



ORIGINAL ARTICLES. SPORT

Special physical fitness factors of athletes involved in pole sports

Iryna Sobko^{1 ABCD}, Anastasia Velieva^{1 ABD}, Yana Sobko^{2 ACD}, Olena Slastina^{3 CDE}

¹ H. S. Skovoroda Kharkiv National Pedagogical University

² National Technical University «Kharkiv Polytechnic Institute»

³ Ukrainian Engineering Pedagogics Academy

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Corresponding author: Iryna Sobko, <http://orcid.org/0000-0002-4920-9775>, sobko.iryana18@gmail.com, H. S. Skovoroda Kharkiv National Pedagogical University, Alchevskikh str. 29, Kharkiv, 61002, Ukraine

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Abstract

Purpose: to determine the peculiarities of training female athletes engaged in Pole Sports on the basis of the factor analysis of physical, special physical qualities and functional capabilities.

Material and methods: the study involved 15 girls (age 12-13 years), who are engaged in the sports club "Atmosphere" in Pole Sport and aerial acrobatics, Kharkov. Athletes are in the group of initial training (amateur level) and have the experience of sports activity 1-1,5 year. The study was conducted in September 2021. All participants and their parents agreed to participate in the experiment.

Methods: theoretical analysis of literary sources; methods of testing physical development (height, weight); physical fitness (Push-ups 30 s, jumping rope for 3 min, Sit-ups in 1 min, dynamometry of right and left arms, leaning forward while sitting, cartwheel); special physical condition (chopper, pulling up on the pole, jumping rope for 3 min, half-squat jumps, jumps with turning 180°, jumps with turning 360°, jumping into grouping); methods of functional abilities (Genchi and Ruffier tests), mathematical and statistical methods using "EXCEL" and "SPSS" computer programs (factor analysis by principal component method was used).

Results. A factor analysis of physical development indicators, physical training, functional athletes specializing in Pole Sport. It was found that in the structure of preparation of the athletes of this group overcomes the first factor "Special endurance" (15.21% of the total variance), then the second "Functional abilities" (14.54% of the total variance), the third factor "Power abilities" (14.12% of the total variance) and the fourth factor "Coordination abilities" (14.02% of the total variance), the fifth factor "Flexibility" (13.52% of the total variance), the sixth factor "Technical abilities" (12.37% of the total variance). The percentage contribution of these factors indicates the equivalent importance of these factors.

Conclusions. The training means for the development of special physical qualities and techniques, the dosage of the volume and intensity of loads for athletes 12-13 years old involved in Pole Sports are presented.

Key words: Pole sport, factor analysis, physical qualities, functional capabilities, technical readiness



Анотація

Собко І.М., Велієва А.Р., Собко Я.О., Сластина О.О. Фактори спеціальної фізичної підготовленості спортсменів, які займаються Pole Sports

Мета: визначити особливості підготовки спортсменок, які займаються пілоним спортом на основі застосування факторного аналізу фізичних, спеціальних фізичних та функціональних можливостей.

Матеріал і методи: у дослідженні взяли участь 15 спортсменок (вік 12-13 років), які займаються у спортивному клубі "Атмосфера" з Pole Sport та повітряної акробатики, м. Харків. Спортсменки входять в групу початкової підготовки (аматорський рівень) та мають стаж спортивної діяльності 1-1,5 роки). Дослідження проводилися у вересні 2021 року. Усі учасники та їх батьки дали згоду про участь у експерименті.

Методи: теоретичний аналіз і узагальнення літературних джерел; методи тестування фізичного розвитку (зріст, вага); фізичної підготовленості (згинання розгинання рук в упорі лежачі за 30 с, стрибки зі скакалкою за 3 хв., піднімання тулуба в сід за 1 хв, динамометрія правої та лівої руки, нахил тулуба вперед із положення сидячи); спеціальної фізичної підготовленості (розніжка на пілоні, підтягування на пілоні, стрибки зі скакалкою, стрибки «прип'ятки», стрибки на 180°, стрибки на 360°, стрибки в групування, колесо на прямих руках); методи функціональних можливостей (проби Генча та проби Руф'є), математико-статистичні методи за допомогою комп'ютерних програм «EXCEL», «SPSS» (застосовувався факторний аналіз методом головних компонент, після обертання методом Варимакс).

Результати: Проведено факторний аналіз показників фізичного розвитку, фізичної підготовленості, функціональних спортсменів, які спеціалізуються в Pole Sport. Виявлено, що в структурі підготовленості спортсменів даної групи переважає перший фактор «Спеціальна витривалість» (15,21 % від загальної сумарної дисперсії), далі йдуть другий «Функціональні можливості» (14,54% від загальної сумарної дисперсії), третій «Силові можливості» (14,12% від загальної сумарної дисперсії) та четвертий фактор «Координаційні здібності» (14,02 % від загальної сумарної дисперсії), п'ятий фактор «Гнучкість» (13,52 % від загальної сумарної дисперсії), шостий фактор «Технічні можливості» (12,37 % від загальної сумарної дисперсії). Відсотковий внесок усіх факторів свідчить про рівнозначну важливість даних факторів.

Висновки. Представлено тренувальні засоби розвитку спеціальних фізичних якостей та технічних прийомів, дозування обсягу та інтенсивності навантажень для спортсменів 12-13 років, які займаються пілоним спортом.

Ключові слова: пілонний спорт, факторний аналіз, фізичні якості, функціональні можливості, технічна підготовленість

Аннотация

Собко И.Н., Велиева А.Р., Собко Я.А., Сластина Е.А. Факторы специальной физической подготовленности спортсменок, занимающихся Pole Sports

Цель: определить особенности подготовки спортсменок, занимающихся пилонным спортом на основе применения факторного анализа физических, специальных физических качеств и функциональных возможностей.

Материал и методы: в исследовании приняли участие 15 спортсменок (возраст 12-13 лет), которые занимаются в спортивном клубе "Атмосфера" по Pole Sport и воздушной акробатике, г. Харьков. Спортсменки входят в группу начальной подготовки (любительский уровень) и имеют стаж спортивной деятельности 1-1,5 года. Исследования проводились в сентябре 2021 года. Все участники и их родители дали согласие на участие в эксперименте.

Методы: теоретический анализ литературных источников; методы тестирования физического развития (рост, вес); физической подготовленности (сгибание разгибание рук в упоре лежа за 30 с, прыжки со скакалкой за 3 мин., поднимание туловища за 1 мин, динамометрия правой и левой руки, наклон туловища вперед из положения сидя); специальной физической подготовленности (разножка на пилоне, подтягивание на пилоне, прыжки со скакалкой за 3 мин, прыжки «припятки», прыжки на 180°, прыжки на 360°, прыжки в группировку, колесо на прямых руках); методы функциональных возможностей (пробы Генча и пробы Руфье), математико-статистические методы с помощью компьютерных программ «EXCEL», «SPSS» (применялся факторный анализ методом главных компонент).

Результаты: Проведен факторный анализ показателей физического развития, физической подготовленности, функциональных спортсменок, специализирующихся в Pole Sport. Выведено, что в структуре подготовленности спортсменок данной группы преобладает первый фактор «Специальная выносливость» (15,21% от общей суммарной дисперсии), далее следуют второй «Функциональные возможности» (14,54% от общей суммарной дисперсии), третий «Силовые возможности» (14,12% от общей суммарной дисперсии) и четвертый фактор «Координационные способности» (14,02% от общей суммарной дисперсии), пятый фактор «Гибкость» (13,52% от общей суммарной дисперсии), шестой фактор «Технические возможности» (12,37% от общей суммарной дисперсии). Процентный вклад всех факторов свидетельствует о равнозначной важности данных факторов.

Выводы. Представлены тренировочные средства развития специальных физических качеств и технических приемов, дозировка объема и интенсивности нагрузок для спортсменок 12-13 лет, занимающихся пилонным спортом.

Ключевые слова: пилонный спорт, факторный анализ, физические качества, функциональные возможности, техническая подготовленность



Introduction

Today, sport is characterized by such features as dynamism, effectiveness and mass. At the same time, an important distinctive feature of modern sport is the emergence of many new species that are rapidly gaining popularity and supplant traditional sports [1, 2, 3]. Thus, in Ukraine, a new sport - Pole sport - is gaining popularity. Pole sport includes elements of gymnastics, acrobatics and choreography, a set of gymnastic and acrobatic exercises, presented in a choreographic style. The status of the sport was obtained relatively recently when the first federation "International Pole Sports" was formed [4, 5]. Currently, there are a number of organizations that unite pole lovers from different countries, the number of their participants has now increased significantly. This sport includes difficult varieties of styles and elements (gymnastics, acrobatics and choreography). During pole sports there is a proper load on all muscle groups: from the abdominal muscles and ending with biceps [3, 6, 7, 8]. Considering the literary data of official sites, the practical activities of private clubs, academies and sports schools [9,10] it was found that the content of Pole Sport is the demonstration of the number on sports shells under the musical accompaniment. These numbers include elements that require those who are engaged in the development of strength, dynamic and static balance, flexibility. Athletes act at a height of up to 4 m, without insurance. During the performance, the athlete is assessed on the complexity of the elements, technique, choreography and artistry [11, 12, 13]. However, there is no available and scientifically confirmed literary data on the planning and preparation of athletes for competitive activities.

In this regard, the purpose of this work is to determine the peculiarities of the training of athletes engaged in pole sports on the basis of the use of factor analysis of physical, special physical and functional capabilities.

Material and methods

Participants

The study was attended by 15 athletes (age 12-13 years) who are engaged in the sports club "Atmosphere" with Pole Sport and air acrobatics. Athletes are in the group of initial training (amateur

level) and have experience of sports activity 1-1,5 years).

Procedure

The research was conducted in September 2021. All participants and their parents agreed to participate in the experiment. At the first stage of the study, athletes tested physical development, special physical and functional preparedness (17 indicators). At the second stage, a factor analysis was carried out and a technique for the development of physical and technical training for athletes of this age category was developed and rational means, forms and methods of athletic training of athletes were selected.

Physical measurements

1. Body length (sm). The length of the body was measured with a height meter in the position of the "main stand" when touching its rod with the head, interspatular area, buttocks and heels. Body length indicators were fixed on the height meter stand on the lower edge of the tablet, touching the crown of the head;

2. Body weight, (kg). Body weight was determined on special medical scales with an accuracy of up to 50 g. weighing was carried out from a position standing in a calm state in the middle of the weight area of the scales.

Methods of testing physical fitness

1. Push-ups 30 s (number of times). The athlete had to make the maximum amount of bending-extension of the hands in the rest of the lying. Allowed to count when the athlete half bent his hands in the rest of the lying[6].

2. Sit-ups (number of times). The athlete lies on her back on a flat surface, her legs are bent at the knees at a right angle, the distance between her feet is 30 centimeters, her fingers are joined behind her head. The partner holds her feet so that the heels touch the support. At the signal, she sits up, touches her elbows to her knees and returns to the starting position, touching her back and hands to the floor. During 1 minute, she repeats the exercise with the maximum frequency. The result of the test is the number of lifts from a lying position to a sitting position within 1 minute.

3. Dynamometry of the right hands (kg). The dynamometer is taken in the hand with the dial facing inward. The hand is extended to the side at shoulder level and the dynamometer is squeezed as



much as possible. Two measurements are taken on each hand, the best result is recorded

4. Dynamometry of left hands (kg). The dynamometer is taken in the hand with the dial facing inward. The hand is extended to the side at shoulder level and the dynamometer is squeezed as much as possible. Two measurements are taken on each hand, the best result is recorded.

5. Leaning forward while sitting (cm). Testing was carried out sitting on the floor, the result of testing was a mark on the perpendicular markings in centimeters, in which athletes reached with their fingertips in the best of three attempts.

Determining the level of functionality

1. Genchi's test (s). The pulse is measured in 30 seconds while standing, then the breath is held on a full exhalation, after three breaths in 3/4 depth. During detention, you must use a nose clip. Time is recorded by a stopwatch in seconds. Then you need to measure the pulse for 30 seconds immediately after the restoration of breathing. If the delay is less than 34 seconds, the result is considered unsatisfactory. Any result within 35-39 seconds indicates a satisfactory indicator, and the result of more than 40 seconds is a good result

2. Ruffier's test (conventional units). It is a simple cardiovascular endurance test which involves measuring heart rate before (P1) and after (P2) performing 30 squats in 45 seconds. After the end of loading, the tested person lies down and heart rate is measured again after 15 s of the recovery period (P3). The performance of the heart is assessed according to the formula:

$$\text{Ruffier index} = (4 * (P1 + P2 + P3) - 200) / 10$$

The results are assessed by the value of the index from 0 to 15. Less than 3 - good performance 3-6 - average; 7-9 - satisfactory; 10-14 - bad (moderate heart failure) 15 and above (severe heart failure).

Methods of testing special physical fitness

1. Test «Chopper on a pole» (number of times). The athlete standing with the right shoulder near the pole, the right hand (in the area under the armpit) covers the Pole. The left hand holds the pole from above. Both arms are bent at the elbow joints, the hands are in a straight grip. Pulling the bent legs in the knee joints to the elbows, the athlete tilts the body back, straightening the arms in the elbows and the legs in the knees. Vision is directed forward. Try to perform the movement without swinging. The exercise is aimed at developing and strengthening the strength of the

muscles of the abdomen and arms, it is performed on both sides, while changing the position of the arms.

2. Test «Pulling up on the pole» (number of times). The athlete covers the pole with his feet and straightens his arms above his head. After that, he performs flexion in the elbow joints and at the same time releasing the pole legs and keeping them parallel to the floor, thus performing pull-ups on the pole. When the athlete pulled up, he again covered the projectile with his feet and continued to move to its top.

3. Jumping skipping-rope for 3 minutes (number of times). The number of jumps was recorded.

4. Half-squat jumps (number of times). The athlete performs one ordinary jump with his legs together, and the second with the shin pulling back, hold his hands on the belt. During the first jump, make sure that your feet are completely straight, from the knees to the tips of your toes, and during the second jump, make sure that your feet try to touch your buttocks and that your feet are stretched out. The whole exercise should be done at the same pace, with high jumps and without stopping.

5. 180° jumps (number of times). Performed on the spot, recorded the number of times in 30 s.

6. 360° jumps (number of times). Performed on the spot, recorded the number of times in 30 s.

7. Grouping jumps (number of times). The athlete performs one ordinary jump with the legs together, and the hands on the belt, and the second - with the pull of the knees tightly to the chest, the hands cover the lower legs, fulfilling the position of «grouping». During the first jump, make sure that your feet are completely straight, from the knees to the fingertips, during the second - so that the athlete can keep the grouping position in the air for as long as possible. The exercise is performed at one pace, high jumps, without stopping.

8. Test «Wheel on straight arms» (number of times). The athlete performs the wheel on straight arms for 30 s. Fixed number of times.

Statistical methods

The digital material was processed using the IBM SPSS Statistics program, 20. Factor analysis by the method of principal components, rotation method: Varimax with Kaiser normalization was used. For each indicator, the arithmetic mean value \bar{x} , the mean square deviation S was determined. The percentage value



of the total variance of the main factors of the testing of female athletes specializing in pole sports was calculated. The sample was tested for normality of distribution using the one-sample Kolmogorov-Smirnov's test.

According to the data in Table 1., 2., for all test indicators $p > 0.05$, this indicates that there is no significant difference between the subjects in the a group of athletes in Pole sport, from the normal distribution, and therefore it is possible to use statistical data for calculations in this group.

Results

Table 1

The results of testing physical fitness and functional capabilities for the normal distribution of a group of athletes in pylon sports (n = 15) according to the one-sample Kolmogorov-Smirnov criterion before the experiment

Tests *		1	2	3	4	5	6	7	8	9
Normal parameters a,b	\bar{X}	145.9	37.27	24.06	18.20	25.73	11.13	248.47	18.33	18.07
	S	2.71	2.05	1.38	1.37	1.58	1.41	7.93	1.18	0.96
Differences of extremes	Module	0.11	0.24	0.21	0.24	0.21	0.26	0.14	0.21	0.27
	Positive	0.10	0.13	0.12	0.22	0.21	0.14	0.14	0.21	0.26
	Negative	-0.11	-0.24	-0.21	-0.24	-0.12	-0.26	-0.11	-0.13	-0.27
Statistics		0.427	0.93	0.83	0.94	0.82	1.02	0.53	0.82	1.05
Asymptotic value (bilateral)		0.99	0.36	0.50	0.34	0.51	0.25	0.95	0.51	0.22
The value of Monte Carlo		0.985 ^c	0.307 ^c	0.436 ^c	0.291 ^c	0.451 ^c	0.210 ^c	0.909 ^c	0.454 ^c	0.182 ^c
Lower bound		0.982	0.29	0.42	0.28	0.44	0.20	0.90	0.44	0.17
Upper bound		0.985	0.32	0.45	0.30	0.46	0.22	0.92	0.47	0.19

a – comparison with the normal distribution.

b – estimated from the data.

c – based on 10000 sample tables with initial kernel 1535910591

* – a description of all tests 1-9 is provided in the section "Material and methods"

Table 2

The results of testing special physical fitness for the normality of distribution according to the one-sample Kolmogorov-Smirnov criterion of a group of athletes in pylon sports (n = 15) before the experiment

Tests *		10	11	12	13	14	15	16	17
Normal parameters a,b	\bar{X}	11.13	10.67	7.33	12.07	22.80	9.73	37.67	5.13
	S	1.36	1.72	1.05	0.88	1.66	2.89	3.04	0.83
Differences of extremes	Module	0.14	0.25	0.24	0.27	0.21	0.19	0.20	0.30
	Positive	0.14	0.15	0.22	0.20	0.19	0.19	0.14	0.30
	Negative	-0.14	-0.25	-0.24	-0.27	-0.21	-0.18	-0.20	-0.24
Statistics		0.54	0.96	0.94	1.05	0.83	0.74	0.79	1.15
Asymptotic value (bilateral)		0.93	0.32	0.34	0.22	0.49	0.64	0.57	0.14
The value of Monte Carlo		0.893 ^c	0.269 ^c	0.297 ^c	0.190 ^c	0.437 ^c	0.570 ^c	0.504 ^c	0.116 ^c
Lower bound		0.88	0.26	0.28	0.18	0.42	0.56	0.49	0.11
Upper bound		0.90	0.28	0.31	0.20	0.45	0.58	0.52	0.12

a – comparison with the normal distribution.

b – estimated from the data.



c – based on 10000 sample tables with initial kernel 1535910591

* – a description of all tests 10-17 is provided in the section "Material and methods"

Due to the fact that the athletes participating in the study are engaged in pylon sports at an amateur level, it is necessary to determine their level of preparedness. The average characteristics of the results of testing physical and functional fitness and their statistical values are

presented in table. 3. Based on the results of assessing the level of physical and functional training, it can be argued that the level of training of athletes involved in pylon sports is sufficient [5].

Table 3

Average test scores for female athletes aged 12-13 involved in pole sports (n=15)

№	Name of metrics	\bar{x}	S
1	Body length, cm	145.93	2.71
2	Body weight, kg	37.27	2.05
3	Dynamometry of the right hand, kg	24.06	1.38
4	Dynamometry of the left hand, kg	18.20	1.37
5	Push-ups 30 s, number of times	25.73	1.58
6	Test «Pulling up on the pole», number of times	11.13	1.41
7	Jumping rope, number of times	248.47	7.93
8	Grouping jumps, number of times	19.20	4.20
9	Sit-ups, number of times	18.07	0.96
10	Test «Chopper on a pole», number of times	11.13	1.36
11	180° jumps, number of times	10.67	1.72
12	360° jumps, number of times	7.33	1.05
13	Test «Wheel on straight hands», number of times	12.07	0.88
14	Half-squat jumps, number of times	22.87	1.68
15	Leaning forward while sitting, cm	9.73	2.89
16	Genchi's test, s	37.67	3.04
17	Ruffier's test, conventional units	8.60	13.69

As is know [14, 15, 16, 17], factor analysis is used to reduce variables and determine hidden relationships between indicators and identify the main components that determine the structure of athletes' preparedness. In this study, factor analysis made it possible to identify six factors (table 4).

The first factor included the indices of tests of «Push-ups 30 s» ($r=0.905$), «Body length» ($r=-0.854$), «360° jumps» ($r=0.594$), «Jumping into grouping» ($r=-0.504$). During one performance, the athlete performs a large number of power tricks, breaks, jumps, somersaults, rotation on the pylon. The combination of these elements and performance for 3-4 minutes characterize the special endurance of athletes, so the first factor is called «Special Endurance».

The second factor included indicators that form the highest correlation coefficients with the first indicator of this factor «Ruffier's test» ($r = 0.900$), these are indicators of «Sit-ups» ($r = -0.813$), «Grouping jumps» ($r= 0.652$), «Body weight», ($r=0.584$). This factor was called

«Functionality». Training of athletes should focus on the development and improvement of functional reserves and processes in the body.

The third factor included such indicators as «Dynamometry of the right hand» ($r = 0.865$), «Dynamometry of the left hand» ($r = 0.733$), «Genchi test» ($r=0.600$). The relationship between these indicators can be explained by the fact that Pole Sport gives priority to the implementation of various trick and power elements. During the performance, all elements must be held in a fixed position for at least 3 seconds, otherwise they will not be counted, in some elements a parallel with the floor must be demonstrated. Therefore, the third factor was called «Power capabilities».

The fourth factor included «Test Half-squat jumps», ($r = 0.767$), the «Wheel on straight arms» test ($r = 0.745$) and the «Jumping rope» test ($r = 0.686$), this factor was called «Coordination capabilities». In this sport, the implementation of an individual program contributes to a significant development of coordination, since asymmetric tasks are performed to different parts of the body.



When performing acrobatic and choreographic combinations, plasticity still develops in the stalls.

The fifth factor included the indicators of the test «180° jumps» ($r = 0.915$), «Leaning forward while sitting» ($r = 0.752$), it was called «Flexibility». Increased mobility in the joints of athletes helps to provide a greater range of motion, increases the efficiency of work and reduces energy consumption when performing exercises of varying complexity.

The sixth factor included the indicators of testing «Pulling up on the pole» ($r = 0.883$), the test «Chopper on a pole», the number of times ($r = 0.807$), these tricks are performed at the entire height of the projectile, have an air phase, the athlete needs to demonstrate a dynamic holistic performance element, which is why it was called "Technical Capabilities".

Table 4

Matrix of components (after rotation by the Varimax method) in factor analysis of indicators of complex testing of athletes specializing in pole sport ($n = 15$)

The name of the factor	Indicators	Factors					
		1	2	3	4	5	6
Special endurance	Push-ups 30 s, number of times	0.905					
	Body length, cm	-0.854					
	360° jumps, number of times	0.594					
	Jumping into grouping, number of times	-0.504					
Functionality	Ruffier's test, conventional units		0.900				
	Sit-ups, number of times		-0.813				
	Grouping jumps, number of times		0.652				
	Body weight, kg		0.584				
Power capabilities	Dynamometry of the right hand, kg			0.865			
	Dynamometry of the left hand, kg			0.733			
	Genchi's test, s			0.600			
Coordination capabilities	Test Half-squat jumps, number of times				0.767		
	Test «Wheel on straight hands», number of times				0.745		
	Jumping rope, number of times				0.686		
Flexibility	180° jumps, number of times					0.915	
	Leaning forward while sitting, cm					0.752	
Technical capabilities	Test «Pulling up on the pole», number of times						0.883
	Test «Chopper on a pole», number of times						0.807

Thus, general structure of preparedness of female athletes engaged in pole sports, six factors

were identified, the percentage value of which from the total variance is presented in Fig. 1.

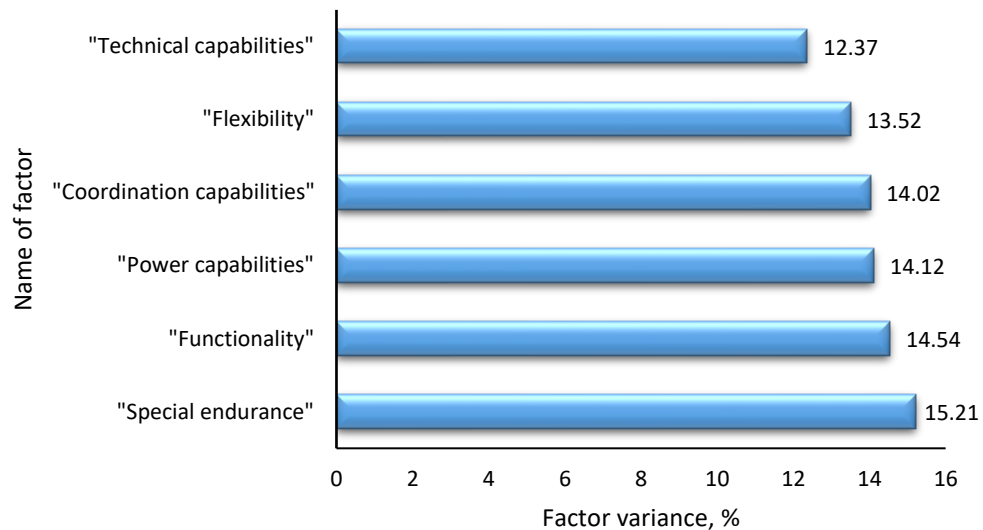


Fig. 1. Percentage of total variance of main factors testing of athletes specializing in Pole sport

A factor analysis of physical development indicators, physical training, functional athletes specializing in Pole Sport. It was found that in the structure of preparation of the athletes of this group overcomes the first factor "Special endurance" (15.21% of the total total dispersion), then the second "Functional abilities" (14.54% of the total total dispersion), the third factor "Power capabilities" (14.12% of the total cumulative variance), the fourth factor "Coordination abilities" (14.02% of the total cumulative variance), the fifth factor " Flexibility " (13.52% of the total cumulative variance), the sixth factor "Technical capabilities" (12.37% of the total cumulative variance). The percentage contribution of these factors indicates the equivalent importance of these factors.

Thus, the leading factors in the preparation of athletes of this category are, firstly, the development of special endurance, which will allow athletes to effectively perform all simple and complex technical elements on the implement and ground tricks throughout the entire individual program [18, 19]. Secondly, it is the expansion of the level of functional capabilities of female athletes, which mainly determine the specific performance, so the effectiveness of the training and the adaptation process can be significantly increased by using targeted, additional funds for different aspects of the functioning of the body. Further development of strength qualities, because the implementation of technical elements in Pole Sport requires significant strength efforts [20, 21]. The development of coordination abilities, because the implementation of all techniques is complicated by the fact that there are many changes

in static postures and modes of movement (static, dynamic). All this increases the requirements for the manifestation of coordination abilities, the function of balance, stability and, accordingly, the mechanism for controlling the movements of athletes. The development of flexibility should be given special attention, because there is an inverse relationship between the indicators of strength and flexibility - the development of flexibility is in opposition to the development of strength. This is due to the limitation of mobility in the joints due to muscle hypertrophy and strengthening of the ligamentous apparatus, excessive muscle pumping leads to a decrease in flexibility. Therefore, it is necessary to increase flexibility only to the extent that it is necessary for optimal movement technique in this sport [5, 23,24].

Discussion

Modern scientists (Kozina, Kozin, Cieślicka, Prusik, Muszkieta, Sobko, Ryepko, Bazilyuk, Polishchuk, Osiptsov, Kostiukevych, 2017; 2019; 2018; 2020,2021) [14,15,16,24,25] actively use multidimensional analysis methods for study of the structure of integral preparedness of young and qualified athletes in various sports. Leading Ukrainian specialists Kozina, Kozin, Boychuk, Skaliy, Zelenskiy, Honcharenko (2019, 2021) consider the most suitable mathematical tool - factor analysis, which allows you to reduce a wide range of readiness indicators and identify the main components that determine the exact characteristics of individual characteristics of athletes [14,15]. The use of modern methods of



analysis helps to create optimal training techniques that most meet the requirements of the training process in a specific period of time. In sports games, with the help of factor analysis, scientists Kozina, Khrapov, Yevstratov, Kolomiets, Hryshchenko, Minenok, Nosko, (2019) develop individual factor models of physical fitness of athletes of different game role [15]. In martial arts, on the basis of the individual factorial structure of psychophysiological and biomechanical indicators, scientists identify the fighting style of veteran boxers [14]. In this regard, the researches in this work confirm and supplement the data of the above authors, regarding the need for a factor analysis of physical development indicators, special physical and functional preparedness to determine the peculiarities of training athletes with Pole Sport.

The purpose of this study was to determine the characteristics of the training of athletes involved in Pole Sport. Therefore, the results of the study determine the main directions of special physical training of Pole Sport athletes aged 12-13. [6, 26]. This sport is based on aerobic exercises, and the pylon itself serves as a simulator as such. During one performance, athletes perform a large number of rotations on the pole at different heights without contact with the floor. In the process of rotation on the pylon, the weight of the body is held by the muscles of the thigh, gluteal, calf muscles. The muscles of the upper shoulder girdle, pectoralis major and upper back are also involved. During rotation at the pylon and exercises on the floor, the gluteal muscles and thigh muscles receive an intense load. There are squats, spins, certain dance moves that require balancing on bent knees. An essential role for complex tricks with flips is played by the abdominal muscles, which stabilize the athlete's body. The muscles of the back provide lifting of the body, keeping it in a horizontal position and flips. They are needed to fix the body in any position. Thus, performing complex tricks with a combination requires the participation of a large number of athletes' muscles.

The results of the study determine the main directions of special physical training of athletes with Pole Sport 12-13 years. To optimize the training process of athletes of this age category, rational means of special physical and technical training of athletes were selected.

General-development exercises for the development of strength

1. Push-ups in a narrow (wide) set of hands (2x12 times).

2. Emphasis lying «Planck» (30 s). Stand on the elbows with a tense press, the muscles of the body and the muscles of the back of the thigh. Maintaining the correct position 20-30 s.

3. Lifting bent (straight) legs in the height of the buffet wall (2x15 times).

4. Exercise «Boat». Starting position lying on your back, legs together, arms along the body. As you exhale, raise your arms and legs about 40-50 cm from the floor. The back and head also rise, only the pelvis remains on the floor. Stay in this position, do not bend your elbows and knees. Get down to the starting position. (20 times).

Specially-developed exercises for the development of strength

1. Exercise «Chopper on a pole» (Fig. 2.). The athlete stands with his right shoulder by the pole, right hand (under the armpit) covers the projectile. The left hand holds the pole from above. Both hands are bent in the elbow joints, brushes - in a straight grip (Fig. 3.). Tightening the bent legs in the knee joints to the elbows, the athlete deflects the body back, straightening his hands in the elbows, and his legs in the knees. The look is directed forward. Try to perform a movement without a swing. The exercise is aimed at developing and strengthening the strength of the muscles of the belly and hands, performed on both sides, changing the position of the hands. Perform this 10 times on each side.



Fig.2. Exercise «Chopper on a pole»



Fig.3. «Straight grip»

2. Exercise «Peter Pan» (Fig.4). The athlete stands with his right shoulder by the pole, the right leg covers the pole with the knee from the outside. The left leg is straight, standing at the base of the pole. Hands in position behind the head/on the belt. The athlete performs the slope of the body to the left, stretching left shoulder down, and the strength of the muscles of the belly returns itself to the right, without the help of hands. The exercise is aimed at developing and strengthening the strength of the lateral muscles of the abdomen and the ability to hold tightly of the pole with foot. It is performed at a slow or medium pace on both sides, while changing the position of the legs. Perform this 10 times on each side.



Fig.4. Exercise «Peter Pan»

3. Exercise «Pulling up on the pole». The athlete covers with straight legs a pole, straightened in the elbow joints of the hands holding a projectile above the head, right above the left. Performing pull-ups, he releases the pole with his feet, spreading them to the sides. When the hands are completely bent in the elbows, the athlete again covers the pole with his legs, and his hands are rearranged so that the left is above the right. Thus, he moves up the pole. The exercise is aimed at developing and strengthening the strength of the

muscles of the hands and the grip of the brushes. Perform this 2 approaches.

4. Exercise «Corner in stop» (Fig. 5.). The athlete faces the pole, the right arm straightened at the elbow joint is held by a straight grip over the head, the left is at the level of pelvis, also straightened in an elbow joint with a "grip of emphasis" (Fig.6.). An athlete raises the straightened legs in the knee joints to parallel them with the floor, or higher. The exercise is performed on both sides, while changing the position of the hands. Make sure that the movement is performed without a swing. The exercise is aimed at developing and strengthening the strength of the muscles of the hands and the grip of the brushes. Perform this 8 times per hand.



Fig. 5. Exercise «Corner in stop»



Fig.6. «Grip of emphasis»

5. «Glass» with a pole (Fig. 7). The right hand is straightened in the elbow joint holds the pole back grip of the brush, the shoulder of the right hand in contact with the pole. The left hand is at a standstill on the floor, as for a stand on the hands. The athlete pulls the legs bent in the knee joints to the chest, trying to hold this position. The look is aimed at the support arm. For complications, an athlete can slowly straighten your legs in the knee joints upwards in a stand on the arm with a pole. The exercise is preparatory to the element stand



near the pole, strengthens and trains the muscles of the hands and back. Performed on both sides, changing the position of the hands. Perform this 8 times per hand.



Fig.7. Exercise «Glass»

General-developing exercises for the development of flexibility

1. Exercises «Fold» (15 s). Fold. Starting position lying on your back, legs straightened, arms straight behind your head, press your lower back to the floor. As you exhale, raise your legs up and twist the body, trying to reach your feet with your palms. Hold at the point of maximum tension for a few seconds. As you inhale, gently, without jerking, lower yourself to the starting position. Do not lower your arms and legs to the end to the floor, keep your back rounded, and the press tense.

2. Move your legs (10 times). Starting position lying on your back perform alternating leg swings at an angle of 30°.

3. Twine on the right (left leg). Hold position from 30 s. to 1 min.

4. Exercises «Backbend». Starting position standing, feet shoulder width apart, hands on the waist. Tilt back, bending as much as possible in the back. Maintain balance so as not to lose balance, for this the hips can be moved forward a little. Perform 10 times with fixation.

5. Exercise «Basket». Starting position: lying on your stomach, stretch your arms back to your legs and catch them from the outside by the ankles. Then bend in the back, raise your shoulders and head up, and try to straighten your legs a little up. Perform 5 times with fixation.

6. Exercises «Gymnastic bridge». Starting position: the back when performing the bridge should be arched in an arc. The buttocks should be above the head and shoulders. The limbs should be as straight as possible, the hands should be on the

palms, and the legs on the feet. The distance between the palms (as well as between the feet) should be equal to the width of the shoulders. Perform 2 times with fixation

7. Exercises «Balance» Starting position: standing on one leg, the other leg behind, arm to the side. Perform 4-5 times on each leg.

Specially-developed exercises for the development of flexibility

1. Jumping into a twine near the pole with the help of a partner. The athlete stands with his left shoulder to the pole and his right shoulder to his partner. He holds the pole with his left hand, and he holds the partner's shoulder with his right hand. The athlete perform a jump with the opening of the longitudinal right twine, based on the pole and shoulder of the partner. Make sure that the legs do not bend in the knee joints during the jump. The exercise is aimed at developing active flexibility, performed on both sides. Perform this 10 jumps per leg.

2. Exercise «Pole twine» (Fig.8). The athlete stands facing the pole, performs the position of the twine right / left on the pole, holding with both hands the pole at the level of the thighs. The exercise is aimed at developing passive flexibility, performed on both legs. Hold the position from 15 to 30 seconds.



Fig.8. Exercise «Pole twine»

3. Exercise «Footwork near the pole». The athlete stands with his left shoulder by the pole, holding left hand behind the projectile, right foot perform the swing forward/sideways/backward. Perform without additional swings of the trunk. The exercise is aimed at developing active flexibility, performed on both legs. Perform this 10 times on each leg.



General development exercises for the development of coordination

1. Exercise «Turn on the toe of one foot». Turns in a standing position on one leg are performed with a swing forward or backward, with a bent or straight leg. Perform 4 approaches in each direction.
2. Performance jump with turning 90°/180°/360°. Perform 4 approaches in each direction.
3. Exercise «Wheel on straight arms». The athlete performs the wheel on straight arms for 7-8 times.

Specially-developed exercises for the development of coordination

1. Exercise «Mill» (Fig.9). The athlete stands with his right shoulder by the pole, right hand (area under the armpit) covers the projectile. The left hand holds the pole from above. Both brushes in a straight grip, elbow joints bent. The athlete, pulled up on his hands, performs a semicircle bottom-right-up with his left foot. Then the right leg continues to move in the opposite direction - up-to-left-down. The exercise is performed in both directions. To ensure that the legs remain straight in the knee joints, and the movement of one leg is successively changed by the movement of the other. Perform this 6 times on each side.



Fig.9. Exercise "Mill"

2. Exercise "Screw." The athlete stands on his toes facing the pole, clasping his arms outstretched pole on top (one hand above the other). He releases his feet from the floor by lowering his shoulder blades down. Rotation of the case to the right and to the left due to force rotation of brushes is carried out. Do not allow the exercise

to be performed by rocking the torso. Perform 2 approaches to 8 turns of the body.

3. Rotation «Chair» (Fig. 10). The athlete stands with his right shoulder to the pole at a distance of a step, embracing the pole with his right straight hand from above. To perform this exercise, you need to take a step with the right, grab the pole with your left straight hand at waist level, swing your left foot in a circle. Next, the athlete performs rotation in a circle from the pole, the hands must be kept straight, and the legs are bent on the knees, imitating the position of the chair. You can complicate the exercise by grabbing your knee with your left hand. The exercise is performed on both sides 4 times.



Fig. 10. Rotation "Chair"

4. Rotation «Pencil». The athlete stands right shoulder to the pole at a distance of a step, clutching the pole with his right straight hand from above. To perform the exercise, you need to take a step with the right, with the attempt of the left to grab the pole with the left hand above the right grip "cup". Perform rotation around the pole. The arm to the middle of the forearm can touch the pole. The look is directed at the hands. The whole body forms a straight line. Legs straight together. Hands straight. Runs on both sides 4-5 times.

5. Rotation «Mermaid». The athlete stands right shoulder to the pole at a distance of a step, clutching the pole with his right straight hand from above. Performs the step with the right, with a swing of the left, grasps the pole with the left shin, takes the right back bent in the knee joint. Brushes and shin of the left leg in contact with the pole. The body does not touch the pole. The exercise is performed on both sides 4-5 times.



General-development exercises for the development of endurance

1. Jumping on the rope. Perform from 1 to 3 min.
2. Circular training. Use from 5 exercises from 40 pp to 1 min.

Specially-developed exercises for endurance development

1. The athlete performs a set of set exercises with and without a pole music duration from 1 to 4 minutes. Exercises are performed consistently without stopping. Example: a) Reverse pull-up on the pole – 2 times. b) Jumping from a sitting position – 10 times. c) Exercise «Chopper» " 5 times on each side. d) «Shoulders» 3 times on each side". When the cycle of exercise is complete, the athlete continues to perform it from the beginning until the music is over. Performing an individual competition program to music 1-2 times during training.
2. Performing an individual competitive program to music 1-2 times during training.

Conclusions

1. It has been established that as of January 2022, pole sport is represented in international and national federations as an independent sport and as a sports discipline. Analysis of modern literature showed that modern pole dancing has several directions, the most famous of which are Pole Sport (Pole Fitness) and Pole Art (Artist).

2. It was found that as a result of the factor analysis, the features of the sports training of athletes of this category are the development of special endurance, which will allow athletes to effectively perform technical elements on the projectile and tricks on the floor during the entire individual program, the expansion of the level of functional abilities of female athletes, which mainly determine specific work capacity, development of coordination and strength qualities, development of flexibility and improvement of technical readiness/

3. Training equipment for the development of special physical qualities and technical techniques, dosage of volume and intensity of loads for 12-13-year-old athletes engaged in pole sports are presented.

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Conflict of interest

The authors declare that there is no conflict of interest.

References

1. Dale JP. The future of pole dance. *Australasian Journal of Popular Culture*, 2013, 2(3):381-396.
2. Drach T, Tsimbalyuk O. Influence of pilot sports and air acrobatics on the general physical condition of performers. *Young Scientist*. 2021;7(95):6-8. <https://doi.org/10.32839/2304-5809/2021-7-95-2>
3. Harding JW, Mackintosh CG, Hahn AG, James DA. Classification of aerial acrobatics in elite half-pipe snowboarding using body mounted inertial sensors (P237). *Engineering of Sport 7*, Vol 2. 2008:447-452
4. Sobko IM, Velieva AR. Methods of developing the physical qualities of athletes who are engaged Pole Sport. *Health-saving technologies, rehabilitation and physical therapy. Collection of articles of the XIV International Scientific Conference, Kharkiv*, 2021: 131-136.
5. Ukrainian Pole Sport & Aerial Acrobatics Federation <https://www.polesportua.org/sport-na-piloni>
6. Jusufi A, Goldman DI, Revzen S, Full RJ. Active tails enhance arboreal acrobatics in geckos. *Proceedings of the National Academy of Sciences of the United States of America*. 2008;105(11):4215-9.
7. Saldana CGO, Gavira JF, Oliver AJS. Evaluation of motivational factors in the practice of pole sport: preliminary validation. *Revista de psicologia del deporte*. 2017, 26: 62-67.
8. Weaving C. Sliding Up and Down a Golden Glory Pole: Pole Dancing and the Olympic Games. *Sport Ethics and Philosophy*. 2020;14(4):525-36.
9. Jensen AL, Lone FT. Performing Gender in Recreational Pole Dancing: Enabling and Constraining Factors. *Sociological Focus*, 2022, <https://doi.org/10.1080/00380237.2022.2066589>



10. Lee JY, Lin L, Tan A. Prevalence of pole dance injuries from a global online survey. *Journal of Sports Medicine and Physical Fitness*. 2020;60(2):270-5.
11. Fennell D. Pole Sports: Considering Stigma. *Sport Ethics and Philosophy*. 2022;16(1):96-110.
12. Goluchowska AM, Humka MI. Types of the locomotor system injuries and frequency of occurrence in women pole dancers. *Journal of Sports Medicine and Physical Fitness*. 2022;62(5):661-6.
13. Kartali I. Pole-dance fitness. *Maidenhead: Meyer & Meyer Sport (UK) Ltd.*,2018:403-412.
14. Kozin V, Boychuk Y, Skaliy A, Zelenskiy R, & Honcharenko V. Individual Factorial Structure of Biomechanical and Psychophysiological Indicators as a Basis for Determining the Fighting Style of Qualified Veteran Boxers. *Health, Sport, Rehabilitation*, 2021,7(3):8-30.
<https://doi.org/10.34142/HSR.2021.07.03.0>
15. Kozina Z, Khrapov S, Yevstratov S, Kolomiets N, Hryshchenko S, Minenok A, & Nosko I. Individual factor structure of qualified volleyball players' preparedness. *Health, sport, rehabilitation*, 2019, 5(1), 56-65.
[doi:http://dx.doi.org/10.34142/HSR.2019.05.01.06](http://dx.doi.org/10.34142/HSR.2019.05.01.06)
16. Kozina ZhL, Cieslicka M, Prusik K, Muszkieta R, Sobko IN, Ryepko OA, Bazilyuk TA, Polishchuk SB, Osiptsov AV, Korol SA. Algorithm of athletes' fitness structure individual features' determination with the help of multidimensional analysis (on example of basketball). *Physical education of students*,2017, 21(5):225-238.
17. Sobko I, Zharkova Y, Vitsko S, Zhukov V, Tsapko A. Formation of doubles and mixed categories in badminton using multivariate analysis methods. *Journal of Physical Education and Sport*, 2020, 20 (6), 425: 3138 – 3145.
18. Haering D, Huchez A, Barbieri F, Holvoet P, Begone M. Identification of the contribution of contact and aerial biomechanical parameters in acrobatic performance. *Plos One*. 2017;12(4).
19. Kozin S, Cretu M, Kozina Z, Chernozub A, Ryepko O, Shepelenko T, Sobko I, Oleksiuk M. Application closed kinematic chain exercises with eccentric and strength exercises for the shoulder injuries prevention in student rock climbers: A randomized controlled trial. *Acta of Bioengineering and Biomechanics*, 2021, 23(2). <https://doi.org/10.37190/ABB-01828-2021-01>
20. Brescianini D, Hehn M, D'Andrea R, editors. Quadrocopter Pole Acrobatics. *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*; 2013 Nov 03-08; Tokyo
21. Fennell, D Pole Sports: Considering Stigma. *Sport ethics and philosophy*, 2020 DOI. 10.1080/17511321.2020.1856914
22. Fennell D. Pole studios as spaces between the adult entertainment, art, fitness and sporting fields. *Sport in Society*. 2018;21(12):1957-73.
23. Muszkieta R, Napierała M, Cieślicka M, Zukow W, Kozina Z, Iermakov S, et al. The professional attitudes of teachers of physical education. 2018. *Journal of Physical Education and Sport*. 2019;19:100-7. <https://doi.org/10.7752/jpes.2019.s1014>
24. Kozina Z, Cretu M, Safronov D, Gryn I, Shkrebtii Y, Bugayets N, Shepelenko T, Tanko A. Dynamics of psychophysiological functions and indicators of physical and technical readiness in young football players aged 12-13 and 15-16 years during a 3-month training process. *Physiotherapy Quarterly*, 2019;27(3):20–27.
<https://doi.org/10.5114/pq.2019.86464>
25. Sobko IN, Ulaeva LA, Yakovenko YA. Factorial structure of physical rehabilitation group students' complex fitness. *Physical education of students*. 2016;20(2):32-37.
26. Dittrich F, Beck S, Burggraf M, Busch A, Dudda M, Jager M, et al. A small series of pole sport injuries. *Orthopedic Reviews*. 2020;12(3):143-4

Information about authors

Iryna Sobko

sobko.iryana18@gmail.com

<http://orcid.org/0000-0002-4920-9775>

H.S. Skovoroda Kharkiv National Pedagogical University
Alchevskikh st. 29, Kharkiv, 61002, Ukraine

Anastasia Velieva

reginavelieva21@gmail.com

<https://orcid.org/0000-0002-7563-6359>

H.S. Skovoroda Kharkiv National Pedagogical University
Alchevskikh st. 29, Kharkiv, 61002, Ukraine

Yana Sobko

sobkoyana4@gmail.com

<https://orcid.org/0000-0002-5511-4561>

National Technical University «Kharkiv Polytechnic Institute»;
2, Kyrpychova str., 61002, Kharkiv, Ukraine



Olena Slastina

slastinaelena8@gmail.com

<https://orcid.org/0000-0001-5118-9825>

Ukrainian Engineering Pedagogics Academy;
vul. Universitetskaya, 16, 61003 Ukraine, Kharkiv

Інформація про авторів

Ірина Собко

sobko.iryana18@gmail.com

<http://orcid.org/0000-0002-4920-9775>

Харківський національний педагогічний університет імені Г.С. Сковороди,
вул. Алчевських 29, Харків, 61002, Україна

Анастасія Велієва

reginavelieva21@gmail.com

<https://orcid.org/0000-0002-7563-6359>

Харківський національний педагогічний університет імені Г.С. Сковороди,
вул. Алчевських 29, Харків, 61002, Україна

Яна Собко

sobkoyana4@gmail.com

<https://orcid.org/0000-0002-5511-4561>

Національний технічний університет "Харківський політехнічний інститут";
вул. Кирпичова, 2, 61002, м. Харків, Україна

Олена Сластина

slastinaelena8@gmail.com

<https://orcid.org/0000-0001-5118-9825>

Українська інженерно-педагогічна академія;
вул. Університетська, 16, 61003, м. Харків, Україна

Информация об авторах

Ирина Собко

sobko.iryana18@gmail.com

<http://orcid.org/0000-0002-4920-9775>

Харьковский национальный педагогический университет имени Г.С. Сковороды,
ул. Алчевских 29, Харьков, 61002, Украина

Анастасия Велиева

reginavelieva21@gmail.com

<https://orcid.org/0000-0002-7563-6359>

Харьковский национальный педагогический университет имени Г.С. Сковороды,
ул. Алчевских 29, Харьков, 61002, Украина

Яна Собко

sobkoyana4@gmail.com

<https://orcid.org/0000-0002-5511-4561>

Национальный технический университет «Харьковский политехнический институт»;
ул. Кирпичева, 2, 61002, г. Харьков, Украина

Елена Сластина

slastinaelena8@gmail.com

<https://orcid.org/0000-0001-5118-9825>

Украинская инженерно-педагогическая академия;
ул. Университетская, 16, 61003, г. Харьков, Украина

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