Technology of Teaching Game Techniques in Volleyball at the Stage of Initial Training	34-40
Serhii Chernenko, Radosław Muszkieta, Iuriy Dolynnyi, Oleg Oliynyk and Oleg Honcharenko	
Impact of Physical Education on Peculiarities of Functional State of 18-22 Year Old Female Students’ Cardiovascular and Respiratory Systems	41-45
Reviewer Guidelines	46
Ethical Principles	47

Журнал теорії та методології навчання
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Зміст

Михайло Харьковщенко Дидактика: особливості програмованого навчання перевороту убік дівчат 14 років	5-10
Інна Мугурудінова, Сергій Єрмаков Розпізнання образів: ефективність процесу навчання стійки силою на голові і руках хлопців 14 років	11-17
Кирило Сєдих, Ольга Іващенко, Павол Бартік, Вікторія Веремеєнко Розпізнання образів: ефективність процесу навчання стійки силою на голові і руках хлопців 15 років	18-24
Хердіан, Юіс Рахаю «Я не хочу чинити академічної нечесності»: роль витримки та мислення зростання у зменшенні академічної нечесності	25-33
Едуард Дорошенко, Олександр Соловей, Михайло Мельник Технологія навчання ігровим прийомам у волейболі на етапі початкової підготовки.....	34-40
Сергій Черненко, Радослав Мушкета, Юрій Долинний, Олег Олійник, Олег Гончаренко Вплив фізичного виховання на особливості функціонального стану серцево-судинної та дихальної системи студенток 18-22 років	41-45
Рекомендації для рецензента	46
Етичні принципи	47



DIDACTICS: PECULIARITIES OF PROGRAMMED TEACHING OF THE CARTWHEEL TO GIRLS AGED 14

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Abstract

The purpose of the study was to determine the peculiarities of programmed teaching of the cartwheel to girls aged 14.

Materials and methods. The study participants were 20 girls aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, factor analysis, nearest neighbor analysis.

Results. The analysis of the effectiveness of the program of teaching girls aged 14 the cartwheel, using different repetition modes (1 – mode of 6 sets 1 time each with a rest interval of 60 s; 2 – mode of 6 sets 2 times each with a rest interval of 60 s) showed that the girls of the first group need fewer repetitions to master the cartwheel than the girls of the second group ($p < 0.05$). Thus, repetition modes have statistically significantly different effects on the cartwheel motor skill development in girls aged 14. The analysis of similarities revealed that the program components are interrelated.

Conclusions. Factor analysis showed that teaching programs organized by the method of algorithmic instructions are combined in nature. The analysis of similarities revealed that the program components are interrelated. Series of training tasks 2, 3, and 5 are most correlated with one another and provide conditions for teaching girls aged 14 the cartwheel. Optimization of the number of repetitions of the exercise depends on the speed of mastering the exercises of the third and fourth series of training tasks.

Keywords: programmed teaching, method of algorithmic instructions, acrobatic exercises, girls aged 14.

Introduction

The ideas of behaviorism became the methodological basis of programmed instruction (Skinner, 1965, 1984a,b; Fishman, Keller, & Atkinson, 1968). Skinner (1965) points out that a special branch of psychology, the so-called experimental analysis of behavior, has produced a technology of teaching characterized by the introduction of teaching machines and programmed instruction. The basis of programming is the “response – stimulus” scheme. According to Skinner (1984), operant conditioning can replace, as well as complement, the natural selection of behavior.

Physical education uses the traditional scheme of a teaching program, which includes: informative frame (what is performed) – operational frame (how it is performed) – control frame (transition to training the next exercise) (Shlemmin, 1973; Gaverdovskii, 2007; Khudolii, 2008). In physi-

cal education of schoolchildren, the method of algorithmic instructions is used to develop teaching programs (Shueva, Ivashchenko, & Jagiello, 2021; Marchenko, & Taranenko, 2020; Minenko, & Marchenko, 2021).

The results of a number of studies highlight the importance of a focused approach to the process of teaching schoolchildren (Ivashchenko, Abdulkhalikova, & Cieślicka, 2017; Ivashchenko, Berezhna, & Cieślicka, 2020; Ivashchenko & Sirichenko, 2020). Studies also consider the models of teaching the basic volleyball movements to primary schoolchildren (Samsudin, Setiawan, Taufik, & Solahuddin, 2021); the patterns of developing motor competences in children and adolescents (Chan, Ha, Ng, & Lubans, 2019; D'elia, Tortella, Sannicandro, & D'isanto, 2020; dos Santos, Nevill, Burana-ruga, Pereira, Gomes, Reyes, Barnett, & Maia, 2018).

Thus, it is relevant to determine the peculiarities of programmed teaching of schoolchildren.

The purpose of the study was to determine the peculiarities of programmed teaching of the cartwheel to girls aged 14.

Materials and methods

Study participants

The study participants were 20 girls aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, factor analysis, nearest neighbor analysis.

The pedagogical experiment examined the influence of 6 and 12 repetitions with a 60-second rest interval during a physical education class on the number of repetitions of training tasks to the 100% level of proficiency. In the first group ($n = 10$), the girls repeated the tasks 6 sets 1 time each with a rest interval of 60 s, in the second group ($n = 10$) – 6 sets 2 times each with a rest interval of 60 s.

During teaching, the method of algorithmic instructions was used (Shlemin, 1973). The program of teaching

the cartwheel included the training tasks given in Table 1. It was developed based on the data of Shlemin (1973), Khudolii (2008). The next exercise started on condition of correct performance of the previous exercise on three consecutive attempts. The number of repetitions required for correct performance on three consecutive attempts was recorded.

Statistical analysis

The study materials were processed using the IBM SPSS 20 statistical analysis program. Factor analysis and nearest neighbor analysis were used.

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed consent document was obtained from all the parents.

Results

The analysis of the effectiveness of the program of teaching girls aged 14 the cartwheel, using different repetition modes (1 – mode of 6 sets 1 time each with a rest interval of 60 s; 2 – mode of 6 sets 2 times each with a rest interval of 60 s) showed that the girls of the first group need fewer rep-

Table 1. Program of teaching the cartwheel to girls aged 14 (Shlemin, 1973, Khudolii, 2008)

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (transition to training the next exercise)
<i>The first series of training tasks – exercises to develop motor abilities</i>		
From normal standing position, lean forward, touch the floor with the hands and, moving the hands forward on the floor, adopt a push-up position, return to starting position in the same way	When performing the exercise, do not bend the knees	If the student performs three times in 10 seconds, proceed to the next exercise
Perform push-ups as quickly as possible (5 times in 3-4 s)	Perform the exercise as quickly as possible, maintaining a gymnastic style	If the student performs the exercise in 3-4 seconds, proceed to the next exercise
<i>The second series of training tasks – exercises to master starting and ending positions</i>		
From standing position with raised arms, step forward and perform a switch leg handstand with assistance	Switch leg handstand	Correct performance on 3 consecutive attempts
Handstand with legs apart with assistance	Switch leg handstand, maintaining balance for 3-4 seconds	Correct performance on 3 consecutive attempts
<i>The third series of training tasks – actions without which it is impossible to perform the target exercise</i>		
Standing on hands with legs apart with assistance, shift the body weight from one hand to the other	Perform everything only with assistance	Correct performance on 3 consecutive attempts
<i>The fourth series of training tasks – teaching the ability to assess movements in space, by time and muscular effort</i>		
Arriving to handstand quickly with assistance	Pay attention to the technique of performance	Correct performance on 3 consecutive attempts
Arriving to handstand slowly with assistance	Pay attention to the technique of performance	Correct performance on 3 consecutive attempts
<i>The fifth series of training tasks – preliminary exercises</i>		
Arriving to handstand quickly with the wall support	Maintain balance for 3-4 seconds	Correct performance on 3 consecutive attempts
Handstand with legs apart with 90-degree rotation with assistance	Perform all exercises for this element only with assistance	Correct performance on 3 consecutive attempts
<i>The sixth series of training tasks – the entire exercise</i>		
Cartwheel with assistance	Pay attention to the technique of performance	Correct performance on 3 consecutive attempts
Cartwheel without assistance	Maintain a gymnastic style	Correct performance on 3 consecutive attempts

Table 2. Analysis of the effectiveness of the program of teaching girls aged 14 the cartwheel, using different repetition modes (1 – mode of 6 sets 1 time each with a rest interval of 60 s; 2 – mode of 6 sets 2 times each with a rest interval of 60 s)

Indicator	modes	n	M	SD	t-test for Equality of Means					
					t	p	MD	SED	95% Confidence Interval of the Difference	
									Lower	Upper
Total number of repetitions	1	10	37.9	3.03	8.996	0.000	-12.4	1.378	-15.295	-9.504
	2	10	50.3	3.12						

etitions to master the cartwheel than the girls of the second group ($p < 0.05$). Thus, repetition modes have statistically significantly different effects on the cartwheel motor skill development in girls aged 14 (Table 2).

Structural analysis of the program of teaching girls aged 14 the cartwheel (mode of 6 sets 1 time each with a rest interval of 60 s)

The Bartlett's test indicates the possibility of using factor analysis. The value of KMO characterizes the satisfactory adequacy of the use of factor analysis with this sample (Table 3).

Table 3. Evaluation of the Feasibility of Applying Factor Analysis

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)		0.286
Bartlett's Test of Sphericity	Approx. Chi-Square	24.634
	Df	15
	Sig.	0.055

As a result of the analysis, two factors that explain 68.035% of the variation of results were identified (Table 4). The first factor explains 36.184% of the variation of learning outcomes.

Table 4. Results of Factor Analysis of the Teaching Program (6 repetitions, rest interval of 60 s). Rotated Component Matrix. Girls Aged 14

Series of training tasks	Component		h^2
	1	2	
Series I – exercises to develop motor abilities	.209	.727	.572
Series II – exercises to master starting and ending positions	-.195	.921	.887
Series III – actions without which it is impossible to perform the target exercise	.839	.466	.922
Series IV – exercises to master the movement control ability	.685	-.137	.488
Series V – preliminary exercises	-.570	.624	.714
Series VI – the entire exercise	-.704		.499

Table 5. Total Variance Explained. Girls Aged 14

Component	Rotation Sums of Squared Loadings	
	% of Variance	Cumulative %
1	36.184	36.184
2	31.851	68.035

The series that are most correlated with the factor are:

- Series 3 – actions without which it is impossible to perform the target exercise ($r = 0.839$),
- Series 6 – the entire exercise ($r = -0.704$),
- Series 4 – exercises to master the movement control ability ($r = 0.685$).

The factor is bipolar and indicates that optimization of the number of repetitions of the exercise depends on the speed of mastering the exercises of the third and fourth series of training tasks. The factor is interpreted as movement control.

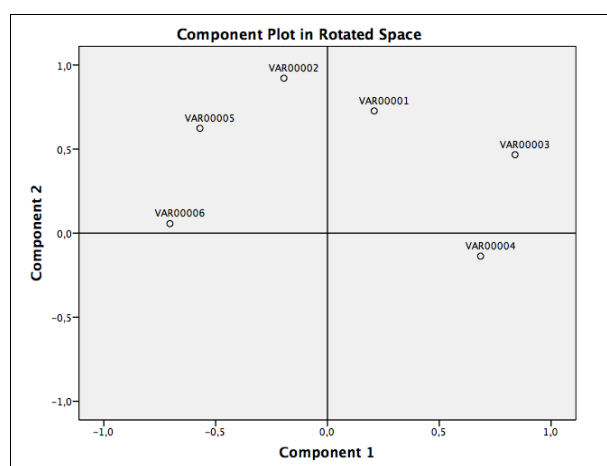
The second factor explains 31.851% of the variation of learning outcomes.

The series that are most correlated with the factor are:

- Series 2 – exercises to master starting and ending positions ($r = 0.921$),
- Series 1 – exercises to develop motor abilities ($r = 0.727$),
- Series 5 – preliminary exercises ($r = 0.624$).

The factor can be interpreted as basic movements.

The analysis of similarities revealed that the program components are interrelated (Table 4). Series of training tasks 2, 3, and 5 are most correlated with one another and provide conditions for teaching girls aged 14 the cartwheel (Fig. 1).

**Fig. 1.** Results of factor analysis of the teaching program (6 repetitions, rest interval of 60 s)

Structural analysis of the program of teaching girls aged 14 the cartwheel (mode of 6 sets 2 times each with a rest interval of 60 s)

The Bartlett's test indicates the possibility of using factor analysis. The value of KMO characterizes the satisfactory adequacy of the use of factor analysis with this sample (Table 6).

Table 6. Evaluation of the Feasibility of Applying Factor Analysis. Girls Aged 14

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO)		0.5
Bartlett's Test of Sphericity	Approx. Chi-Square	13.306
	Df	15
	Sig.	.579

Table 7. Results of Factor Analysis of the Teaching Program (12 repetitions, rest interval of 60 s). Rotated Component Matrix. Girls Aged 14

Series of training tasks	Component		h ²
	1	2	
Series I – exercises to develop motor abilities	-.541	.437	.484
Series II – exercises to master starting and ending positions	.813	-.148	.683
Series III – actions without which it is impossible to perform the target exercise	.270	-.859	.811
Series IV – exercises to master the movement control ability	.805		.649
Series V – preliminary exercises	.597		.366
Series VI – the entire exercise		.960	.926

Table 8. Total Variance Explained. Girls Aged 14

Component	Rotation Sums of Squared Loadings	
	% of Variance	Cumulative %
1	42.092	42.092
2	23.241	65.333

As a result of the analysis, two factors that explain 65.333% of the variation of results were identified (Table 7).

The first factor explains 42.092% of the variation of learning outcomes.

The series that are most correlated with the factor are:

- Series 2 – exercises to master starting and ending positions ($r = 0.813$),
- Series 4 – exercises to master the movement control ability ($r = 0.805$),
- Series 5 – preliminary exercises ($r = 0.597$).

The factor characterizes the use of the following methods: method of separate teaching (series 2), method of immediate information about the exercise performance (series 4), and method of preliminary exercises (series 5). It points to the combined nature of the teaching program.

The second factor explains 23.241% of the variation of learning outcomes.

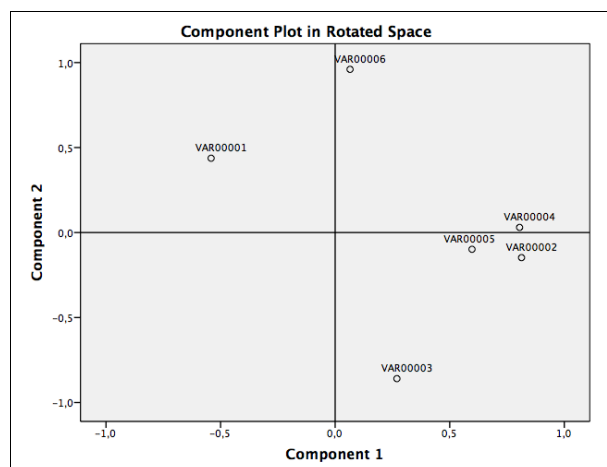
The series that are most correlated with the factor are:

- Series 6 – the entire exercise ($r = 0.960$),
- Series 3 – actions without which it is impossible to perform the target exercise ($r = -0.859$).

The factor can be interpreted as basic movements. The factor characterizes training tasks that are directly related to the cartwheel technique.

The analysis of similarities revealed that the program components are interrelated (Table 2). The training tasks of

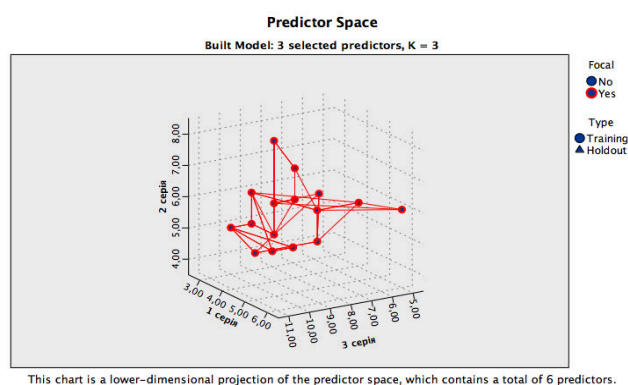
series 2, 4, and 5 are combined into one group and provide conditions for teaching girls aged 14 the cartwheel (Fig. 2).

**Fig. 2.** Results of factor analysis of the teaching program (12 repetitions, rest interval of 60 s)

The analysis of implementation of the teaching program under the conditions of two exercise modes, using nearest neighbor analysis showed that the tasks of series 1, 2, and 3 are most connected with one another (Table 9, Fig. 3).

Table 9. Analysis Results. Nearest Neighbor Analysis. Girls Aged 14

Case Processing Summary		N	Percent
Sample	Training	17	89.5%
	Holdout	2	10.5%
Valid		19	100.0%
Excluded		1	
Total		20	



This chart is a lower-dimensional projection of the predictor space, which contains a total of 6 predictors.

Fig. 3. Analysis Results. Nearest Neighbor Analysis. Girls Aged 14

Discussion

Thus, the assumption is made about the impact of different exercise modes on the effectiveness of teaching series of tasks. The study found that factor analysis and nearest neighbor analysis make it possible to substantiate the teaching program and identify the relationship between series of

training tasks. Factor analysis points to the combined nature of the teaching program.

The obtained data supplement the information about the effectiveness of the method of algorithmic instructions for developing programs of teaching physical exercises to children and adolescents (Shueva, Ivashchenko, & Jagiello, 2021; Marchenko, & Taranenko, 2020; Minenko, & Marchenko, 2021).

The study found that the tasks to master the movements without which it is impossible to perform the entire exercise (series 3) and the movement control ability (series 4) are of particular importance in the process of teaching. The data complement the findings of Shueva, Ivashchenko, and Jagiello (2021) and also confirm the combined nature of the method of algorithmic instructions (Shlemin, 1973; Khudolii, 2008; Ivashchenko, 2016).

Similarly to the research by Ivashchenko and Kapkan (2015), Shueva, Ivashchenko, & Jagiello (2021), the study found that factor analysis and nearest neighbor analysis can be used to substantiate the teaching program, which makes it possible to identify the program structure and the relationship between each factor and the result of teaching series of training tasks.

Thus, programmed teaching such as algorithmic instructions can be considered as a technological process with a given result, which includes methods and techniques of teaching that exist in physical education and aims to develop the motor function of schoolchildren.

Conclusions

Factor analysis showed that teaching programs organized by the method of algorithmic instructions are combined in nature. The analysis of similarities revealed that the program components are interrelated. Series of training tasks 2, 3, and 5 are most correlated with one another and provide conditions for teaching girls aged 14 the cartwheel. Optimization of the number of repetitions of the exercise depends on the speed of mastering the exercises of the third and fourth series of training tasks.

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Conflict of interest

The authors declare that there is no conflict of interest.

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ДИДАКТИКА: ОСОБЛИВОСТІ ПРОГРАМОВАНОГО НАВЧАННЯ ПЕРЕВОРОТУ УБІК ДІВЧАТ 14 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 9 табл., 3 рис., 21 джерело.

Мета дослідження – визначити особливості програмованого навчання перевороту убік дівчат 14 років.

Матеріали і методи. У дослідженні прийняли участь 20 дівчат 14 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження; хронометраж навчальних завдань; педагогічний експеримент, методи математичної статистики, факторний аналіз, метод найближчих сусідів.

Результати. Аналіз ефективності програми навчання перевороту убік дівчат 14 років при різних режимах повторень (1 – режим 6 підходів по 1 разу з інтервалом відпочинку 60 с; 2 – режим 6 підходів по 2 рази з інтервалом відпочинку 60 с) показав, що дівчата першої групи витрачають менше повторень на оволодіння перевороту убік ніж

дівчата другої групи ($p < 0,05$). Отже режими повторень статистично достовірно мають різний вплив на формування рухової навички перевороту убік у дівчат 14 років. Аналіз спільностей дозволив встановити, що компоненти програми взаємозв'язані.

Висновки. На основі факторного аналізу встановлено, що програми навчання упорядковані за методом алгоритмічних розпоряджень мають комбінований характер. Аналіз спільностей дозволив встановити, що компоненти програми взаємозв'язані. Найбільшу кореляцію мають 2, 3 та 5 серії навчальних завдань і забезпечують умови для навчання перевороту убік дівчат 14 років. Оптимізація кількості повторень вправи залежить від швидкості засвоєння вправ третьої і четвертої серії навчальних завдань.

Ключові слова: програмоване навчання, метод алгоритмічних розпоряджень, акробатичні вправи, дівчата 14 років.

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PATTERN RECOGNITION: EFFECTIVENESS OF TEACHING BOYS AGED 14 THE PRESS HEADSTAND AND HANDSTAND

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Abstract

Purpose. To determine the impact of exercise modes on the effectiveness of teaching boys aged 14 the press headstand and handstand.

Materials and methods. The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

Results. The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 14 the press headstand and handstand. The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6.

Conclusions. The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 14 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly.

Keywords: discriminant analysis, boys, acrobatic exercises, exercise mode, teaching.

Introduction

Motor skills development at school is a priority task of physical education of schoolchildren (Ivashchenko, Iermakov, Khudolii, Cretu, & Potop, 2017; Krutsevich, Pangelova, & Trachuk, 2019; Ivashchenko, Berezhna, & Cieśllicka, 2020). The regularities of basic motor skills development are the object of research of a number of scientists (Adamo, Wilson, Harvey, Grattan, Naylor, Temple, & Goldfield, 2016; Abate, Pallonetto, & Palumbo, 2020; Barnett, & Makin, 2018). Researchers have studied the structure of basic motor skills (Basman, 2019; Pfeiffer, Saunders, Brown, Dowda, Addy, & Pate, 2013), age-related peculiarities of development (Bardid, Lenoir, Huyben, De Martelaer, Seghers, Goodway, & Deconinck, 2017; Barnett, Telford, Strugnell, Rudd, Olive, & Telford, 2019), pedagogical control of the level of development (Bryant, James, Birch, & Duncan, 2014; Ivashchenko, Kapkan, Khudolii, & Yermakova, 2017; Ivashchenko, 2017).

Acrobatic exercises can be considered as part of the structure of basic motor skills (Kapkan, Khudolii, & Bartik, 2019; Khudolii, Kapkan, Harkusha, Marchenko, & Veremeenko, 2020; Ivashchenko, Abdulkhalikova, & Cieśllicka, 2017).

During motor skills development, the selection of physical exercises and the modes of their performance are of importance (Marchenko, & Kovalenko, 2020; Marchenko, Jagiello, Iermakov, Ivashchenko, & Khudolii, 2021; Ivashchenko, Nosko, & Ferents, 2019).

The analysis of motor skills development uses multivariate statistical methods, including discriminant analysis (Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018; Silverman, Woods, & Subramaniam, 1998; Ivashchenko, 2020).

Therefore, the study of the effectiveness of teaching is relevant.

The purpose of the study was to determine the impact of exercise modes on the effectiveness of teaching boys aged 14 the press headstand and handstand.

Materials and methods

Study participants

The study participants were 20 boys aged 14. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training

tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

The pedagogical experiment examined the influence of 6 and 12 repetitions with a 60-second rest interval during a physical education class on the number of repetitions of training tasks to the 100% level of proficiency. In the first group ($n = 10$), the boys repeated the tasks 6 sets 1 time each with a rest interval of 60 s, in the second group ($n = 10$) – 6 sets 2 times each with a rest interval of 60 s.

During teaching, the method of algorithmic instructions was used (Shlemin, 1973). The program of teaching the press headstand and handstand was developed based on the data of Shlemin (1973), Khudolii (2008) and included the following training tasks:

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (transition to training the next exercise)
First series of training tasks – exercises to develop motor abilities		
From standing position, with the back against stall bars, proceed to arch hang	Performed by jumping off both feet, hold the position for 3-4 seconds	Repeat 3–5 times
A push-up position. Bend arms and knees (5 times in 5-6 seconds)	Performed with maximum amplitude	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Second series of training tasks – exercises to master starting and ending positions		
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Hold the position for 3-4 seconds	Repeat 3 times
The same, lifting the legs off the floor and keeping them bent, straighten the back	Perform the exercise with assistance	Repeat 3 times
Third series of training tasks – actions without which it is impossible to perform the target exercise		
Lifting the legs off the floor and keeping them bent, straighten the back	Arriving to headstand and handstand should be done without any effort, by simply straightening the legs	Repeat 3 times
Lifting the legs off the floor and keeping them bent, straighten the back	Push off with the feet and, helping with hands, arrive to headstand. Straighten the legs	Repeat 3 times
Fourth series of training tasks – teaching the ability to assess movements in space, by time and muscular effort		
In kneeling position, bending and straightening of the arms (5 times)	Bend the arms simultaneously with straightening the legs as quickly as possible	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Bending and straightening of the arms in stoop standing position (5 times)	Plant the hands on the floor a step's length away from the toes	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
From normal standing position, lean forward, touch the floor with the hands and, moving the hands forward on the floor, adopt a push-up position, return to starting position in the same way	Do not bend knees when performing the exercise	Perform the exercise for 6 seconds
Fifth series of training tasks – preliminary exercises		
From squat, lean forward, put the head down on mat and evenly shift the body weight to the head and arms for 3–4 seconds	Straightening the back, hold balance with bent legs	If the student performs the exercise 3 times, proceed to the next exercise
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Straighten the legs, hold balance without bending the legs for 3-4 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Focus on the exercise technique	Correct performance of the series on 3 attempts
Sixth series of training tasks – the entire exercise		
A headstand with the back and legs against the stall bars, with assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts
A headstand without assistance	Hold the position for 5–6 seconds	Correct performance of the series on 3 attempts

Table 1. Group Statistics. Boys Aged 14

Series of tasks	6 repetitions, rest interval of 60 s		12 repetitions, rest interval of 60 s		Δx	Wilks' Lambda	F	df1	df2	Sig.
	Mean	Std. Deviation	Mean	Std. Deviation						
1	5.3	2.11	4.8	2.39	0.5	.987	.245	1	18	.626
2	6.9	2.02	12.1	3.63	-5.2	.535	15.620	1	18	.001
3	14.6	2.87	15.5	2.17	-0.9	.967	.624	1	18	.440
4	9.4	2.06	13.4	1.71	-4	.448	22.222	1	18	.000
5	5.6	2.98	12.0	3.16	-6.4	.454	21.634	1	18	.000
6	6.6	1.83	10.0	2.05	-3.4	.542	15.211	1	18	.001

The next exercise started on condition of correct performance of the previous exercise on three consecutive attempts. The number of repetitions required for correct performance on three consecutive attempts was recorded. The level of proficiency in the exercises was determined by the alternative method: “performed” or “failed”. A technically correct performance of the exercise gave the students “1” point; a failure to perform the exercise gave them “0” entered in the protocol.

Statistical analysis

The study materials were processed using the IBM SPSS 20 statistical analysis program. Discriminant analysis was conducted. For each canonical discriminant function, the study calculated the following: eigenvalue, variance percentage, canonical correlation, Wilks' lambda, Chi-square. For each step: prior probabilities, Fisher's function coefficients, unstandardized function coefficients, Wilks' lambda for each canonical function.

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed consent document was obtained from all the parents.

Results

The analysis of averages shows that statistically significant differences in the number of repetitions are observed in performing series of training tasks 2, 4, 5, and 6. The boys aged 14 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the movements (Table 1).

To determine the impact of different modes of exercises on the level of proficiency, discriminant analysis was conducted (Tables 2-6). A necessary condition for discriminant analysis is the homogeneity of variances and covariances of data. The Box's M test confirms the assumption about the homogeneity of variances and covariances (Table 2).

Table 2. Box's M Test For Testing Equal Population Covariance Matrices (DA)

Box's M		32.952
F	Approx.	1.521
	df1	15
	df2	1304.526
	Sig.	.090

The first canonical function explains 100% of the results variation, which indicates its high informativity ($r = 0.891$) (see Table 3). The analysis of the canonical function shows its statistical significance ($\lambda_1 = 0.207$; $p_1 = 0.001$). The first function has a high discriminative ability and value in interpretation of the general population (Table 4).

Table 3. Eigenvalues for Developing Discriminant Model (Canonical Correlation). Boys Aged 14

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	3.832	100.0	100.0	.891

Table 4. Outcomes of Calculated Wilks' Lambda of Discriminant Function. Boys Aged 14

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.207	24.417	5	.000

The standardized canonical discriminant function coefficients make it possible to determine the ratio of the contribution of variables to the function result. The results of the second and fifth series of training tasks make the largest contribution to the first canonical function. The above indicates that the exercises of the second (exercises to master starting and ending positions) and the fifth (preliminary exercises) series of training tasks are the most sensitive to exercise modes in boys aged 14 (Table 5).

Table 5. Standardized Canonical Discriminant Function Coefficients. Boys Aged 14

Series of tasks	Function
	1
Series 1	-.494
Series 2	.814
Series 3	-.478
Series 4	.139
Series 5	.982

The structure canonical discriminant function coefficients are the coefficients of correlation between the variables and the function. Thus, the function is most closely connected with the number of repetitions of exercises of the fourth (the ability to assess movements in space, by time and muscular effort), the fifth (preliminary exercises), and the second (exercises to master starting and ending positions) series of training tasks ($r_4 = 0.568$; $r_5 = 0.560$; $r_2 = 0.476$) (Table 6).

Table 6. Structure Matrix. Boys Aged 14

Series of tasks	Function
	1
Series 4	.568
Series 5	.560
Series 2	.476
Series 6 ^a	.462
Series 3	.095
Series 1	-.060

^aThis variable is not used in the analysis.

Table 7. Canonical Discriminant Function Coefficients (Unstandardized coefficients)

Series of tasks	Function
	1
Series 1	-.219
Series 2	.277
Series 3	-.188
Series 4	.073
Series 5	.319
(Constant)	-2.345

Table 8. Functions at Group Centroids. Boys Aged 14

Exercise Mode	Function
	1
1 – 6 repetitions, rest interval of 60 s	-1.857
2 – 12 repetitions, rest interval of 60 s	1.857

The coordinates of centroids for two groups make it possible to interpret the canonical function in relation to the role in classification. At the positive pole is a centroid for the exercise mode of 12 repetitions ($M_{12} = 1.857$), at the negative – a centroid for the exercise mode of 6 repetitions ($M_6 = -1.857$) (see Table 8, Fig. 1, 2). This indicates a significant difference in the impact of exercise repetition modes on the number of repetitions required for motor skills development in boys aged 14 during physical education classes. The results of classification of the groups show that 100.0 % of the original grouped cases were classified correctly (Table 9). Based on the discriminant function coefficients and centroids, it is pos-

Table 9. Classification Results^{a,c}

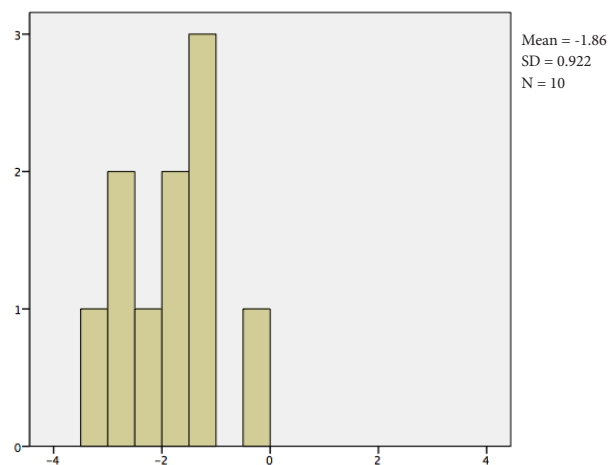
Exercise Mode			Predicted Group Membership		Total
			1	2	
Original	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	0	10	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	.0	100.0	100.0
Cross-validated ^b	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	1	9	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	10.0	90.0	100.0

a. 100.0% of original grouped cases correctly classified.

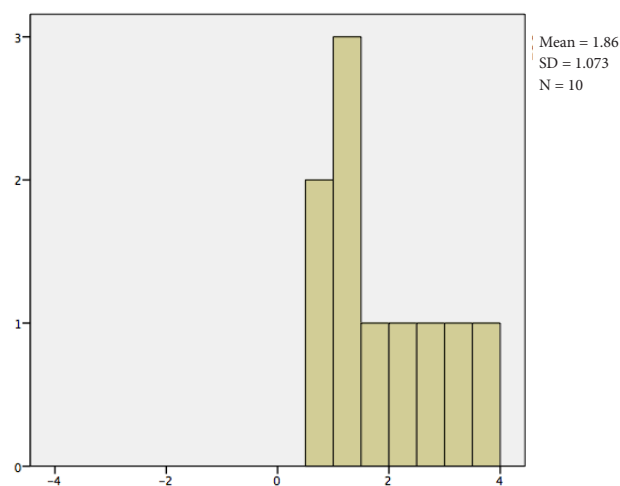
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 90.0% of cross-validated grouped cases correctly classified.

Canonical Discriminant Function 1

**Fig. 1.** Graphic representation of classification results: 6 repetitions, rest interval of 60 s

Canonical Discriminant Function 1

**Fig. 2.** Graphic representation of classification results: 12 repetitions, rest interval of 60 s

sible to calculate the number of repetitions for mastering the motor skill (Table 7). The value of the centroid for the exercise mode of 6 repetitions is approximate for calculation ($M_6 = -1.857$).

Discussion

The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 14 the press headstand and handstand. The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6 ($p < 0.05$).

These data complement the knowledge about the development of motor skills (Adamo, Wilson, Harvey, Grattan, Naylor, Temple, & Goldfield, 2016; Abate, Pallonetto, & Palumbo, 2020; Barnett, & Makin, 2018) and the importance of teaching in schoolchildren's physical education (Ivashchenko, Iermakov, Khudolii, Cretu, & Potop, 2017; Krutsevich, Pengelova, & Trachuk, 2019; Ivashchenko, Berezhna, & Cieřlicka, 2020).

Structure canonical discriminant function coefficients indicate that the process of motor skills development is influenced by the selection of motor tasks and the modes of their performance. The obtained data complement the knowledge about the effectiveness of using discriminant analysis to assess the teaching process (Ivashchenko, Khudolii, Iermakov, Chernenko, & Honcharenko, 2018; Silverman, Woods, & Subramaniam, 1998; Ivashchenko, 2020), the level of schoolchildren's motor fitness (Teunissen, ter Welle, Platvoet, Faber, Pion, & Lenoir, 2021; Tkachenko, 2020; Zhang, Chen, Chen, S., Hong, Loflin, & Ennis, 2014) and on the impact of exercise regimes on learning effectiveness (Ivashchenko, & Karpunets, 2001; Ivashchenko, & Kapkan, 2015; Cieřlicka, & Ivashchenko, 2017).

To plan the teaching process on the basis of unstandardized discriminant function coefficients and centroids, it is possible to calculate the number of repetitions for mastering the motor skill:

$Y = -2.345 - 0.219X_1 + 0.277X_2 - 0.188X_3 + 0.073X_4 + 0.319X_5$, where Y is the function value, X_1 - X_5 are the number of repetitions to master the motor task.

The value of the centroid for the exercise mode of 6 repetitions is approximate for calculation ($M_6 = -1.857$).

Conclusions

The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 14 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly.

The study found that the mode of 6 sets 1 time each with a rest interval of 60 s is more effective than the mode of 6 sets 2 times each with a rest interval of 60 s when teaching series of training tasks 2, 4, 5, and 6.

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Conflict of interest

The authors declare that there is no conflict of interest.

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РОЗПІЗНАННЯ ОБРАЗІВ: ЕФЕКТИВНІСТЬ ПРОЦЕСУ НАВЧАННЯ СТІЙКИ СИЛОЮ НА ГОЛОВІ І РУКАХ ХЛОПЦІВ 14 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 6 с., 9 табл., 2 рис., 28 джерел.

Мета дослідження – визначити вплив режимів виконання вправ на ефективність процесу навчання стійки силою на голові і руках хлопців 14 років.

Матеріали і методи. У дослідженні прийняли участь 20 хлопців 14 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь

в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження, хронометраж навчальних завдань; педагогічний експеримент, методи математичної статистики, дискримінантний аналіз.

Результати. Приймається припущення про суттєвий вплив режимів чергування повторень вправ та інтервалу відпочинку на ефективність навчання стійки силою на голові і руках хлопців 14 років. Встановлено що режим 6 підходів по 1 разу з інтервалом відпочинку 60 с має більшу ефективність ніж режим 6 підходів по 2 рази з інтервалом

відпочинку 60 с у процесі навчання 2, 4, 5 та 6 серій навчальних завдань

Висновки. На основі аналізу нормованих, структурних коефіцієнтів та центрів груп визначено, що режими виконання вправ мають суттєвий вплив на процес навчання стійки силою на голові і руках хлопців 14 років на уроках фізичної культури. Результати класифікації груп показують, що 100 % вихідних згрупованих спостережень класифіковано правильно.

Ключові слова: дискримінантний аналіз, хлопці, акробатичні вправи, режим виконання вправ, навчання.

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PATTERN RECOGNITION: EFFECTIVENESS OF TEACHING BOYS AGED 15 THE PRESS HEADSTAND AND HANDSTAND

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Abstract

Purpose. To determine the impact of exercise modes on the effectiveness of teaching boys aged 15 the press headstand and handstand.

Materials and methods. The study participants were 20 boys aged 15. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment. To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

Results. The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 15 the press headstand and handstand. The study found that statistically significant differences in the number of repetitions are observed in performing all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of motor tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions).

Conclusions. The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 15 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly. The study found that the mode of 6 sets 2 times each with a rest interval of 60 s is more effective than the mode of 6 sets 1 time with a rest interval of 60 s when teaching series of motor tasks 1, 3, 4, 5, and 6.

Keywords: discriminant analysis, boys aged 15, acrobatic exercises, exercise mode, teaching.

Introduction

The importance of increasing motor activity of school-children is highlighted by the findings of researchers (Prystynskyi, Babych, Zaytsev, Boychuk, & Taymasov, 2020; Samsudin, Setiawan, Taufik, & Solahuddin, 2021; Krutsevich, Marchenko, Trachuk, Panhelova, Napadij, & Dovgal, 2021). It was found that the increase in motor activity is associated with the level of development of fundamental movements (Ré, Logan, Cattuzzo, Henrique, Tudela, & Stodden, 2018; Peers, Issartel, Behan, O'Connor, & Belton, 2020; Newell, 2020), the priority of motor skills development (Ivashchenko, Berezhna, & Cieśllicka, 2020; Ivashchenko & Sirichenko, 2020; Khudolii, Golovnin, & Bartik, 2020), as well as the development of teaching technologies (Khudolii, Iermakov, & Bartik, 2020; Kapkan, Khudolii, & Bartik, 2019; Shueva, Ivashchenko, &

Jagiello, 2021). In the process of developing the skills of fundamental movements, it is also important to test the level of their development (Valentini, Zanella, & Webster, 2017; Wagner, Kipling Webster, & Ulrich, 2017; Webster, & Ulrich, 2017).

One of the factors that influence the effectiveness of teaching is the mode of alternating repetitions and rest intervals (Marchenko & Kovalenko, 2020; Marchenko, & Taranenko, 2020; Marchenko, Jagiello, Iermakov, Ivashchenko, & Khudolii, 2021). Ivashchenko and Karpunets (2001), Ivashchenko and Kapkan (2015), Browne, Flynn, O'Neill, Howatson, Bell, and Haskell-Ramsay (2017) point out a more significant impact of exercise modes on the effectiveness of performing complex coordination exercises. Thus, the study of the effectiveness of motor skills development is relevant.

The purpose of the study was to determine the impact of exercise modes on the effectiveness of teaching boys aged 15 the press headstand and handstand.

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Materials and methods

Study participants

The study participants were 20 boys aged 15. The children and their parents were fully informed about all the features of the study and gave their consent to participate in the experiment.

Organization of the study

To solve the tasks set, the following research methods were used: study and analysis of scientific and methodological literature; pedagogical observation, timing of training

tasks; pedagogical experiment, methods of mathematical statistics, discriminant analysis.

The pedagogical experiment examined the influence of 6 and 12 repetitions with a 60-second rest interval during a physical education class on the number of repetitions of training tasks to the 100% level of proficiency. In the first group ($n = 10$), the boys repeated the tasks 6 sets 1 time each with a rest interval of 60 s, in the second group ($n = 10$) – 6 sets 2 times each with a rest interval of 60 s.

During teaching, the method of algorithmic instructions was used (Shlemin, 1973). The program of teaching the press headstand and handstand was developed based on the data of Shlemin (1973), Khudolii (2008) (Table 1).

Table 1. Program of teaching boys aged 15 the press headstand and handstand (Shlemin, 1973; Khudolii, 2008)

Informative frame (what is performed)	Operational frame (how it is performed)	Control frame (transition to training the next exercise)
First series of training tasks – exercises to develop motor abilities		
From standing position, with the back against stall bars, proceed to arch hang	Performed by jumping off both feet, hold the position for 3-4 seconds	Repeat 3-5 times
A push-up position. Bend arms and knees (5 times in 5-6 seconds)	Performed with maximum amplitude	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Second series of training tasks – exercises to master starting and ending positions		
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Hold the position for 3-4 seconds	Repeat 3 times
The same, lifting the legs off the floor and keeping them bent, straighten the back	Perform the exercise with assistance	Repeat 3 times
Third series of training tasks – actions without which it is impossible to perform the target exercise		
Lifting the legs off the floor and keeping them bent, straighten the back	Arriving to headstand and handstand should be done without any effort, by simply straightening the legs	Repeat 3 times
Lifting the legs off the floor and keeping them bent, straighten the back	Push off with the feet and, helping with hands, arrive to headstand. Straighten the legs	Repeat 3 times
Fourth series of training tasks – teaching the ability to assess movements in space, by time and muscular effort		
In kneeling position, bending and straightening of the arms (5 times)	Bend the arms simultaneously with straightening the legs as quickly as possible	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
Bending and straightening of the arms in stoop standing position (5 times)	Plant the hands on the floor a step's length away from the toes	If the student performs the exercise for 5-6 seconds, proceed to the next exercise
From normal standing position, lean forward, touch the floor with the hands and, moving the hands forward on the floor, adopt a push-up position, return to starting position in the same way	Do not bend knees when performing the exercise	Perform the exercise for 6 seconds
Fifth series of training tasks – preliminary exercises		
From squat, lean forward, put the head down on mat and evenly shift the body weight to the head and arms for 3-4 seconds	Straightening the back, hold balance with bent legs	If the student performs the exercise 3 times, proceed to the next exercise
From squat, lean forward, put the head down on mat on the marking and evenly shift the body weight to the head and arms	Straighten the legs, hold balance without bending the legs for 3-4 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Focus on the exercise technique	Correct performance of the series on 3 attempts
Sixth series of training tasks – the entire exercise		
A headstand with the back and legs against the stall bars, with assistance	Hold the position for 5-6 seconds	Correct performance of the series on 3 attempts
A headstand with the back and legs against the stall bars, without assistance	Hold the position for 5-6 seconds	Correct performance of the series on 3 attempts
A headstand without assistance	Hold the position for 5-6 seconds	

Table 2. Group Statistics. Boys Aged 15

Series of tasks	6 repetitions, rest interval of 60 s		12 repetitions, rest interval of 60 s		Δx	Wilks' Lambda	F	df1	df2	Sig.
	Mean	Std. Deviation	Mean	Std. Deviation						
1	8.2	1.61	4.7	1.33	3.5	.393	27.771	1	18	.000
2	8.6	1.64	6.6	1.57	2	.701	7.692	1	18	.013
3	11.2	1.47	14.2	2.09	-3	.568	13.682	1	18	.002
4	16.0	1.49	12.3	1.25	3.7	.333	36.132	1	18	.000
5	8.9	1.52	6.7	1.33	2.2	.605	11.773	1	18	.003
6	7.9	1.28	6.4	1.34	1.5	.736	6.470	1	18	.020

The next exercise started on condition of correct performance of the previous exercise on three consecutive attempts. The number of repetitions required for correct performance on three consecutive attempts was recorded. The level of proficiency in the exercises was determined by the alternative method: "performed" or "failed". A technically correct performance of the exercise gave the students "1" point; a failure to perform the exercise gave them "0" entered in the protocol.

Statistical analysis

The study materials were processed using the IBM SPSS 20 statistical analysis program. Discriminant analysis was conducted. For each canonical discriminant function, the study calculated the following: eigenvalue, variance percentage, canonical correlation, Wilks' lambda, Chi-square. For each step: prior probabilities, Fisher's function coefficients, unstandardized function coefficients, Wilks' lambda for each canonical function.

The study protocol was approved by the Ethical Committee of the University. In addition, the children and their parents or legal guardians were fully informed about all the features of the study, and a signed informed consent document was obtained from all the parents.

Results

The analysis of averages shows that statistically significant differences in the number of repetitions are observed in performing all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of training tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions) (Table 2).

To determine the impact of different modes of exercises on the level of proficiency, discriminant analysis was conducted (Tables 3-10). A necessary condition for discriminant analysis is the homogeneity of variances and covariances of data. The Box's M test confirms the assumption about the homogeneity of variances and covariances (Table 3).

The first canonical function explains 100% of the results variation, which indicates its high informativity ($r=0.935$) (see Table 4). The analysis of the canonical function shows its statistical significance ($\lambda_1 = 0.125$; $p_1 = 0.001$). The first function has a high discriminative ability and value in interpretation of the general population (Table 5).

Table 3. Box's M Test For Testing Equal Population Covariance Matrices (DA)

Box's M		33.236
F	Approx.	.996
	df1	21
	df2	1191.671
	Sig.	.465

Table 4. Eigenvalues for Developing Discriminant Model (Canonical Correlation). Boys Aged 15

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	6.988 ^a	100.0	100.0	.935

Table 5. Outcomes of Calculated Wilks' Lambda of Discriminant Function. Boys Aged 15

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.125	31.169	6	.000

The standardized canonical discriminant function coefficients make it possible to determine the ratio of the contribution of variables to the function result. The results of the first (exercises to develop motor abilities) and the fourth (teaching the ability to assess movements in space, by time and muscular effort) series of training tasks make the largest contribution to the first canonical function. The above indicates that in the classification of exercise modes for boys aged 15, the exercises of the first and fourth series of training tasks are a priority (Table 6).

The structure canonical discriminant function coefficients are the coefficients of correlation between the variables and the function. Thus, the function is most closely connected with the number of repetitions of exercises of the fourth and first series of training tasks ($r_4 = 0.536$; $r_1 = 0.470$) (Table 7).

Table 6. Standardized Canonical Discriminant Function Coefficients. Boys Aged 15

Series of tasks	Function
	1
Series 1	.695
Series 2	-.541
Series 3	-.536
Series 4	.858
Series 5	.472
Series 6	.116

Table 7. Structure Matrix. Boys Aged 15

Series of tasks	Function
	1
Series 4	.536
Series 1	.470
Series 3	-.330
Series 5	.306
Series 2	.247
Series 6	.227

Table 8. Canonical Discriminant Function Coefficients (Unstandardized coefficients)

Series of tasks	Function
	1
Series 1	.468
Series 2	-.336
Series 3	-.296
Series 4	.623
Series 5	.329
Series 6	.088
(Constant)	-8.725

Table 9. Functions at Group Centroids. Boys Aged 15

Exercise Mode	Function
	1
1 – 6 repetitions, rest interval of 60 s	2.508
2 – 12 repetitions, rest interval of 60 s	-2.508

The coordinates of centroids for two groups make it possible to interpret the canonical function in relation to the role in classification. At the positive pole is a centroid for the exercise mode of 6 repetitions ($M_6 = 2.508$), at the negative – a centroid for the exercise mode of 12 repetitions ($M_{12} = -2.508$) (see Table 9, Fig. 1, 2). This indicates a significant difference in the impact of exercise repetition modes on the number of repetitions required for motor skills development in boys aged 15 during physical education classes. The results of classification of the groups show that 100.0 % of the original grouped cases were classified correctly (Table 10). Based on the discriminant function coefficients and centroids, it is possible to calculate

Table 10. Classification Results^{a,c}

Exercise Mode			Predicted Group Membership		Total
			1	2	
Original	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	0	10	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	.0	100.0	100.0
Cross-validated ^b	Count	1 – 6 repetitions, rest interval of 60 s	10	0	10
		2 – 12 repetitions, rest interval of 60 s	1	9	10
	%	1 – 6 repetitions, rest interval of 60 s	100.0	.0	100.0
		2 – 12 repetitions, rest interval of 60 s	10.0	90.0	100.0

a. 100.0% of original grouped cases correctly classified.

b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 100.0% of cross-validated grouped cases correctly classified.

Canonical Discriminant Function 1

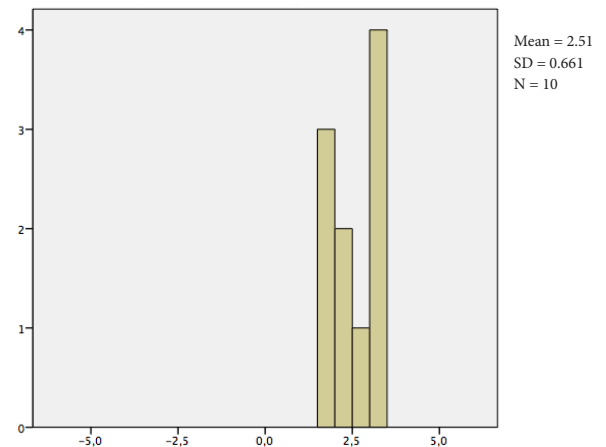


Fig. 1. Graphic representation of classification results: 6 repetitions, rest interval of 60 s

Canonical Discriminant Function 1

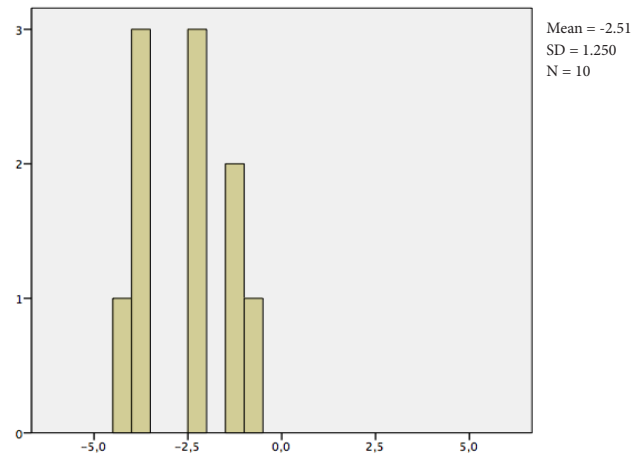


Fig. 2. Graphic representation of classification results: 12 repetitions, rest interval of 60 s

the number of repetitions for mastering the motor skill (Table 8). The value of the centroid for the exercise mode of 12 repetitions is approximate for calculation ($M_{12} = -2.508$).

Discussion

The assumption was made about a significant influence of the modes of alternating exercise repetitions and the rest interval on the effectiveness of teaching boys aged 15 the press headstand and handstand. The study found that statistically significant differences in the number of repetitions are observed in performing all training tasks. The boys aged 15 who use the second mode (6 sets 2 times each with a rest interval of 60 s) need fewer repetitions to master series of motor tasks 1, 3, 4, 5, and 6. The boys aged 15 who use the first mode (6 sets 1 time each with a rest interval of 60 s) need fewer repetitions to master the second series of training tasks (exercises to master starting and ending positions) (Table 2).

The obtained data complement the knowledge about the regularities of motor skills development in children and adolescents (Ré, Logan, Cattuzzo, Henrique, Tudela, & Stodden, 2018; Peers, Issartel, Behan, O'Connor, & Belton, 2020; Newell, 2020).

The analysis of standardized and structure discriminant function coefficients shows that in the process of teaching the press headstand and handstand, previous strength training (first series of tasks) and the ability to control movements (fourth series) are a priority. This confirms the information on the impact of exercise modes with a complex coordination structure (Browne et al., 2017).

The results of the analysis of the teaching process confirm the effectiveness of the discriminant function for determining the regularities of motor skills development and complement the knowledge about its use in physical education and sports (Broadhead & Church, 1982; Baudry, Sforza, Leroy, Lovecchio, Gautier, & Thouwarecq, 2009; Kermarrec, & Michot, 2007).

To plan the modes of exercises on the basis of discriminant function coefficients and centroids, it is possible to calculate the number of repetitions for mastering the motor skill. The calculation is performed using the following equation:

$Y = -8.725 + 0.468X_1 - 0.336X_2 - 0.296X_3 + 0.623X_4 + 0.329X_5 + 0.088X_6$, where Y is the function result, X_1 - X_6 are the number of repetitions of series of training tasks 1-6.

The value of the centroid for the exercise mode of 12 repetitions is approximate for calculation ($M_{12} = -2.508$).

Conclusions

The analysis of standardized, structure coefficients, and group centroids revealed that exercise modes significantly influence the process of teaching boys aged 15 the press headstand and handstand during physical education classes. The results of classification of the groups show that 100 % of the original grouped cases were classified correctly.

The study found that the mode of 6 sets 2 times each with a rest interval of 60 s is more effective than the mode of 6 sets 1 time with a rest interval of 60 s when teaching series of motor tasks 1, 3, 4, 5, and 6.

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Conflict of interest

The authors declare that there is no conflict of interest.

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РОЗПІЗНАННЯ ОБРАЗІВ: ЕФЕКТИВНІСТЬ ПРОЦЕСУ НАВЧАННЯ СТІЙКИ СИЛОЮ НА ГОЛОВІ І РУКАХ ХЛОПЦІВ 15 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 7 с., 9 табл., 2 рис., 26 джерел.

Мета дослідження – визначити вплив режимів виконання вправ на ефективність процесу навчання стійки силою на голові і руках хлопців 15 років.

Матеріали і методи. У дослідженні прийняли участь 20 хлопців 15 років. Діти та їхні батьки були інформовані про всі особливості дослідження і дали згоду на участь в експерименті. Для вирішення поставлених завдань були використані методи дослідження: вивчення та аналіз науково-методичної літератури; педагогічне спостереження, хронометраж навчальних завдань; педагогічний експеримент, методи математичної статистики, дискримінантний аналіз.

Результати. Приймається припущення про суттєвий вплив режимів чергування повторень вправ та інтервалу відпочинку на ефективність навчання стійки силою на голові і руках хлопців 15 років. Встановлено, що статистично значущі розбіжності у кількості повторень спостерігаються у виконанні всіх навчальних завдань. Хлопці 15 років, які використовують другий режим (6 підходів по 2 рази з інтервалом відпочинку 60 с), витрачають менше повторень на оволодіння 1, 3, 4, 5 та 6 серії рухових завдань. Хлопці 15 років, які використовують перший режим (6 підходів по 1 разу з інтервалом відпочинку 60 с) витрачають менше повторень

на оволодіння другої серії навчальних завдань (вправи на оволодіння вихідних і кінцевих положень).

Висновки. На основі аналізу нормованих, структурних коефіцієнтів та центроїдів груп визначено, що режими виконання вправ мають суттєвий вплив на процес навчання стійки силою на голові і руках хлопців 15 років на уроках фізичної культури. Результати класифікації груп показу-

ють, що 100 % вихідних згрупованих спостережень класифіковано вірно. Встановлено що режим 6 підходів по 2 рази з інтервалом відпочинку 60 с має більшу ефективність ніж режим 6 підходів по 1 разу з інтервалом відпочинку 60 с у процесі навчання 1, 3, 4, 5 та 6 серії рухових завдань.

Ключові слова: дискримінантний аналіз, хлопці 15 років, акробатичні вправи, режим виконання вправ, навчання.

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"I DON'T WANT TO COMMIT ACADEMIC DISHONESTY": THE ROLE OF GRIT AND GROWTH MINDSET IN REDUCING ACADEMIC DISHONESTY

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Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

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Abstract

Online learning is a substitute for learning in the classroom during a global pandemic. The problem that arises is that academic dishonesty behavior increases when online learning takes place. We assess how academic dishonesty occurs during online learning.

Purpose. We examine how academic dishonesty occurs during online learning. We review unethical behavior based on growth mindset and Grit as mediator variables.

Materials and methods. The questionnaire was filled out by 266 students (196 female; 70 male) from universities in Indonesia. Data collection uses three scales, namely the academic dishonesty scale ($\alpha = 0.862$), the growth mindset scale ($\alpha = 0.826$), and the grit scale ($\alpha = 0.760$). The path analysis using the multiple linear regression techniques was utilized to analyze the data in this study.

Results. This study demonstrates a negative correlation between growth mindset and academic dishonesty, indicating that the greater growth mindset, the less academic dishonesty. Additionally, there is a considerable negative correlation between Grit and academic dishonesty, such that the greater a person's Grit, the less academic dishonesty there is. Additionally, a positive correlation exists between the growth mindset and Grit. The greater one's growth attitude, the greater one's Grit. The primary finding is that Grit mediates the growth mindset's attitude toward academic dishonesty, implying that the growth mindset affects academic dishonesty by Grit.

Conclusions. The conclusion is that the growth mindset acts as a buffer against academic dishonesty. However, Grit's position is ideal for mediating the association between growth mindset and academic dishonesty. Thus, a growth mindset can boost students' Grit, which can help prevent academic dishonesty. We reviewed recommendations for decreasing unethical behavior in online education and its consequences for higher education.

Keywords: Growth Mindset, Grit, Academic Dishonesty, Online Learning, COVID-19.

Introduction

Education is an effort that aims to develop all the potential in individuals that lasts a lifetime following the values and culture that exist in society (Syahrina & Andini, 2017). Cultivating character building does not only apply when education begins, but higher education must also be the main focus in the development and key to the success of human resources in universities (Dhiu & Bate, 2018). The existing regulations in Indonesia are stated in the Law of the Republic of Indonesia number 12 of 2012, which states that students are members of the academic community who must have awareness in developing their potential in higher education to become intellectuals, scientists, practitioners, and professionals who character. Among the many characters implemented in the university environment is the value of honesty. Honesty is one of the main characters and personalities that

students must possess so that these characters can be integrated into the entire education and learning process (Nugraha et al., 2020).

But in fact, there are still many students who have not been able to apply honesty in the education and learning process. Unethical behavior is still often found, such as dishonesty in the form of cheating or plagiarism (Herdian & Wahidah, 2020). Academic dishonesty behavior is one way to overcome difficulties in learning (Fitria, 2019). Napisah and Yulianto (2018) stated that academic dishonesty among students is considered normal, so many students do this without feeling afraid or guilty.

Academic dishonesty is various forms of behavior that dishonestly benefits students, including cheating, plagiarism, stealing, and falsifying something related to academics (Sagita & Mahmud, 2019). Another definition says that academic dishonesty is an attitude that refers to the extent to which a person has a positive or negative evaluation of what he does

(Beck & Ajzen, 1991). The behavior of academic dishonesty is not a new one to be studied. Until now research on academic dishonesty has been carried out in various countries such as: Indonesia (Herdian et al., 2021), Malaysia (Yusoff, 2019), Thailand (Onu et al., 2021), Cina (Fatima et al., 2019), Afrika (Onu et al., 2021), Turki (Alan et al., 2019), Arab Saudi (Aljurf et al., 2020), Spanyol (Ezama et al., 2015), Australia, Amerika Serikat, Inggris dan Kanada (Amigud & Lancaster, 2019), dan some country others like Swedia, Jerman, Republik Ceko, Polandia dan Rumania (Ramberg & Modin, 2019; Amir & Sabbih, 2019; Mahmud et al., 2019).

Some researches found that there were internal factors and external factors that affect academic dishonesty. External factors consist of: peer pressure (Pantu et al., 2020), authoritarian parenting/parental pressure (Muflihah & Widyana, 2019), weak supervision during exams (Ezama et al., 2015), friendship (Griebeler, 2017), teacher pressure (Huang et al., 2015), group level (Mazar et al., 2008). In comparison, internal factors that influence academic dishonesty include: learning styles (Jurdi et al., 2011), anxiety (Pantu et al., 2020), stress (Simpson, 2016), and growth mindset (Thomas, 2017). Based on previous research, our research focuses on internal factors that affect academic dishonesty. To reduce academic fraud, let alone eliminate it, we must focus more on internal factors (Roig, 2006). This will be more effective because it can change students' perceptions of educational goals.

We highlight one internal factor that influencing academic dishonesty: the growth mindset. The growth mindset is the development of the mindset (Dweck, 2006). Mindset provides an overview of individual characteristics related to how someone views their abilities and intelligence, whether they are permanent or changeable (Duckworth, 2016). Ravenscroft et al. (2012) stated that individuals who have a growth mindset are more willing to try, conduct self-evaluation, and are motivated to learn. In line with this, Jach et al. (2018) view that individuals with a growth mindset will always have a positive view of their efforts, are more able to overcome difficulties in completing a task and are more motivated in challenging situations. According to Dweck (2015), students who believe that their abilities can be developed (growth mindset) will be superior to students who believe that their abilities are fixed or can no longer be changed (fixed mindset). In academia, it is important to see the difference between these two mindsets in how students perceive academic studies and their tendencies towards academic dishonesty.

Currently, studies that examine the effect of a growth mindset on academic dishonesty in students are still scarce. One of the studies that discuss the relationship between growth mindset and intellectual dishonesty is a study conducted by Thomas (2017) at several universities in Thailand with 207 students as respondents. The research report states that a growth mindset has a negative relationship with academic dishonesty. So when the growth mindset is high, it will reduce the behavior of academic dishonesty. In other words, for someone who has a growth mindset, the tendency to do academic dishonesty is minimal.

A growth mindset has been widely researched able to have a positive impact on the problems encountered in the field of education, such as helping to overcome some psychological barriers (Duchi et al., 2020), even being able to cope with issues that arise from events COVID-19 today (Zhao

et al., 2021). In addition, other studies said that the growth mindset could improve school wellbeing (Wahidah & Royanto, 2019), learning engagement (Zhao et al., 2021), as well as being able to make the students survive and take action in the face of decline (Bai et al., 2021).

Dweck (2006) said that students with a growth mindset believe that getting an optimal result requires hard work and effort. Besides, students with a growth mindset will assume that their intelligence and abilities can be achieved. Change so that they will be more diligent and focus on long-term learning, and more appreciative of the efforts they have made. They will tend to be more able to cope with a task and be more motivated when facing a challenging condition (Dweck et al., 2014; Chrisantiana & Sembiring, 2017). This means that students who have a growth mindset will tend to have Grit (Wahidah & Royanto, 2019).

Based on the research results of Duckworth et al. (2007) & Hochanadel and Finamore (2015), the results show that the growth mindset affects increasing one's Grit. This means that someone with a growth mindset will have Grit and perseverance in achieving a goal. This is also evidenced in another study in Indonesia of 418 high school students. Research results show that a growth mindset can predict a person's grit level at a higher level, meaning that someone who assumes that his ability can develop tends to have a higher grit level. So that, they will diligently try to achieve a goal (Wahidah & Royanto, 2019).

Sturman and Piemme (2017) state that persistence is considered a noncognitive factor that predicts student success. This is related to one's resilience in trying, despite facing obstacles in achieving long-term goals (Duckworth, 2016). According to Duckworth et al. (2007), Grit is a person's ability to maintain interest and effort towards a long-term goal and is formed from Grit and a combination of passion and perseverance to achieve specific goals. In other words, Grit can be nurtured and grown, tested and forged, which is then developed and changed through consistent efforts. Duckworth (2016) states that students which have high grit will gain success because they try hard to face challenges and maintain efforts to achieve their goals. Conversely, students with low grit will not succeed because they stop trying when facing challenges, problems, or difficulties.

Grit has a good effect on many psychological problems such as mental health (Masuyama et al., 2021), can eliminate the negative effects received by the environment (Blalock et al., 2015), is positively related to all factors of wellbeing (Vainio & Daukantaitė, 2016), and able to reduce academic dishonesty behavior (Herdian & Wahidah, 2021). In another study that discusses the effect of Grit on academic dishonesty, Amigud and Lancaster (2019) study found that lack of grit is an important factor in a student's decision to undertake academic dishonesty. In addition, Park (2003) in his research states that a student who gets better grades in a relatively short time and with less effort/resistance in trying less can contribute to the student's decision to cheat. In this case, perseverance is aspects of Grit (Dweck, 2006), so based on the relationship above, it is known that there is a relationship between low Grit and a student's decision to perform academic dishonesty behavior.

In this study, we predict that Grit as mediator variable in the relationship between growth mindset and academic

dishonesty. This is reinforced by a research report conducted by Wahidah and Royanto (2019) regarding Grit as a mediator variable between growth mindset and school wellbeing. The results show that growth mindset and Grit significantly affect school wellbeing, meaning that Grit can mediate well the relationship between growth mindset and school wellbeing. In another study, Chun-hua et al. (2019) make Grit, a mediator between future time perspective and procrastination. In addition, in their research, Siah et al. (2019) made Grit's personality a mediator for the effects of internet addiction on procrastination, with the result that consistency, which is one aspect of Grit, is a mediator for the effects of internet addiction on procrastination. Based on the two studies above, it can be seen that Grit can mediate negative behaviors such as academic procrastination and internet addiction. Therefore, researchers researched Grit as a mediator variable to see the effect of a growth mindset on academic dishonesty.

Based on the background described above, the researcher further investigated the role of Grit as a mediator variable in the relationship between growth mindset and academic dishonesty. So our hypothesis is that there is an influence of growth mindset on academic dishonesty, there is an influence of growth mindset on academic dishonesty, there is an effect of Grit on academic dishonesty, and there is an influence of growth mindset on academic dishonesty mediated by Grit.

Materials and methods

This study uses a quantitative approach to determine the effect of the independent variable on the dependent variable through the mediating variable. So path analysis is used for this study.

Study participants

Participants in the study are 266 students of the Faculty of Math and Science in Indonesia comprising of three departments of Mathematics (N: 37/14%), Chemicals (N: 105/39%), and Physics (N: 124/47%). The female gender dominated this study, namely 196 (74%) students, while 70 (26%) students were male. The number of participants by semester, semester 2 is 116 (44%), semester 4 is 80 (30%), semester 6 is 48 (18%), and semester 8 is 22 (8%). The number of participants based on GPA, participants with GPA 2.00-2.75 were 7 (3%), 2.76-3.50 were 113 (42%), 3.51 – 4.00 were 146 (55%) (Table 1).

Study organization

Academic Dishonesty Scale

Data collection using an academic dishonesty scale measuring instrument. This scale is based on aspects of academic dishonesty McCabe and Trevino (1993) and Stone et al., (2010), developed by Ampuni et al. (2019), including fraud, unauthorized collaboration, and plagiarism. An example of an item on a scale academic dishonesty is "Helping others to commit fraud during the test". Scoring data using a Likert scale from 1 (Never at all) to 5 (very often) in the form of a statement favorable, with 14 – items. Cronbach alpha coefficient the academic dishonesty scale is 0.862.

Table 1. Demographics of Participants

Demographics	Levels	Counts	% of Total	Cumulative %
Sex	Male	70	26.3 %	26.3 %
	Female	196	73.7 %	100.0 %
Age	17	2	0.8 %	0.8 %
	18	50	18.8 %	19.5 %
	19	86	32.3 %	51.9 %
	20	76	28.6 %	80.5 %
	21	38	14.3 %	94.7 %
	22	10	3.8 %	98.5 %
	23	4	1.5 %	100.0 %
Major	Fisika	124	46.6 %	46.6 %
	Kimia	105	39.5 %	86.1 %
	MTK	37	13.9 %	100.0 %
Semesters	2	116	43.6 %	43.6 %
	4	80	30.1 %	73.7 %
	6	48	18.0 %	91.7 %
	8	22	8.3 %	100.0 %
GPA	2.00-2.75	7	2.6 %	2.6 %
	2.76-3.50	113	42.5 %	45.1 %
	3.51-4.00	146	54.9 %	100.0 %

Growth Mindset Scale

It is collecting data using a growth mindset scale. This scale is based on aspects of the growth mindset according to Dweck (2006), which has been developed by Wahidah and Royanto (2019), which include: Beliefs about intelligence, talent, and character that can be developed; Belief in challenges, difficulties, and failures for self-development; Beliefs about effort and hard work; Confidence in criticism and input from others as feedback on success. An example of an item on this scale is "I can develop myself to be more positive". Scoring data using a Likert scale from 1 (Strongly Disagree) to 4 (Strongly Agree) for the favorable statement, as for the unfavorable statements, using a Likert scale from 4 (Strongly Disagree) to 1 (Strongly Agree), with a total of 20 items. Cronbach alpha coefficient of this scale is 0.826.

Grit scale

Data retrieval using a grit scale measuring instrument, this scale is arranged based on grit aspects according to Sturman & Piemme (2017), namely: Perseverance of Effort. An example of an item on this scale is "I don't always really try". Scoring data using a Likert scale from 1 (Strongly Disagree) to 4 (Strongly agree) for favorable statements, and 4 (Strongly Disagree) to 1 (Strongly agree) for unfavorable statements, with a total of 12 items. The grit scale has Cronbach alpha coefficient = 0,760.

Statistical analysis

This study aims to determine the role of grit as a mediator in the relationship between Growth Mindset and Academic Dishonesty. The analytical method used in this study is multiple linear regression path analysis which aims to see the direct and indirect relationship between the independent variable and the dependent variable and the independent

Table 2. Intercorrelation among Growth Mindset, Grit and Academic dishonesty

Indicators	Mean	SD	1	2	3	4	5
1. Growth Mindset	56.8	5.15	—				
2. GRIT	35.3	5.71	0.367 *** < 0.001	—			
3. Academic dishonesty	22.3	6.43	-0.158 ** 0.01	-0.371 *** < 0.001	—		
4. Semester	3.82	1.94	0.007 0.912	0.047 0.445	0.008 0.893	—	
5. Age	19.5	1.17	-0.04 0.52	-0.037 0.543	0.024 0.699	0.828 *** < 0.001	—

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

variable on the dependent variable mediated by the mediator variable based on the guidelines according to Baron & Kenny (cited in Urbayatun, 2013).

Results

Correlation among variables

Based on table 2. It is known that there is a significant negative relationship between growth mindset and academic dishonesty ($r = -0.158$; $p < 0.010$). That is, the higher score of growth mindset, the lower score of academic dishonesty. There is also a significant negative relationship between Grit and academic dishonesty ($r = -0.371$; $p < 0.000$). The higher score of Grit, the lower score of academic dishonesty. In addition, there is a significant positive relationship between growth mindset and Grit ($r = 0.367$; $p < 0.000$). That is, the higher score of growth mindset, the higher score of Grit also. On the other hand, there are no significant relationship between variable (growth mindset, grit, academic dishonesty) with demographics of participants (semester and age).

Regression and Mediation Result

The first analysis was conducted to see the direct path of the independent variable, namely growth mindset, to the dependent variable, namely academic dishonesty. Table 3 shows a significant effect of growth mindset on academic dishonesty ($R^2 = 0.025$; $p < 0.010$). However, the effect is relatively small. Amount of 2.5% growth mindset contributes to academic dishonesty, while other factors influence the remaining 97.5%.

Table 3. Model Summary – Growth mindset to Academic dishonesty

Model	R	R ²	Adjusted R ²	R ² Change	F Change	Estimate	P
H ₀	0	0	0	0		0	
H ₁	0,158	0.025	0.021	0.025	6,738	-0.197	< 0.010

Table 4. Model Summary – Growth mindset to Grit

Model	R	R ²	Adjusted R ²	R ² Change	F Change	Estimate	p
H ₀	0	0	0	0		0	
H ₁	0,367	0.135	0.131	0.135	41,111	0.407	< 0.000

The third analysis was conducted to see the effect of the variable grit path on academic dishonesty. Table 5 shows a significant effect of growth mindset on Grit ($R^2 = 0.138$; $p < 0.000$). However, the effect is relatively small, namely

13.8% growth mindset contributes to Grit, while other factors influence the remaining 86.2%.

Table 5. Model Summary –Grit to Academic dishonesty

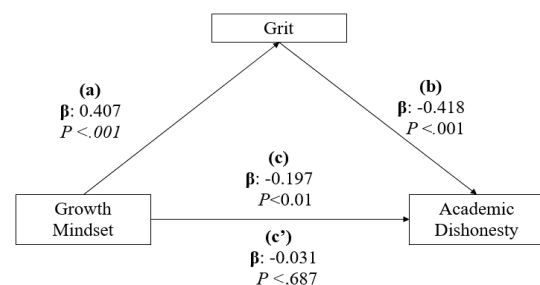
Model	R	R ²	Adjusted R ²	R ² Change	F Change	Estimate	p
H ₀	0	0	0	0		0	
H ₁	0,371	0.138	0.135	0.138	42,200	-0.418	< 0.000

The last analysis was carried out to see the path of the two independent variables, namely growth mindset and Grit, to the dependent variable, namely academic dishonesty. In this last analysis, it can be seen how the results of the mediation analysis were obtained. Table 6. shows that the results are insignificant between growth mindset and Grit on academic dishonesty ($R^2 = 0.138$; $p < 0.687$). When compared with the results of the direct path previously obtained a significant value between the growth mindset and academic dishonesty, and the indirect results obtained insignificant results. So the conclusion is that there is a difference in the significant value of direct and indirect effects. So it can be concluded that Grit can fully mediate the relationship between growth mindset and academic dishonesty.

Table 6. Model Summary – Growth mindset to Academic dishonesty with Grit mediation

Model	R	R ²	Adjusted R ²	R ² Change	F Change	Estimate	p
H ₀	0	0	0	0		0	
H ₁	0.372	0.138	0.132	0.138	21.115	-0.031	> 0.687

Based on the results of path analysis, we conclude all the research results in Figure 1. This study confirms that grit can mediate the relationship between growth mindset and academic dishonesty. This is shown by the change in the value of the direct effect to the indirect effect, which becomes insignificant.

**Figure 1.** Mediation model

Discussion

Growth mindset dan Academic dishonesty

Based on the multiple linear regression test path analysis results, which is related to the influence of growth mindset on academic dishonesty or called path c, it is obtained that the value of F count = 6.738 and t count = -2.596 and probability Sig. (p) = 0.010 ($p < 0.050$), meaning that it can be said that the growth mindset variable has a significant effect on the academic dishonesty variable, so the hypothesis is accepted that there is a significant effect of the growth mindset on academic dishonesty.

In addition, the influence of a growth mindset on academic dishonesty is strengthened by the regression equation results, namely: $y = 33,508 + (-0.197)X$. The equation shows that if the growth mindset is considered constant, the change in academic dishonesty will decrease or decrease by (-0.197) units for each addition of $X = 1$. These results prove that the growth mindset can have a negative effect on academic dishonesty. If students have a high growth mindset, then academic dishonesty will always decline. Vice versa, if students have a low growth mindset, academic dishonesty will always increase. The results of this study are in line with research conducted by Thomas (2017), which states that a growth mindset has a negative relationship with academic dishonesty. So when an individual has a high growth mindset, it will reduce academic dishonesty behavior. In other words, the tendency to do academic dishonesty is minimal for someone who has a growth mindset/ developing thinking.

A growth mindset is a person's belief that his skills and abilities can grow and develop over time (Dweck, 2006). According to Hochanadel and Finamore (2015), individuals with a growth mindset believe that they can develop intelligence over time. In the academic field, Jach et al. (2018) view that individuals with a growth mindset will always tend to have a favorable view of their efforts, be more able to overcome difficulties in completing a task, and be more motivated in challenging situations. In other words, individuals with a growth mindset will avoid doing negative behaviors such as doing academic dishonesty.

The correlation coefficient (R^2) variable growth mindset towards academic dishonesty amounted to 0.158 while the coefficient of determination R^2 of 0.025 means that the growth mindset influence or effective contribution to academic dishonesty by 2.5%, while the remaining 97.5% is the contribution of a factor. Other variables that were not investigated were positive thinking variables that contributed effectively to cheating behavior by 8.9% (Nurmayasari & Murusdi, 2015).

Growth mindset and Grit

Based on the multiple linear regression path analysis results, which is related to the influence of growth mindset on Grit, or called path a, obtained F count = 41.111 and t count = 6.412 and probability Sig. (p) = 0.000 ($p < 0.050$), then the hypothesis is accepted, namely that growth mindset has a significant effect on Grit.

This is reinforced by the results of the regression equation, namely: $y = 12.230 + 0.407x$. From this equation, it can be concluded that the growth mindset will increase or

increase by 0.407 for every change that occurs in Grit. These results prove that the growth mindset can have a positive effect on Grit. If students have a high growth mindset, Grit will always increase. Likewise, if a student has a lower growth mindset than the Grit, it will be below.

In-depth research conducted by Duckworth et al. (2007) & Hochanadel and Finamore (2015) regarding the effect of growth mindset on Grit found that growth mindset affects increasing one's Grit. This means that someone who has a high growth mindset will have Grit and perseverance in achieving a goal.

Grit is a person's ability to maintain interest and effort towards a long-term goal and is formed from perseverance and a combination of passion and persistence to achieve specific goals (Duckworth et al., 2007). Sturman and Piemme (2017) state that persistence is considered a noncognitive factor that predicts student success. In this case, the persistence in question is related to perseverance in one's business.

The correlation coefficient (R^2) variable growth mindset against the Grit of 0.367, while the coefficient of determination R^2 of 0.135 means that the growth mindset influence or practical contribution to the Grit of 13.5% while the remaining 86.5% is the contribution of other factors not investigated such as the perception of father involvement in parenting which contributed effectively to Grit of 5.5% (Kusumawardhani et al., 2018).

Grit and Academic dishonesty

Based on the multiple linear regression path analysis results, which is related to the effect of Grit on academic dishonesty or called path b, the obtained F value = 42.200 and t count = -6.496 and probability Sig. (p) = 0.000 ($p < 0.050$), then the hypothesis is accepted, namely that Grit significantly affects academic dishonesty.

In addition, the effect of Grit on academic dishonesty is strengthened by the results of the regression equation, namely: $y = 37.100 + (-0.418)X$. The equation shows that if Grit is considered constant, the change in academic dishonesty will decrease or decrease by (-0.197) units for each addition. $X = 1$. These results prove that Grit can have a negative effect on academic dishonesty. If students have high Grit, then academic dishonesty will always decline. Vice versa, if students have low Grit, then academic dishonesty will always increase. This is in line with the research by Amigud and Lancaster (2019), which found that lack of grit /diligence is an important factor in a student's decision to undertake academic dishonesty.

The correlation coefficient (R^2) variable grit against academic dishonesty result R^2 of 0.371 while the coefficient of determination R^2 of 0.138 means that the grit influence or effective contribution to academic dishonesty of 13.8%, while the remaining 86.2% is contributed from other factors that were not examined, such as the self-confidence variable, which contributed effectively to the academic dishonesty variable of 51.2% (Syahrina & Andini, 2017).

Growth mindset and Academic dishonesty with Grit as a mediator variable

The results of the multiple linear regression model path analysis have been able to prove the research hypothesis that

there is an influence of growth mindset on academic dishonesty mediated by Grit or called path c' , wherein path c' it is expected that data analysis shows insignificant results (Urbayatun & Widhiarso, 2012). Based on the analysis of the data on path c' , it is obtained that the calculated F value = 21.115 and the probability of Sig. (p) = 0.687 ($p > 0.050$) from these results, it can be seen that the significance value is greater than 0.05, meaning that the value is not significant. Due to the difference in the significant value of the direct and indirect effects of growth mindset on academic dishonesty, namely Sig. (p) = 0.000 to Sig. (p) = 0.687 so that the hypothesis is accepted, namely that there is an influence of growth mindset on academic dishonesty mediated by Grit.

Based on the provisions of the significance of the mediator variable, according to Baron and Kenny (1986) that the results on path c' must be insignificant, and data from the research analysis on the influence of growth mindset on academic dishonesty mediated by Grit shows insignificant results, so it can be concluded that the growth mindset through Grit as a mediator variable affects academic dishonesty by mediating in full (full mediation).

Wahidah and Royanto (2019) research shows that persistence can completely mediate the relationship between growth mindset and academic dishonesty (full mediation). This means that to have good school wellbeing, students with a growth mindset need to have persistence. Research conducted by Wahidah and Royanto (2019) strengthens the results of this study which showed that Grit could mediate perfect/full (full mediation) the relationship between the growth mindset towards academic dishonesty. This means that students with a high growth mindset will increase their Grit to affect their decision not to perform academic dishonesty behavior. In other words, to reduce academic dishonesty behavior, students with a growth mindset also need to have Grit.

Students who believe that their intelligence, abilities, and character can be continuously developed (have a growth mindset) will have a positive academic attitude so that they do not commit academic violations such as doing academic dishonesty behavior. This happens because the student will diligently try to achieve the desired goals and ideals without justifying any means, thus making him not easily give up with the challenges and difficulties he faces. The main emphasis is that having a growth mindset is not enough to make a student not perform academic dishonesty because Grit is needed as an intermediary. This means that a growth mindset must be accompanied by resilience in trying (serious effort/ grit) to avoid engaging in academic dishonesty behavior.

Influence or effective contribution is given Grit as mediator variables influence the growth mindset towards academic dishonesty indicated by the value of R^2 of 0.372 and R-square of 0.138. This shows that the growth mindset through Grit as a mediator variable effectively influences academic dishonesty by 13.8%. The remaining 86.2% is a contribution from other factors (factors not examined).

The role of the mediating variable can also be seen by comparing the value of R-square, namely the value of the influence or effective contribution given before passing through the mediator variable (Rsquare direct path) with Rsquare after passing through the mediator variable (Rsquare indirect path). Based on the analysis on path c , namely the influence of a growth mindset on academic dishonesty, the result is an

R-square value of 2.5%. In contrast, after going through the mediator variable, namely Grit (path c'), the R-square value is 13.8%, meaning a higher value. On the effect of growth mindset on academic dishonesty by 11.3%.

This study provides practical implications for educational institutions to consider growth mindset and Grit as targets for intervention. One example of a growth mindset intervention was Paunesku et al. (2015) on high school students in America. The growth mindset intervention affects students' beliefs and beliefs about academic tasks. The growth mindset intervention must be accompanied by Grit, especially related to persistence in trying to reduce academic dishonesty behavior. Interventions related to Grit in reducing academic dishonesty can be done by training fighting skills such as holding adversity intelligence training. The fighting power training related to the effectiveness of Islamic-based adversity intelligence training to increase the fighting power of new students at the Uin Antasari Banjarmasin that had been carried out by Ma'ruf (2020) showed the results that Islamic-based adversity intelligence training was proven to be effective in increasing the fighting power of new students.

Conclusions

Based on the research and discussion results, it was concluded that the hypothesis in this study was accepted, namely that there was an influence of growth mindset on academic dishonesty mediated by Grit on students. We believe that academic dishonesty behavior isn't motivated by the growth mindset factor only, but other variables ultimately make a person decide to commit academic dishonesty or not. We suggest paying more attention to how important Grit is to unethical behavior. Grit is considered a noncognitive variable that affects academic achievement but can also be a stronghold for someone to decide whether to behave honestly or dishonestly. The limitation of this study lies in the limited number of participants. So we suggest that other studies use more participants. In addition, it is necessary to consider determining other factors that affect academic dishonesty and Grit to get a more comprehensive conclusion.

Conflict of interest

The authors declare they have no conflicts of interest.

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«Я НЕ ХОЧУ ЧИНИТИ АКАДЕМІЧНОЇ НЕЧЕСНОСТІ»: РОЛЬ ВИТРИМКИ ТА МИСЛЕННЯ ЗРОСТАННЯ У ЗМЕНШЕННІ АКАДЕМІЧНОЇ НЕЧЕСНОСТІ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

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Онлайн-навчання є заміною навчання в класі під час глобальної пандемії. Проблема полягає у тому, що під час онлайн-навчання зростає академічна нечесність. У дослідженні ми оцінюємо, як виникає академічна нечесність під час онлайн-навчання.

Мета дослідження – дослідити, як виникає академічна нечесність під час онлайн-навчання та розглянути неетичну поведінку, що базується на мисленні зростання та витримці як змінних-посередників.

Матеріали і методи. Анкету заповнили 266 студентів (196 дівчат; 70 хлопців) університетів Індонезії. Для збору даних використовувалися три шкали, а саме: шкала академічної нечесності ($\alpha = 0,862$), шкала мислення зростання ($\alpha = 0,826$) та шкала витримки ($\alpha = 0,760$). Для аналізу даних у дослідженні застосовано пат-аналіз з використанням методів множинної лінійної регресії.

Результати. Дане дослідження демонструє негативну кореляцію між мисленням зростання та академічною нечесністю, вказуючи на те, що чим сильніше мислення зростання, тим менше академічної нечесності. Крім того, існує

значна негативна кореляція між витримкою та академічною нечесністю, тобто чим більшу витримку має людина, тим менше вона чинить академічної нечесності. Крім того, існує позитивна кореляція між мисленням зростання та витримкою. Чим сильніше мислення зростання, тим сильніша витримка. Основний висновок полягає в тому, що витримка опосередковує відношення мислення зростання до академічної нечесності, тобто мислення зростання впливає на академічну нечесність через витримку.

Висновки. Висновок полягає в тому, що мислення зростання діє як буфер проти академічної нечесності. Однак позиція витримки є ідеальною для встановлення зв'язку між мисленням зростання та академічною нечесністю. Таким чином, мислення зростання може підвищити витримку студентів, що може допомогти запобігти академічній нечесності. Нами розглянуті рекомендації щодо зменшення неетичної поведінки в онлайн-освіті та її наслідків для вищої освіти.

Ключові слова: мислення зростання, витримка, академічна нечесність, онлайн-навчання, COVID-19

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TECHNOLOGY OF TEACHING GAME TECHNIQUES IN VOLLEYBALL AT THE STAGE OF INITIAL TRAINING

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Abstract

Purpose. To scientifically substantiate the method of teaching game techniques at the stage of initial training to increase the level of technical fitness of young volleyball players.

Materials and methods. The experimental research involved 36 young volleyball players born in 2011 – 18 athletes from the CI “Zaporizhzhia Regional Children and Youth Sports School” of the Zaporizhzhia Regional Council (main group) and 18 athletes from the CI “Vilniansk City Children and Youth Sports School ‘Kolos’” (comparison group) during the 2020-2021 academic year.

Results. In the course of experimental research, the indicators of physical fitness of young volleyball players of the main group significantly increased in 80% of tests. The analysis of technical fitness indicators of young volleyball players of the main group shows that the introduction of the author's method affects their positive dynamics in the tests: consecutive wall passes from a 3 m distance in 30 s; consecutive overhead passes in 30 s; consecutive forearm passes in 30 s; tennis ball toss over the net to the front line; tennis ball toss over the net to the back line (statistically significant differences, if $p < 0.05$).

Conclusions. The author's method of teaching game techniques in volleyball is effective and contains the algorithm of teaching, the levels of mastering game techniques, the stages of teaching game techniques, the sequence of teaching game techniques, the classification, occurrence and prevention of young volleyball players' errors in the process of teaching game techniques, differentiation of exercises.

Keywords: volleyball, method, teaching, ability, skill.

Introduction

In the modern theory and methodology of sports training in general, and in volleyball in particular, it is axiomatic that at the stage of initial training of young athletes the leading role is played by the components of teaching motor actions that are directly related to the development of basic knowledge, abilities and skills (Khudolii, Iermakov, & Bartik, 2020). These components significantly determine the level of proficiency in volleyball techniques, without a successful acquisition of which further quality sports training is practically impossible (Altavilla, 2021).

Modern scientific research highlights various methodological directions regarding the development of game techniques in young volleyball players, which focus on determining and applying the sequence of training, taking into account the age peculiarities of sensory systems functioning

(Boichuk, Iermakov, Vintoniak, & Yermakova, 2021); on developing the abilities for spatial and temporal orientation of young volleyball players when performing game techniques, using the extrapolation of motor actions (Boichuk, 2012); on applying anticipation reactions regarding the result of the elementary motor act, which is the basic part of a game technique (Oliinyk, Doroshenko, Melnyk, Sushko, Tyshchenko, & Shamardin, 2021); comprehensive teaching of game techniques in volleyball, using psychophysiological and physical components (Raiola, Tafuri, & Lipoma, 2016; Raiola, 2017).

Another promising direction is the comprehensive improvement of teaching game techniques to young volleyball players and developing corresponding motor abilities that determine the effectiveness of their stable performance (Hnatchuk, Lynets, Khimenes, & Pityn, 2018). In addition, it is effective to use the pedagogical principles of programmed teaching of certain elements of game techniques in volleyball at the stage of initial training (Boichuk, Iermakov, & Nosko, 2017).

The studies by Raiola, (2014b); Marchenko and Boiechko, (2018) highlight problematic issues about taking into account sexual dimorphism factors in the process of teaching motor actions, with an emphasis on developing coordination abilities in girls engaged in volleyball. The authors state that the great majority of girls who played volleyball according to the main program had an “average”, “below average”, and “low” level of coordination abilities and rather low levels of performing the basic game techniques – overhead passes, forearm passes, types of serves, attack and fake hits). Similar tendencies regarding the development of motor qualities during volleyball classes were recorded in experimental studies with girls aged 13-14 (Nešić, Ilić, Majstorović, Grbić, & Osmankač, 2013) and 15 years (Marchenko & Dykhanova, 2019).

Also promising are the directions that focus on the use of intensive and extensive means of cognitive orientation in the methodology of teaching game techniques in volleyball. (D’isanto, Altavilla, & Raiola, 2017) and the formation of appropriate types of feedback based on models of behavior in the “coach – player” system (Giannousi, Mountaki, Karamoussalidis, Bebetos, & Kioumourtzoglou, 2016). These directions help to significantly intensify the process of teaching game techniques in volleyball and to improve the quality of mastering the basic motor actions. The methodological basis of these directions is the studies (Raiola, 2011; Raiola, 2014a) which analyze the factors of motor control in the process of abilities and skills development in the context of behavioral, cognitive, gestalt-pedagogical, phenomenological theories and the neurophysiological and didactic foundations of their application in physical education and sports.

The direction that is based on the use of active methods of teaching and creating problem situations is close to the above. The study by Renshaw and Chow (2019) shows that such a methodological approach is an effective pedagogical option for teaching voluntary movements in physical education and sports.

The development of a certain abstract model of the future structure of motor activity, including game techniques in volleyball, using logical means, ensures the achievement of predicted states of the athlete’s motor function. The studies by Chernenko et al. (2017), Hakman, Nakonechniy, Moseichuk, and Liasota (2017), Samsudin, Setiawan, Taufik, and Solahuddin (2021) show the possibilities of using modeling methods in the process of teaching game techniques in volleyball, based on the material of training sessions with schoolchildren and students. At the same time, of importance are the sequence of applying exercises and their availability in the context of corresponding physical development of young athletes (Forte, D’isanto, Di Domenico, & Altavilla, 2019) and the current level of athletes’ functional fitness as a prerequisite for successful development and further improvement of motor abilities and skills – volleyball game techniques (Maklout, 2014; Tishchenko, Sokolova, & Popov, 2019; Shchepotina et al., 2021).

Researchers (Rogal, & Vaskevych, 2019; Oliynyk & Doroshenko, 2018) emphasize the importance of developing a positive psychological climate in volleyball teams, which helps increase athletes’ motivation to learn and improve the game techniques, and leads to increased efficiency of competitive activities.

The study by Tishchenko and Lysenchuk (2019) focuses on analyzing modern approaches to the development and

practical use of innovative technologies for improving special physical and technical-tactical fitness in team sports. The authors emphasize that comprehensive improvement of athletes’ special physical and technical fitness is a necessary basis for successful implementation of the process of teaching motor skills and abilities, technical and tactical actions and their combinations, which leads to increased efficiency of the competitive process.

Despite the detailed and thorough study of the problems of teaching motor actions in volleyball, a number of issues regarding the age-related peculiarities of developing athletes’ motor function, determination of an optimal sequence of mastering game techniques, integrated development of principal motor qualities and basic game techniques in volleyball are not yet completely solved.

Hypothesis. The introduction of a scientifically grounded method of teaching game techniques at the stage of initial training will help increase the level of technical fitness and efficiency of competitive activities of young volleyball players.

Purpose. To scientifically substantiate the method of teaching game techniques at the stage of initial training to increase the level of technical fitness of young volleyball players.

Material and methods

Participants

The experimental research involved 36 young volleyball players born in 2011 – 18 athletes from the CI “Zaporizhzhia Regional Children and Youth Sports School” of the Zaporizhzhia Regional Council (main group) and 18 athletes from the CI “Vilniansk City Children and Youth Sports School ‘Kolos’” (comparison group).

Organization of the research

The research was conducted during the 2020-2021 academic year at sports facilities of the Communal Institution “Zaporizhzhia Regional Children and Youth Sports School” of the Zaporizhzhia Regional Council, the Communal Institution “Vilniansk City Children and Youth Sports School ‘Kolos’”, and the Department of Physical Rehabilitation, Sports Medicine, Physical Education and Health of Zaporizhzhia State Medical University of the Ministry of Health of Ukraine. The comparison group was trained in accordance with the current volleyball curriculum for children and youth sports schools, specialized children and youth sports schools of the Olympic reserve, sports schools of high sportsmanship, and specialized sports educational institutions (2009). The main group was trained using the developed author’s technology for teaching motor actions in volleyball, which contains the following components:

Algorithm of teaching. 1) Building knowledge about the features of a particular game technique (biomechanical and pedagogical analysis of the performance technique). 2) Forming an idea of the performance of a particular game technique, using verbal and nonverbal means, description, visual materials, etc. 3) Developing motor abilities related to a particular game technique. 4) Developing motor skills related to a particular game technique and their improvement.

Levels of mastering game techniques. 1) Developing the abilities and skills of diagnostics and classification of separate

locomotor acts that are part of the integral game technique. 2) Developing the capability to reproduce the acquired abilities and skills based on understanding of the logic of their internal structure and the athlete's psychophysiological qualities. 3) Developing the capability of the athlete to use the acquired information for implementing motor actions in the training and competitive processes. 4) Developing the capability of the athlete to feel at ease in highly variable competitive situations and make correct decisions concerning the application of variants of game techniques based on the anticipation reaction and its improvement.

Stages of teaching volleyball techniques.

1) Stage of initial learning. The goal is to teach to perform a game technique at the motor ability level.

2) Stage of in-depth learning. The goal is to ensure the performance of game techniques at the motor skill level.

3) Stage of reinforcement and improvement. The goal is to ensure the integral performance of game techniques and their combinations in highly variable conditions of the competitive activity.

Sequence of teaching volleyball techniques.

1) Game stand, moving. 2) Overhead pass. 3) Forearm pass. 4) Serve. 6) Spikes. 7) Blocking. 8) Combinations of game techniques.

Classification, occurrence and prevention of young volleyball players' errors in the process of teaching game techniques.

1) Classification: errors in separate game techniques and common errors; local and complex; typical and atypical; automatic and non-automatic; significant and insignificant. 2) Occurrence: athletes' incorrect understanding of the criteria for performing the game technique; athletes' inability to imaginatively analyze the performance of the game technique; mismatch between the level of intellectual development and muscle sensations; insufficient level of physical fitness; unbalanced development of physical qualities; inappropriate technical means; psychological determinants – uncertainty, hesitancy, etc. 3) Prevention: understanding of the general purpose of teaching game techniques; athletes' understanding of the rational technique of performance; availability of educational materials (intellectual, psychological, physical components); technical specification of game techniques; rational relationship between the speed and accuracy of performing game techniques.

Differentiation of exercises. General development, preliminary, preparatory, special (model).

To determine the effectiveness of the author's method of teaching game techniques, the study conducted pedagogical testing of physical and technical fitness of young volleyball players. The main group included the indicators of 18 young volleyball players of the CI "Zaporizhzhia Regional Children and Youth Sports School" of the Zaporizhzhia Regional Council, the comparison group – the indicators of 18 young volleyball players of the CI "Vilniansk City Children and Youth Sports School 'Kolos'". During the 2020-2021 academic year, the author's method of teaching volleyball game techniques was introduced into the training process of athletes born in 2011 of the Communal Institution "Zaporizhzhia Regional Children and Youth Sports School" of the Zaporizhzhia Regional Council.

Research methods

The analysis and generalization of scientific and methodological literature and the Internet materials helped summarize the experience of specialists who studied the problem of developing a method of teaching the elements of volleyball technique. Pedagogical testing was conducted to determine the level of physical and technical fitness of young volleyball players. The pedagogical experiment involved the development of a method of teaching the elements of volleyball technique and experimental verification of its effectiveness.

Statistical analysis

The obtained indicators were analyzed using the methods of mathematical statistics – determination of the arithmetic mean ($\bar{X}$), square deviation (S), percentage value (%), and statistically significant differences ($p < 0.05$).

Results

The results of pedagogical testing of young volleyball players of the main and comparison groups before and after the application of the author's method are presented in Tables 1 and 2.

The analysis of physical fitness indicators of young volleyball players of the main and comparison groups shows

Table 1. Indicators of physical fitness of young volleyball players of the main and comparison groups before and after the pedagogical experiment, $n = 36$ ($\bar{X} \pm S$)

Tests	Indicators			
	Main group ($n = 18$)		Comparison group ($n = 18$)	
	09.2020	06.2021	09.2020	06.2021
20 m run, s	4.61±0.11	4.32±0.12*	4.81±0.28	4.68±0.29
Standing high jump, cm	26.17±2.23	31.08±3.36*	23.39±3.41	24.47±3.57
Standing long jump, cm	139.99±10.08	156.22±12.28*	141.88±10.93	142.22±12.57
6×5 m shuttle run, s	11.69±0.69	10.31±0.58*	11.75±0.79	11.33±0.88
Tossing a medicine ball weighing 1 kg, m:				
sitting	3.65±0.68	4.00±0.74	3.16±0.50	3.26±0.49
standing	5.69±1.41	6.73±1.23*	5.32±1.01	5.72±1.34
jumping	5.60±1.21	6.81±1.34*	5.54±0.98	5.58±1.09

Note: * – statistically significant differences, if $p < 0.05$

Table 2. Indicators of technical fitness of young volleyball players of the main and comparison groups before and after the pedagogical experiment, $n=36$ ($X \pm S$)

Tests	Indicators			
	Main group (n = 18)		Comparison group (n = 18)	
	09.2020	06.2021	09.2020	06.2021
Wall passes from a 3 m distance in 30 s, n	14.44±2.17	19.79±2.08*	13.86±2.77	15.72±2.45
Overhead passes in 30 s, n	14.37±2.23	20.57±3.11*	13.11±3.15	16.85±3.48
Forearm passes in 30 s, n	13.31±2.09	20.12±3.14*	2.89±3.03	15.86±3.66
Tennis ball toss over the net to the front line, n	4.08±1.02	6.89±1.07*	4.28±1.07	5.26±1.44
Tennis ball toss over the net to the back line, n	5.47±1.18	8.58±1.06*	5.34±1.67	6.33±1.74

Note: * – statistically significant differences, if $p < 0.05$

that the introduction of the author's method has an indirect impact on their positive dynamics (Table 1). At the beginning and end of the 2020-2021 academic year, the indicators of physical fitness of young volleyball players of the main group significantly increased in the following tests: 20 m run; standing high jump; standing long jump; 6x5 m shuttle run; tossing a medicine ball weighing 1 kg while standing and jumping ($p < 0.05$). No statistically significant differences were recorded in the results of tossing a medicine ball weighing 1 kg while sitting, although there is a linear tendency towards an increase in the results after the introduction of the author's method of teaching volleyball techniques. No statistically significant differences were recorded in the results of physical fitness of young volleyball players of the comparison group, but there is a linear tendency towards an increase in the results in the second testing (at the end of the academic year). In this context, the indicators of physical fitness are considered as a necessary prerequisite for quality acquisition of game techniques in volleyball.

The analysis of technical fitness indicators of young volleyball players of the main and comparison groups shows that the introduction of the author's method directly affects their positive dynamics (Table 2). Pedagogical testing of young volleyball players of the main and comparison groups before and after the introduction of the author's method of teaching game techniques shows that statistically significant differences were recorded in the following tests: consecutive wall passes from a 3 m distance in 30 s; consecutive overhead passes in 30 s; consecutive forearm passes in 30 s; tennis ball toss over the net to the front line; tennis ball toss over the net to the back line ($p < 0.05$). No statistically significant differences were recorded in the indicators of technical fitness of young volleyball players of the comparison group, although there is also a linear tendency towards an increase in the indicators in the second testing (at the end of the academic year).

Discussion

The analysis of literary sources and the results of our own research allow us to state that the author's method of teaching game techniques in volleyball occupies a leading place in the educational and training process with young volleyball players (10-11 years old). At the same time, the motor ability in volleyball is considered as a level of performing game techniques based on the detailed conscious control at the

main reference points, which is characterized by a low speed of performance, instability of obtained results, low resistance to external factors, and a low level of memorization. The motor skill in volleyball is the next level of performing game techniques. The main differences from the motor ability are the following: minimal participation of consciousness in motor action control at the majority of the main reference points, which indicates the automation of game techniques performance, sufficiently high speed of performance, stability of obtained results, sufficiently high resistance to external factors, and a high level of memorization.

Scientists note that the principal feature distinguishing the motor skill from the motor ability is the automatic nature of separate components and the motor action in general (Boichuk, Iermakov, & Nosko, 2017). The consistent release of motor action performance from conscious control occurs with the establishment of a specific subordination of control levels in the central nervous system: during motor skill development, lower levels begin to control the processes of muscular and intermuscular coordination. Instead, higher levels ensure the achievement of the motor action goal through the control of its overall sequence.

Another feature of the motor skill is a high speed of motor action performance, which is ensured by a high level of muscular and intermuscular coordination and its general rationality, based on the absence of constraint and ease of elementary motor locomotions (Maklout, 2014; Forte, D'isanto, Di Domenico, & Altavilla, 2019).

The stability of obtained results of the action is the third principal feature in the process of developing the motor skill. The motor skill, if it is well developed and improved in the practice of training, practically does not disappear, even during long breaks caused by sports injuries, long illnesses, other factors (Tishchenko, Sokolova, & Popov, 2019; Shchepotina et al., 2021; Mykhaliuk, Syvolap, & Horokhovskiy, 2021).

Also important in the process of teaching motor actions is the transfer of learning phenomenon, which is justified from the standpoint of the conditioned-reflex nature of voluntary movements of young volleyball players (Hakman, Osadets, Lymarenko, 2021). From researchers' point of view (Maklout, 2014), the motor action, the purpose of which is analogous to young volleyball players' past motor experience and contains a corresponding dynamic stereotype, is solved according to a previously formed scheme based on the algorithm of development of a previous motor skill. Re-

searchers note that the transfer of learning phenomenon is differentiated into negative and positive (Boichuk, Iermakov, & Nosko, 2017; Altavilla, 2021), which can lead to both deterioration and improvement of the process of motor skills development. At the same time, when teaching game techniques to young volleyball players, it is important to avoid motor skills interference – the transfer of already developed skills to the motor action being studied, which complicates the development of a new skill (Hakman, Osadets, & Lymarenko, 2021).

It is also important to detailize the process of teaching game techniques in volleyball, which implies a certain stage-by-stage approach, namely:

- stage of initial learning of a game technique, which corresponds to the stage of creating prerequisites for mastering the motor act at the motor ability level;
- stage of in-depth detailed learning, which corresponds to the stage of mastering at the motor ability level;
- stage of reinforcement and further improvement of the motor action, which corresponds to the stage of mastering at the skill level.

In addition, some researchers (Platonov, 2017) single out as a separate stage higher order abilities and skills which are used mainly in Olympic and professional sports and are characterized by increased resistance to the influence of external factors in extreme conditions of competitive activities.

Conclusions

The author's method of teaching game techniques in volleyball is effective and contains the algorithm of teaching, the levels of mastering game techniques, the stages of teaching game techniques, the sequence of teaching game techniques, the classification, occurrence and prevention of young volleyball players' errors in the process of teaching game techniques, differentiation of exercises.

The analysis of technical fitness indicators of young volleyball players of the main group shows that the introduction of the author's method affects their positive dynamics in the tests: consecutive wall passes from a 3 m distance in 30 s; consecutive overhead passes in 30 s; consecutive forearm passes in 30 s; tennis ball toss over the net to the front line; tennis ball toss over the net to the back line (statistically significant differences, if $p < 0.05$).

The prospects for further research are based on the importance of optimal determination of reference points when teaching game techniques to young volleyball players and improvement of the author's teaching method in accordance with the age peculiarities of motor abilities and skills development.

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Conflict of interest

The authors declare no conflict of interest.

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ТЕХНОЛОГІЯ НАВЧАННЯ ІГРОВИМ ПРИЙОМАМ У ВОЛЕЙБОЛІ НА ЕТАПІ ПОЧАТКОВОЇ ПІДГОТОВКИ

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Реферат. Стаття: 7 с., 2 табл., 32 джерела.

Мета – науково обґрунтувати технологію навчання ігровим прийомом на етапі початкової підготовки для підвищення рівня технічної підготовленості юних волейболістів.

Матеріали і методи. В експериментальних дослідженнях брали участь 36 юних волейболістів 2011 року народження – 18 спортсменів КЗ «Запорізька обласна дитячо-юнацька спортивна школа» Запорізької обласної ради (основна група) і 18 спортсменів КУ Вільнянська міська дитячо-юнацька спортивна школа «Колос» (порівняльна група) протягом 2020-2021 навчального року.

Результати. Протягом експериментальних досліджень, показники фізичної підготовленості юних волейболістів основної групи достовірно підвищилися за 80% тестів. Аналіз показників технічної підготовленості юних волейболістів основної групи свідчить, що впровадження авторської технології має вплив на їх позитивну динаміку за тестами:

послідовні передачі м'яча у стінку з відстані 3 м за 30 с; послідовні передачі м'яча двома руками зверху над собою за 30 с; послідовні передачі м'яча двома руками знизу над собою за 30 с; метання тенісного м'яча через сітку на передню лінію; метання тенісного м'яча через сітку на задню лінію (статистично достовірні розбіжності, при $p < 0,05$).

Висновки. Авторська технологія навчання ігровим прийомом у волейболі містить алгоритм навчання, рівні засвоєння ігрових прийомів, етапи навчання прийомом техніки гри, послідовність вивчення прийомів техніки гри, класифікацію, виникнення і попередження помилок, які трапляються у процесі навчання ігровим прийомом у юних волейболістів, диференціацію вправ і є ефективною.

Ключові слова: волейбол, технологія, навчання, вміння, навичка.

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IMPACT OF PHYSICAL EDUCATION ON PECULIARITIES OF FUNCTIONAL STATE OF 18-22 YEAR OLD FEMALE STUDENTS' CARDIOVASCULAR AND RESPIRATORY SYSTEMS

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Abstract

The purpose of the study was to determine the age-related peculiarities of the functional state of the cardiovascular and respiratory systems of 1st-5th year female students of a higher education institution.

Materials and methods. The study participants were 200 female students: 1st year (n = 44); 2nd year (n = 38); 3rd year (n = 42); 4th year (n = 44); 5th year (n = 32). To solve the tasks set, the following research methods were used: analysis of scientific-methodological and medical literature, pedagogical observation, index method, medical and biological methods, ascertaining experiment, and methods of mathematical statistics.

Results. The study found that at the age of 19 there is a significant deterioration in the results of breathhold in the Stange test (49 s) and the Genchi test (38 s) ($P < 0.05$). At the age of 21, there is a decrease in the Ruffier index (12.4 – “satisfactory”) and the average heart rate after exercise ($f_1 = 34.7$), while there is a decrease in heart rate ($f_2 = 25.8$) after a standard recovery pause ($P < 0.05$). This indicates that during this period, there occur the most successful compensatory processes of cardiovascular activity. At 21-22 (4th-5th years of study), there is an increase in heart rate before exercise (f_0), and the Stange test result improves.

Conclusions. The results of comparative analysis show that with age the number of female students with a “satisfactory” result of the Ruffier index increases (59.4%), and a “good” heart result decreases (15.6%). At the age of 21, women have better heart rate, and at 22, they have better results in breath-holding under hypoxia.

Keywords: women, Ruffier index, heart rate, Stange test, Genchi.

Introduction

The era of urbanization, automation of production, strict regulation of work and leisure set before humanity new objectives aimed at improving the education system and training of highly qualified specialists (Chernenko, Honcharenko, & Marchenko, 2019; Solohubova, Lakhno, Shyyan, & Shyyan, 2020; Bielikova, Tsos, Indyka, Contiero, Pantik, Tomaschuk, Dedeliuk, & Podubinska, 2021). In the course of their study, Bakanova (2011), Podrigalo, Prusik, Krzysztof, and Prusik, Katarzyna (2012) observed insufficient motor activity and mental strain in young people. Decreased physical activity and motivation to exercise in adults, as well as children and young people is a global phenomenon (Sigmundová, Chmelík, Sigmund, Feltlová & Frömel, 2013; Cachón-Zagalaz, Sánchez-Zafra, Lara-Sánchez, Zagalaz-Sánchez, & Shmatkov, 2020; Doroshenko et al., 2021).

The need to control the functional fitness of students is pointed out by Aguilera, Rivera-Aguilera, and Cordovés-Peinado (2020); Amin, Karim, and Jassim (2019); Aparicio-Sarmiento, Gómez-Carmona, Martínez-Romero, Gamonales, and Sainz De Baranda (2021). The most popular control test in mass research is the Ruffier index (Chernenko, Jagiello, Ivashchenko, Khudolii, & Pashkevich, 2021; Solohubova, Lakhno, Shyyan, & Shyyan, 2020). The availability of registration of heart rate indicators, the simplicity of calculations and evaluation of research results make it a universal tool that characterizes the adaptive capabilities of the human cardiovascular system (Hjalmarson, 1991; Fox, 2005; Fox, Ford, & Steg, 2008). In recent decades, perceptions of the importance of heart rate in clinical practice have changed significantly. The studies by Morman and Kheller (2000) revealed a linear relationship between heart rate and myocardial oxygen consumption. According to Fox (2005), Hjalmarson (1991), heart rate affects life expectancy, increased risk of atherosclerosis, myocardial infarction, hypertension, cardiovascular

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disease. Thus, the study of the peculiarities of dynamics of the functional fitness of female students aged 18-22 is relevant.

The purpose of the study was to determine the age-related peculiarities of the functional state of the cardiovascular and respiratory systems of 1st-5th year female students of a higher education institution.

Materials and methods

Study participants

The study participants were 200 female students: 1st year ($n = 44$); 2nd year ($n = 38$); 3rd year ($n = 42$); 4th year ($n = 44$); 5th year ($n = 32$) of Donbas State Engineering Academy, Kramatorsk. All the students participated in physical activity twice a week.

Organization of the study

To solve the tasks set, the following research methods were used: analysis of scientific-methodological and medical literature, pedagogical observation, index method, medical and biological methods, ascertaining experiment, and methods of mathematical statistics.

The program of functional state testing included the Ruffier index, the Stange test, and the Genchi test given in Tables 1, 2 (Romanenko, 1999; Dubrovskij, 2005).

Testing procedure

Ruffier index. The test was used to assess the cardiovascular system activity. Equipment required. Stopwatch.

Test description. On command, the participant, after 5 minutes of sitting calmly, counts the number of pulses for 15 seconds, then performs 30 squats for 45 seconds. Immediately after squatting, the pulse is measured for the first 15 seconds and the last 15 seconds from the first minute of the recovery period.

The testing result is the Ruffier index (RI), which is calculated by the formula: $IR = (4(f_0 + f_1 + f_2) - 200)/10$, where f_0 is the heart rate before the load for 15 s; f_1 is the heart rate after the load; f_2 is the heart rate for the last 15 s from the first minute of recovery.

The cardiovascular system activity was assessed according to the index.

The Ruffier index is less than 0 – athletic heart;

0.1–5 – excellent (very good heart);

5.1–10 – good (good heart);

10.1–15 – satisfactory (heart with moderate insufficiency);

15.1–20 – bad (heart with significant insufficiency).

General instructions and remarks. When measuring the pulse, the student places 2–4 fingers on the inside of her left hand near the thumb and gently presses the artery to the bone or places her hand on the carotid artery (it is comfortable to do this on the right side). Upon the instructor's command and simultaneous start of the stopwatch, the counting begins for 15 seconds with further recalculation for 1 minute.

Stange test (voluntary inspiratory breathhold). The test was used to assess the respiratory system activity.

Equipment required. Stopwatch. The participant stands and does several deep breathing cycles. After a full inhale,

she closes her mouth (tightly closes her lips) and pinches the wings of her nose with the thumb and index finger. The stopwatch determines the time from the moment of breathhold to its recovery. The respiratory system activity was assessed by the indicator of breathhold duration:

more than 90 s – excellent;

from 60 to 90 s – good;

from 30 to 60 s – satisfactory;

less than 30 s – bad (unsatisfactory).

Genchi test (expiratory breathhold). The test was used to assess the respiratory system activity. After several breathing cycles, the subject fully exhales, closes her mouth and pinches her nose with her fingers. The stopwatch records the time of breathhold. The respiratory system activity was assessed by the indicator of breathhold duration:

more than 50 s – excellent;

from 35 to 50 s – good;

from 20 to 35 s – satisfactory;

less than 20 s – bad (unsatisfactory).

Statistical analysis

The study results were processed using the method of mathematical statistics. The study calculated: arithmetic mean ($\bar{x}$), error in calculating the arithmetic mean (s); significance of difference between means (t). The significance of difference between statistical indicators (t) was evaluated using the Student's t -test.

Results

Table 1 shows the results of analysis of the cardiovascular and respiratory systems of the 1st-5th year female students. As a result of comparison of the indicators of heart rate and breathhold tests, the study determined average indicators characterizing the peculiarities of the cardiovascular and respiratory systems in women aged 18-22 years.

At 19, there is a significant deterioration in the results of breathhold in the Stange test (49 s) and the Genchi test (38 s) ($P < 0.05$). The Ruffier index, heart rate indicators f_0 , f_1 , f_2 do not change.

At the age of 19-20 (2nd-3rd years of study), no changes are observed in all indicators.

At the age of 21, there is a decrease in the Ruffier index (12.4 – “satisfactory”) and the average heart rate after exercise ($f_1 = 34.7$), while there is a decrease in heart rate ($f_2 = 25.8$) after a standard recovery pause ($P < 0.05$). This indicates that during this period there occur the most successful compensatory processes of cardiovascular activity.

At 21-22 (4th-5th years of study), there is an increase in heart rate before exercise (f_0) and improvement in the indicators of the Stange test. The Ruffier index, the number of pulses after exercise, the heart rate recovery response, and the Genchi test do not change. This indicates that with age there are characteristic signs of heterochrony and sensitivity of the functional state of the female body.

The obtained Ruffier index and the results of comparative analysis of the functional fitness for cardiovascular assessment show that with age the number of female students with a “satisfactory” Ruffier index increases (59.4%), and a “good” heart indicator decreases (15.6%).

Table 1. Results of testing of the functional fitness of 1st-5th year female students

No.	Test	1 st year (n = 44)		2 nd year (n = 38)		3 rd year (n = 42)		4 th year (n = 44)		5 th year (n = 32)		t ₁₋₂	t ₂₋₃	t ₃₋₄	t ₄₋₅
		X	s	X	s	X	s	X	s	X	s				
1	Ruffier index	12.59	0.57	13.62	0.84	14.91	0.80	12.44	0.66	13.33	0.79	1.02	1.11	2.39	0.90
2	f ₀	20.61	3.26	21.11	5.43	21.69	0.87	20.52	0.49	22.70	0.68	0.49	0.47	0.17	2.68
3	f ₁	34.41	5.34	35.74	6.42	37.81	1.35	34.73	1.23	35.90	0.98	1.01	1.21	2.47	0.99
4	f ₂	26.45	3.91	27.21	4.79	27.79	0.93	25.84	0.61	24.80	0.89	0.78	0.47	1.75	1.08
5	Stange test (s)	57.19	15.97	48.79	17.92	50.90	2.58	47.50	2.39	54.10	1.88	2.22	0.54	0.97	1.78
6	Genchi test (s)	45.53	12.66	37.55	13.78	13.76	1.80	40.80	2.63	37.90	1.21	2.71	0.28	1.25	0.79

Table 2. Ruffier index indicators of 1st-5th year female students

No.	State of the cardiovascular system, %	1 st year (18 years)	2 nd year (19 years)	3 rd year (20 years)	4 th year (21 years)	5 th year (22 years)
		(n = 44)	(n = 38)	(n = 42)	(n = 44)	(n = 32)
1	“bad” - significant heart insufficiency	27.3	36.8	40.5	22.7	25
2	“satisfactory” - moderate heart insufficiency	50.0	31.6	45.2	50.0	59.4
3	“good” – good heart	20.5	28.9	14.3	22.7	15.6
5	“excellent” – athletic heart	2.2	2.7	0	4.6	0

Discussion

The study assumed that the dynamics of the functional state of the cardiovascular and respiratory systems in women aged 18-22 years has its peculiarities. It was found that with age the number of female students with a “satisfactory” Ruffier index increases (59.4%), and a “good” heart result decreases (15.6%). The age of 19-20 is problematic in the functional fitness of women's cardiovascular and respiratory systems.

The obtained data confirm that the third year is a problematic period in physical education of students (Chernenko, Iermakov, Oliynyk, & Dolynnyi, 2018; Chernenko, Jagiello, Ivashchenko, Khudolii, & Pashkevich, 2021).

Decreased indicators of the functional fitness of the cardiovascular and respiratory systems in women aged 19-20 testify to insufficient physical load in the process of physical education of students and complement the data on the need for additional introduction of more intensive forms of training to the system of physical education of students (Solohubova et al., 2020; Amin et al., 2019; Choi et al., 2021), and on the importance of motor activity in the educational process of students (Lynch & Sargent, 2020; Tohmea et al., 2020; Hovey et al., 2020).

The obtained data point to prognostic significance of heart rate and a tendency towards an increase in resting heart rate of students (1st-5th years of study), which confirms the study on the influence of resting heart rate on deterioration of the functional fitness of the human cardiovascular system (Baevskii, 1979; Amosov, & Bendet, 1989).

Thus, the Ruffier index, the Stange test, and the Genchi test can be used to assess the functional fitness of 1st-5th year female students.

Conclusions

The results of comparative analysis show that with age the number of female students with a “satisfactory” result of the Ruffier index increases (59.4%), and a “good” heart result decreases (15.6%). The age of 19-20 is problematic in the

functional fitness of women's cardiovascular and respiratory systems.

Decreased indicators of the functional fitness of the cardiovascular and respiratory systems in women aged 19-20 testify to insufficient physical load, their low motor activity and point to the need for additional introduction of more intensive forms of training to the system of physical education of students.

The Ruffier index, the Stange test, and the Genchi test can be used to assess the functional fitness of 1st-5th year female students.

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Conflict of interest

The authors declare that there is no conflict of interest.

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ВПЛИВ ФІЗИЧНОГО ВИХОВАННЯ НА ОСОБЛИВОСТІ ФУНКЦІОНАЛЬНОГО СТАНУ СЕРЦЕВО-СУДИННОЇ ТА ДИХАЛЬНОЇ СИСТЕМИ СТУДЕНТОК 18-22 РОКІВ

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; Е – збір коштів

Реферат. Стаття: 5 с., 2 табл., 23 джерела.

Мета дослідження – визначити вікові особливості функціонального стану серцево-судинної та дихальної системи студенток 1-5 курсів вищої школи.

Матеріал і методи. У дослідженні взяли участь 200 студенток: 1-го курсу (n = 44); 2-го курсу (n = 38); 3-го курсу (n = 42); 4-го курсу (n = 44); 5-го курсу (n = 32). Для вирішення поставлених завдань були застосовані наступні методи дослідження: аналіз науково-методичної та медичної літератури, педагогічне спостереження, метод індексів, медико-біологічні методи, констатуючий експеримент та методи математичної статистики.

Результати. У дослідженні встановлено, що у 19 років спостерігається значне погіршення результатів затримки дихання проби Штанге (49 с) та Генче (38 с) (P < 0,05). У віці 21 рік відбувається зменшення індексу Руф'є (12,4 – «задовільно») та середнього значення пульсу після навантаження

($f_1 = 34,7$), одночасно спостерігається зменшення серцевих скорочень ($f_2 = 25,8$) після стандартної паузи відновлення (P < 0,05). Це вказує, що у цей період найбільш успішно відбуваються компенсаторні процеси серцево-судинної діяльності. У 21-22 роки (4-5 курс) простежується збільшення ударів пульсу до навантаження (f_0), покращується показник проби Штанге.

Висновки. За результатами порівняльного аналізу спостерігається з віком збільшення кількості студенток з результатом оцінювання індексу Руф'є «задовільно» (59,4%), а також зменшується показник «добре» серце (15,6%). У 21 рік жінки демонструють кращі показники ЧСС, а у 22 роки мають кращі результати у затримці дихання в умовах гіпоксії.

Ключові слова: жінки, індекс Руф'є, частота серцевих скорочень, проба Штанге, Генчі.

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