

## Influence of a 10-week rational breathing training program on technical fitness indicators in girls aged 7–9 engaged in acrobatic track jumping

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Published online: December 30, 2024

Accepted for publication: December 15, 2024

DOI:10.7752/jpes.2024.12308

### Abstract:

**Purpose.** The quality of initial training in many sports is inextricably linked to rational breathing patterns. This issue is relevant in artistic gymnastics, including acrobatic tumbling. Experts believe that in such sports, the establishment of rational breathing at the initial stage of long-term sports training can significantly affect the formation of sports technique, individual style of performance of future athletes, even the effectiveness of the physical training process. The present research aims to improve the technique of acrobatic jumps of girls 7-9 years old who are engaged in rhythmic gymnastics using the experimental method of teaching the methods of rational breathing. Materials and methods. The research was attended by 24 young sportswomen (girls aged 7-9 years old) who are engaged in artistic gymnastics by jumping on an acrobatic track. Some indicators of external respiratory parameters were studied, such as: vital capacity of the lungs (VC), breath-holding on inhalation (BHI), breath-holding on exhalation (BHE), reserve inspiratory volume (RIV), reserve expiratory volume (REV). Changes in indicators of technical fitness of participants of the experiment were recorded. The probability of differences in the level of technical of participants of the control and experimental groups was determined in accordance with the requirements of the Training program in artistic gymnastics for children's and youth sports schools (2023). **Results** The analysis of the results of the formative experiment shows that the level of technical fitness of the experimental group under the influence of the 10-week program of training in rational breathing techniques was much higher in comparison with the control group and has significant differences in the level of  $p<0.05-0.01$ . Starting from the middle of the experiment (5-6 weeks) the dynamics of mastering control exercises by young sportswomen of the experimental group proceeds at a higher level in contrast to gymnasts of the control group. By the end of the experiment (week 10) this difference reached even more significant values ( $p<0.05-0.001$ ). On average, the success of control exercises by participants of the control group was 55% of realization, and of the experimental group - 80%, respectively. Thus, the efficiency using special breathing exercises for the increased of efficiency of mastering the technique of basic complex-coordinated jumps on an acrobatic track is proved. **Conclusions.** The efficiency of the methodology developed and implemented by us for the formation of skills of rational breathing at teaching acrobatic complex coordination elements at the stage of initial and preliminary basic training in gymnastics is proved. The special breathing exercises chosen by us and recommended for performance by the experimental group in the form of a complex have a significant ( $p<0.05-0.001$ ) positive influence on indicators of technical fitness of girls of 7-9 years old who engaged in jumps on an acrobatic track.

**Key words:** gymnastics, breathing, training, sports, fitness

### Introduction.

The modern system of sports training is characterized by a constant search for means and methods of improving sports and technical skills. Breathing accompanies the process of changing the properties of the body and is the functional basis that ensures the successful improvement of all components of sports training. Many scientists have dealt with the problems of improving certain aspects of young athletes' fitness (Dallam, G., & Kies, B., 2020; Lörinczi, Kushkestani & Vanderka, 2023; Lörinczi, Lörincziová & Augustovičová, 2024).

The effectiveness of the learning process in many sports is inextricably linked to rational breathing patterns. This issue is relevant, including in the family of gymnastic disciplines. There is no doubt that in sports involving the performance of acrobatic exercises, complex elements, their combinations on gymnastic apparatus, the correct breathing pattern can have a decisive impact on the final result. The scientific community and coaches who have studied the effect of different breathing modes on exercise performance claim that several chest muscles are involved in the breathing process, primarily the diaphragm (Fig. 1).

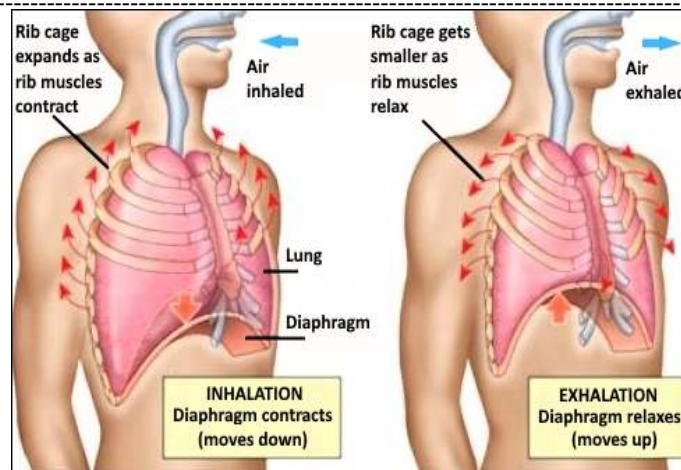


Fig. 1. Processes that occur in the human body during a breathing act

Previous studies have analysed the relationship between breathing patterns and stride rhythm (Fig. 2) and have shown that there are certain breathing patterns that are less energy-intensive and more comfortable for runners (Harbour, Stöggel, Schwameder & Finkenzeller, 2022; <https://blayze.io/blog/general/the-science-of-breathing-for-athletes>; <https://sites.udel.edu/coe-engex/2017/04/09/breathe-in-breathe-out-breathing-during-exercise/>).

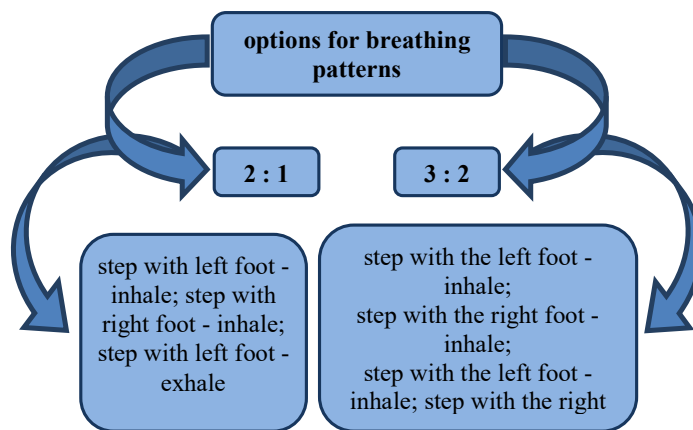


Fig. 2. The most common breathing patterns in the running disciplines of athletics

The diagram below shows a study in which ten athletes ran at different speeds while heel strike and inhalation measurements were recorded. The results showed that runners most often tend to breathe in a 2:1 or 3:2 pattern, which means inhaling for 2 steps and exhaling for 1 (2:1) or inhaling for 3 steps and exhaling for 2 (3:2). When reviewing specialised literature on this issue, it was found that in various sports, many experts (Platonov V., 2019; Laborde S., et al., 2022; Cunha, Rui Sofia, & Dias, 2022; Lörinczi, Lörincziová & Augustovičová, 2024) studied the breathing patterns of athletes during training and competition. It is only in gymnastics, where the problem is quite

obvious, that it has not found proper coverage.

This can be attributed both to the extreme complexity of these types and to the limited number of specialists in this area who belong to the academic environment. Further research only confirmed the assumptions made. The generalisation of the collected factual material and the analysis of specialised literature allow us to express the opinion that the athlete should first of all adhere to the following methodological rule: the phases of movements, the performance of which involves the application of the greatest muscle effort, should be combined with exhalation, and inhalation should be carried out in the unsupported phase (in its ascending or descending part, depending on the nature of the elements performed) (Platonov V, 2019; Chayun, Kletsov, & Manzheley, 2020; Mischenko N., et al., 2021; Lörinczi, F., Kushkestani, M., & Vanderka, M., 2023b).

At the same time, it should be noted that to date, the issue of rational breathing during exercise in complex coordination sports is considered insufficiently studied. In particular, there is almost no information about breathing modes when performing technical elements of complexity of the classification programme not only by highly qualified athletes in artistic gymnastics, acrobatics, rhythmic gymnastics and other its varieties, but also when performing basic elements of technique at the initial stage of training. This complicates the development of a scientifically based methodology for teaching rational breathing during exercise that would meet the modern requirements of Olympic and professional sports (Dallam, G., & Kies, B., 2020; Lörinczi, F., Lörincziová, D., & Vanderka, M., 2023a).

For example, Mischenko N., et al., 2021 found that in the process of muscle activity, a coordination between respiratory and work movements is established. In turn, Murlasits, Z., et al., 2023 found that in acyclic movements, one of the factors contributing to the manifestation of maximum effort is the optimal coordination of the phases of movement and respiratory phases (<https://blayze.io/blog/general/the-science-of-breathing-for-athletes>). Thus, the development, experimental testing and practical implementation of rational breathing skills in the training process of young athletes specialising in artistic gymnastics during the performance of complex coordination elements determine the relevance and practical significance of the presented problem. Proceeding from this thesis, the development of new methods of technical training for novice athletes should be perceived as an improvement of the training process to increase the efficiency of their competitive activity. This, in turn, served as a reason to consider the current study relevant.

**The aim** of the research is to improve the technique of acrobatic jumps of girls 7-9 years old engaged in rhythmic gymnastics by means of experimental methodology of teaching rational breathing techniques.

## **Material and Methods**

### *Analysis of special scientific and methodological literature*

The analysis of publications of specialised professional sports editions showed that the issues of correlation of phases of breathing and movement occupy a significant place in sports scientific literature. In the family of gymnastic disciplines, the optimal coordination of the phases of movement and phases of breathing is of particular importance. This largely determines the rational and optimal choice of training tools. However, the orientation of pedagogical influences of this methodological technique is not sufficiently studied.

### *Sociological methods of research.*

The system of sociological methods, rules, principles, norms of regulation is at the level of a special scientific methodology. This study used the most common methods of sociological research - surveys and questionnaires. The survey expanded the number of sources of information, ensured sufficient systematicity and accuracy of the information received, and allowed obtaining information relatively quickly and cheaply. In the present study, it was also considered appropriate to use a postal survey. This method made it possible to simultaneously conduct a survey over a large territory, including in hard-to-reach areas due to the ongoing hostilities in the Zaporizhzhia region and the temporary occupation of large parts of its territory. The questionnaires contained a certain set of questions formulated and linked to each other according to the established rules. The survey methodology consisted of sending out questionnaires and receiving responses to them via email in the form of a Google form. The length of the questionnaire took into account the fact that the time to complete it should not exceed 40-50 minutes. All questionnaires were filled out by respondents individually and independently.

### *Pedagogical observations*

Pedagogical observations were conducted at educational and training classes in artistic gymnastics in groups of initial training in children's and youth schools and sports clubs of Zaporizhzhia. During the experiment, more than 150 classes were analysed. Pedagogical observations were also conducted (in addition to training sessions) during competitions, demonstration performances, and sports events (a total of 26 performances of female athletes and team performances were monitored).

### *Pedagogical experiment*

The pedagogical experiment was used to compare classes of different directions, to determine their features, the use of certain training tasks, their motor structure and nature, as well as efficiency.

At the first stage (September 2022 - January 2023) 2 groups of subjects were selected, and their training programme and schedule of control measures were drawn up, during which data of physiological tests of the function of external respiration, indicators of control tests characterising the influence of different modes of breathing on the efficiency of acrobatic elements performance will be obtained. It should also be noted that the control over the technical skills of young gymnasts was not limited to any one stage of the experiment, but took place throughout the entire research work, being its main motive and putting forward one of the main objectives of the study. In addition, at this stage, the role of athletes' breathing modes in the process of initial training and further performance of acrobatic elements was studied using a survey.

At the second stage of the study (February - May 2023), the influence of different breathing modes on the effectiveness of acrobatic elements, specially selected taking into account the qualifications of the subjects and the development of complexes of special breathing exercises that would help to improve the process of training efficiency and further daily performance during training sessions, was determined. This was carried out by means of step-by-step control over the technical skills of young gymnasts, regular exchange of information on the dynamics of indicators and work experience, constant analysis of data from our own research and the latest scientific and methodological developments in this area. To test the hypothesis, we conducted a pedagogical experiment, which, in our opinion, allowed us to correct the breathing regimes of athletes and coordinate them with the structure of movements in the process of teaching acrobatic elements. For this purpose, the subjects were divided into two groups, control and experimental, 12 acrobats in each. Both groups performed the same training load during the experiment. The authors analysed 160 training sessions on acrobatic tracks of different

orientations, which took place in sports groups at the stage of initial training. At the beginning and at the end of the experiment the testing was carried out, which included control over the success of performance of control exercises in the course of control training.

In addition to this test, twice during the experiment, individual indicators of external respiration were measured using a spirometer, such as: vital capacity of the lungs (VC), inspiratory breathing hold (IBH), expiratory breathing hold (EBH), reserve inspiratory volume (RIV) and reserve expiratory volume (REV). One of the main tasks of this stage of the study was to develop, on the basis of the experimental material, complexes of breathing exercises that influence the function of the breathing regime, coordinated with the structure of movements at the stage of initial training. The tasks of introducing the experimental methodology of technical training into the educational and training process of young gymnasts in training groups of the 2nd year of training, as well as determining its effectiveness were also solved.

All studies were conducted during 2022-2023 on the basis of the National University «Zaporizhzhia Polytechnic» and Zaporizhzhia National University. The study involved young athletes, girls aged 7-9 years, who were engaged in artistic gymnastics (acrobatic track jumps) in 2nd year training groups.

#### *Control tests*

Pedagogical testing was a standardised form of task that was used to determine the technical proficiency of the trainees. It was conducted at the beginning and end of a sequential pedagogical experiment. The pedagogical testing included exercises to assess the level of technical fitness, with a separate one - jumps on an acrobatic track. Depending on the orientation of motor fitness of young gymnasts who are at the initial stage of long-term training, a complex of control exercises was allocated to determine the parameters of their technical fitness. The quality of performance of control tasks and a course of success of mastering difficult-coordinating elements of gymnastics at the stage of initial preparation were controlled by means of a group of control tasks which are recommended by the Programme on sports gymnastics for sportsmen of children's and youth sports schools (CYSS), (2023). The block of control exercises consisted of 8 acrobatic elements: forward roll, backward roll, handstand, rondat, back flip «flask», «tempo» forward flip from two to two, back flip from a place, forward flip from a jump. The tests were scored on a 10-point scale (from 0 to 10).

Two most difficult jumps were selected for testing of efficiency of the experimental technique of training of modes of rational breathing at performance of difficult-coordinated acrobatic elements, namely:

- «Back flip from a place into a jump, with intervals of repetitions between attempts no more than 10 seconds»;
- «From a standing position on an elevated (30 cm) support, jumping and pushing with two feet - a forward flip in a grouping into a plunge».

They involve repeated, maximally accurate performance of relatively simple acrobatic elements of complex coordination character within a short time interval.

In this case, an alternative assessment system «passed - not passed» was used, i.e. «passed» - when performing a somersault and «not passed» - when performing any other performance. The dynamics of success was tracked within weekly training microcycles for 10 weeks.

The assessment of the level of special technical fitness was carried out on a 10-point scale:

| Point | Level    | Point | Level           |
|-------|----------|-------|-----------------|
| 1-2   | «low»    | 3-4   | «below average» |
| 5-6   | «medium» | 7-8   | «above average» |
| 9-10  | «high»   |       |                 |

#### *Testing of external respiratory function*

To study the parameters of external respiration of young sportswomen who took part in experimental researches, the standard method of spirometry was used with the help of a dry portable spirometer SSP (Rechkina O. O., Rudenko S. M., 2023). Testing was carried out twice during the experiment: at the end of the establishing and at the end of the formative experiments. The following indicators were studied:

- vital capacity of the lungs (VC);
- reserve inspiratory volume (RIV) and reserve expiratory volume (REV);
- breath-holding on inhalation (BHI) and breath holding on exhalation (BHE).

#### *Expert assessment*

In this work, the opinion of specialists-coaches and sports judges was found out, who were able to express their opinion verbally or in any other informative form in terms of the applied means, methods, techniques and technology of technical training of young athletes specialising in women's rhythmic gymnastics. This was done comprehensively and by separate groups of elements. To implement this method, an expert commission of experienced specialists and judges was created to evaluate the proposed parameters in points from 1 to 10 according to the criteria of the international rules of artistic gymnastics competitions. The number of experts in the commission was 3 or 5 judges. The average number of points was considered the result of the expert assessment. Each of the experts received a score, and then the arithmetic mean of the total score of the expert assessments scored by each individual athlete was calculated. The results of the expert assessment of individual parameters were recorded in the judges' protocol. A comprehensive assessment of technical fitness was made when the athletes performed basic acrobatic elements of difficulty. In addition, after participation of young gymnasts in classification competitions the objectivity

of the level of expert assessment was compared with the results of studying of judges' protocols. When choosing exercises for evaluation, experts took into account the classification of elements according to the rules of the International Gymnastics Federation (FIG) ([https://www.gymnastics.sport/publicdir/rules/files/en\\_TRA%20CoP%202022-2024.pdf](https://www.gymnastics.sport/publicdir/rules/files/en_TRA%20CoP%202022-2024.pdf)).

#### *Mathematical statistics methods*

Statistical processing of the data was carried out using Microsoft Excel 'Data Analysis' and SPSS research results processing programs, with the calculation of the following indicators: arithmetic mean ( $\bar{x}$ ), standard deviation (S), coefficient of variation (V,%), confidence interval ( $\Delta x$ ). The reliability of the results was also assessed according to the calculated values of the Student's t-test, by the average level of significance (p). Differences were considered significant at a value equal to  $p < 0.05$ . The Kolmogorov-Smirnov test was used to assess the parameters of the score distribution.

### **Results**

At the first stage of the study, the role of breathing modes of young gymnasts and acrobats in the process of initial training in complex coordination elements was studied by means of a survey. The following was revealed. The majority of coaches (83.0%) believe that it is advisable to teach the correct breathing regime not only when performing acrobatic elements and combinations in floor exercises, but also when teaching exercises on other gymnastic apparatus. Some coaches (about 39%) believe that it is advisable to take one breath with a breath-hold before performing an element, while others (slightly more than 37%) believe that it is better to exhale with a breath-hold. The rest of the respondents (almost 24%) consider it necessary to perform several short and quick inhalations and exhalations in a row. 70% of the coaches surveyed believe that a rational breathing regime can be as follows: inhalation can or should be performed through the nose and mouth simultaneously (in a mixed mode), and exhalation - gradually, in small portions, from element to element. This opinion was especially typical for gymnastics coaches and concerned floor exercises and exercises on gymnastic apparatus. The rest, about 30% of the respondents, recommend breathing in the following mode: deep and sharp inhalation through the nose; full and quick exhalation through the mouth.

The coaches who took part in the survey admitted (more than 90%) that they practically do not use special breathing exercises or their complexes when teaching complex coordination movements, despite the importance of this element of sports training. If they do, the most commonly used breathing exercises are: inhale - hands up, exhale - hands down; deep inhalations and exhalations for 25-30 seconds after the exercise; deep inhalation - breath holding for 5-10 seconds - exhalation; slow jogging; imitation exercises at a slow pace, etc. for 2-3 minutes. The survey showed that, in general, coaches, especially in different, though related, complex and coordinated sports, such as acrobatics and gymnastics, do not have common views on the structure of breathing and do not pay due attention to this element in the process of training athletes.

It should also be noted that the studied athletes (as it turned out from the interview) had never paid attention to the rhythm of their breathing before, did not pay attention to its special setting. The correlations between the phases of breathing and movements observed in their experiments were formed spontaneously, reflexively. Repeated repetition of special exercises stabilised the breathing regime and contributed to the adaptation of respiratory movements to the specific conditions of the elements performed.

The level of technical fitness of sportsmen engaged in artistic gymnastics and acrobatics at the initial stage of sports training was determined during the ascertaining experiment. The level of technical fitness of young sportsmen was determined by the following blocks of tests: basic movements, jumps, acrobatic elements. The results of checking the technical fitness of female sportswomen who took part in the experimental research and whose specialisation is artistic gymnastics and acrobatics are presented in Table 1.

**Table 1. Indicators of technical fitness of young gymnasts during the ascertaining experiment, (n=24)**

| Control exercise (test)                                        | Statistical indicators |      |       |
|----------------------------------------------------------------|------------------------|------|-------|
|                                                                | $\bar{x}$              | S    | V (%) |
| Acrobatic elements                                             |                        |      |       |
| Front roll, points                                             | 9,14                   | 0,27 | 8,56  |
| Back roll, points                                              | 8,42                   | 0,21 | 14,41 |
| Handstand, points                                              | 5,20                   | 0,43 | 31,32 |
| Round off, points                                              | 5,38                   | 0,35 | 25,16 |
| Flic flac, points                                              | 5,70                   | 0,28 | 22,21 |
| Forward salto after a jump, points                             | 4,94                   | 0,60 | 34,32 |
| Backward salto from a standing start, points                   | 4,86                   | 0,33 | 47,94 |
| Tempo forward handspring from two to two legs together, points | 3,32                   | 0,39 | 71,86 |

The results of the research have established that young gymnasts' average group value of indicators on tests representing basic movements and jumps is at the level of «above average». The block of tests «acrobatic elements» revealed an average level of development of the studied indicators. At the same time, the coefficient of variation (V, %) indicates a significant variability of the results of acrobatic elements. This is especially noticeable in the following tests: handstand, «Front flip after a jump», «Backflip from a standing start», «Tempo front flip from two to two» (V, % from 31,32 to 71,86 %).

It should also be noted that raising the level of technical skill, i.e. mastering a perfect sports technique, its structure and level of characteristics, to a certain extent depends on the teaching methodology. In turn, all this directly affects the technical fitness of female athletes, both in gymnastics and acrobatics. Proceeding from this (based on the previous conclusions), we decided to test an experimental methodology of technical training of young gymnasts based on the use of rational breathing modes when performing acrobatic complex coordination elements, specially adapting it for the initial stage of sports training.

The methodology is based on an experimental complex of specially developed complex coordination gymnastics exercises coordinated with the performance of breathing exercises for the technical training of young gymnasts of the experimental group. It contained the following exercises (table 2).

**Table 2. An experimental complex of acrobatic exercises coordinated with the performance of breathing acts during their performance for the improvement of technical fitness of young gymnasts (girls 7-8 years old)**

| The content of the proposed tasks                                                                                                                                                              | Dosage.             | Organisational and methodological guidelines                                             |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|------------------------------------------------------------------------------------------|
| Run 20 m at maximum speed with a breath hold                                                                                                                                                   | 10-12 times         | Perform as you inhale and exhale.                                                        |
| Standing, inhale through the nose, hold the breath for 5 seconds, exhale through the mouth                                                                                                     | 5 times for 1 min   | Can be performed in coordination with hand movements                                     |
| Sitting down, breathing at will, inhale, then hold your breath, jump up (stretch your arms up) - exhale                                                                                        | 5 times for 1 min   | Try to perform without significant pauses between repetitions, evenly                    |
| Sitting down, breathing at will, inhale, then hold your breath, jump up ("Waltz") - flip forward in a group, exhale.                                                                           | 3-5 times for 1 min | Perform at an average pace, without trying to accelerate, control the landing technique  |
| In the starting position for performing a backward salto from a place - 2-3 active breathing cycles - deep ("full") inhalation; backflip - exhalation.                                         | 3-5 times for 1 min | If the technique is not stabilised, perform with the help of a trainer or a safety guard |
| Same exercise + inhale and jump up; landing - exhale.                                                                                                                                          | 3-5 times for 1 min | Similar to exercise 5                                                                    |
| In the starting position for performing a backward salto from a place - 2-3 active breathing cycles, deep ("full") exhalation; backflip - inhalation.                                          | 3-5 times for 1 min | If the technique is not stabilised, perform with the help of a trainer or a safety guard |
| Same exercise + exhale and jump up; landing - inhale.                                                                                                                                          | 3-5 times for 1 min | Similar to exercise 7                                                                    |
| In the starting position for performing a backward salto from a place - 2-3 active breathing cycles, deep ("full") inhalation; backward salto, in a counter-tempo - forward salto, exhalation. | 3-5 times for 1 min | Perform only under the supervision of a trainer and with the assistance of the insured   |
| In the starting position for performing " backward salto from the place" - 2-3 active breathing cycles, deep exhalation; backward salto, in the counter-tempo - forward salto, inhalation      | 3-5 times for 1 min | Similar to exercise 9                                                                    |

To test the hypothesis put forward in the work we conducted a pedagogical experiment which allowed to carry out correction of modes of breathing of sportsmen and its coordination with the structure of the performed motor actions thanks to the developed complex of complex-coordinated gymnastics exercises coordinated with the performance of breathing exercises.

When studying some parameters of external respiration of athletes of both groups (control and experimental), such as FVC, breath holding on inspiration, breath holding on exhalation, reserve inspiratory volume and reserve expiratory volume, it turned out that significant changes were found only in two of them: reserve inspiratory volume and reserve expiratory volume.

As for other parameters of external respiration. Statistically significant changes ( $p < 0.05$ ;  $p < 0.01$ ;  $p < 0.001$ ) were recorded only in sportswomen of the experimental group. In the control group it was not possible to detect such changes at all (Table 3).

**Table 3. Changes in some parameters of external respiration of young sportswomen of control and experimental groups during the experiment, ( $\bar{x} \pm S$ )**

| Parameter | The research stage | Control group   |            |        | Experimental group |            |         |
|-----------|--------------------|-----------------|------------|--------|--------------------|------------|---------|
|           |                    | $\bar{x} \pm S$ | $\Delta\%$ | p      | $\bar{x} \pm S$    | $\Delta\%$ | p       |
| VC, l     | beginning          | 1,63±0,09       | 4,29       | p>0,05 | 1,62±0,07          | 15,43      | p<0,01  |
|           | ending             | 1,70±0,08       |            |        | 1,87±0,08          |            |         |
| RIV, ml   | beginning          | 622,80±60,90    | 10,95      | p<0,05 | 612,0±54,70        | 21,56      | p<0,001 |
|           | ending             | 691,00±63,10    |            |        | 744,0±43,70        |            |         |
| REV, ml   | beginning          | 146,60±31,70    | 9,48       | p<0,05 | 150,0±28,50        | 20,0       | p<0,01  |
|           | ending             | 160,50±18,50    |            |        | 180,0±22,70        |            |         |
| BHI, s    | beginning          | 28,43±1,57      | 2,15       | p>0,05 | 28,46±1,55         | 11,81      | p<0,01  |
|           | ending             | 29,04±1,59      |            |        | 31,82±1,73         |            |         |
| BHE, s    | beginning          | 20,74±1,10      | 5,03       | p>0,05 | 19,14±0,83         | 10,03      | p<0,05  |
|           | ending             | 21,50±1,43      |            |        | 21,06±1,08         |            |         |

Thus, the obtained results allowed us to assert that the special breathing exercises chosen by us and recommended for performance by the experimental group in the form of a complex, significantly affect the studied breathing parameters. Explaining the essence of the training effect of the proposed breathing exercises, we can add the following. Due to the specifics of the technique of exercises in gymnastics and acrobatics, the vast majority of which are even reflexively performed on a breath hold, it is the ability to hold the breath in time and for a long time, *ceteris paribus*, that can have a decisive influence both on the formation of the correct technique of performing gymnastic elements and on the effectiveness of their performance in combinations on gymnastic apparatus. This statement seems to us important, because once again, albeit indirectly, it proves the effectiveness of the developed and adopted methodology of setting up rational breathing when teaching gymnastic elements.

To determine the effectiveness of the proposed means and methods of training, which formed the basis of the experimental methodology, at the end of the stage of initial training of the second year of study the repeated control testing of technical fitness was carried out, which took place at the end of the pedagogical experiment (corresponds to the stage of the formative experiment). The level of technical fitness of young gymnasts was determined by the offered control tests which meet the requirements of the Programme on artistic gymnastics for sportsmen of children's and youth sports schools (CYSS) (tab. 4 - 5).

**Table 4. The results of performing tests on technical training by acrobats of the control group at the beginning and after the end of the pedagogical experiment, (n=12)**

| Control exercise (test)                                           | The research stage | $\bar{x} \pm S$ | V%    | $\Delta\%$ | p     |
|-------------------------------------------------------------------|--------------------|-----------------|-------|------------|-------|
| 1. Forward dive roll, points                                      | beginning          | 9,22±0,31       | 10,90 | 1,95       | >0,05 |
|                                                                   | ending             | 9,40±0,25       | 6,87  |            |       |
| 2. Back roll over a handstand, points                             | beginning          | 8,25±0,55       | 18,65 | 6,06       | >0,05 |
|                                                                   | ending             | 8,75±0,33       | 16,00 |            |       |
| 3. Handstand, points                                              | beginning          | 6,20±0,28       | 33,58 | 12,26      | >0,05 |
|                                                                   | ending             | 6,96±0,70       | 24,35 |            |       |
| 4. Round off, points                                              | beginning          | 6,40±0,39       | 29,58 | 10         | <0,05 |
|                                                                   | ending             | 7,04±0,56       | 22,19 |            |       |
| 5. Flic flac, points                                              | beginning          | 6,55±0,69       | 26,02 | 8,7        | >0,05 |
|                                                                   | ending             | 7,12±0,54       | 21,58 |            |       |
| 6. Forward salto from jump on, points                             | beginning          | 5,46±0,61       | 48,73 | 10,26      | >0,05 |
|                                                                   | ending             | 6,02±0,65       | 23,06 |            |       |
| 7. Backward salto from a standing start, points                   | beginning          | 5,68±0,56       | 45,09 | 11,97      | <0,05 |
|                                                                   | ending             | 6,36±0,80       | 31,41 |            |       |
| 8. Tempo forward handspring from two to two legs together, points | beginning          | 3,70±1,25       | 94,60 | 24,32      | <0,05 |
|                                                                   | ending             | 4,60±1,46       | 49,55 |            |       |

**Table 5. The results of performing tests on technical training by acrobats of the experimental group at the beginning and after the end of the pedagogical experiment, (n=12)**

| Control exercise (test)               | The research stage | $\bar{x} \pm S$ | V%    | $\Delta\%$ | p     |
|---------------------------------------|--------------------|-----------------|-------|------------|-------|
| 1. Forward dive roll, points          | beginning          | 9,20±0,31       | 10,04 | 2,61       | >0,05 |
|                                       | ending             | 9,44±0,27       | 6,16  |            |       |
| 2. Back roll over a handstand, points | beginning          | 8,55±0,63       | 14,90 | 5,26       | >0,05 |
|                                       | ending             | 9,00±0,38       | 9,80  |            |       |

|                                                                   |           |           |       |       |        |
|-------------------------------------------------------------------|-----------|-----------|-------|-------|--------|
| 3. Handstand, points                                              | beginning | 6,48±0,85 | 28,57 | 16,05 | <0,05  |
|                                                                   | ending    | 7,52±0,55 | 19,99 |       |        |
| 4. Round off, points                                              | beginning | 6,48±0,85 | 23,20 | 23,77 | <0,001 |
|                                                                   | ending    | 8,02±0,61 | 20,04 |       |        |
| 5. Flic flac, points                                              | beginning | 6,48±0,48 | 22,77 | 24,23 | <0,001 |
|                                                                   | ending    | 8,05±0,44 | 17,93 |       |        |
| 6. Forward salto from jump on, points                             | beginning | 5,48±0,47 | 45,05 | 27,01 | <0,001 |
|                                                                   | ending    | 6,96±0,19 | 14,95 |       |        |
| 7. Backward salto from a standing start, points                   | beginning | 5,92±0,61 | 40,77 | 12,16 | <0,01  |
|                                                                   | ending    | 6,64±0,15 | 15,06 |       |        |
| 8. Tempo forward handspring from two to two legs together, points | beginning | 3,68±0,74 | 63,59 | 82,61 | <0,001 |
|                                                                   | ending    | 6,72±0,43 | 18,52 |       |        |

Analysing the results of checking the technical fitness of young gymnasts before and at the end of the experiment we can state that according to Student's t-test in the control group (Table 4) statistically significant improvement of the result at the minimum level ( $p < 0.05$ ) is only in separate tests, namely: 'Rondat', "Back flip from a place", "Tempo forward flip from two to two" ( $p < 0.05$ ).

Instead, in the experimental group (Table 5) statistically significant improvement of results was observed in 6 tests: 'Handstand', ( $p < 0.05$ ); "Rondat", "Back flip - flask", 'Forward flip from a jump' 'Back flip from a place', "Tempo forward flip from two to two" ( $p < 0.001$ ).

Comparing results of the control and experimental groups (Table 6) it is noticeable that at the end of the experimental research significant differences between groups were found in 5 tests: 'Handstand', "Back flip - flask", "Forward flip from a jump", "Back flip from a place", "Tempo forward flip from two to two" ( $p < 0.05$  -  $p < 0.001$ ).

**Table 6. Comparison of the results of the tests on technical training by acrobats of the control (CG, n=12) and experimental (EG, n=12) groups at the beginning and after the pedagogical experiment**

| Control exercise (test)                                           |    | At the beginning of the experiment |            |       | At the end of the experiment |            |        |
|-------------------------------------------------------------------|----|------------------------------------|------------|-------|------------------------------|------------|--------|
|                                                                   |    | $\bar{x} \pm S$                    | $\Delta\%$ | p     | $\bar{x} \pm S$              | $\Delta\%$ | p      |
| 1. Forward dive roll, points                                      | CG | 9,22±0,31                          | 0,22       | >0,05 | 9,40±0,25                    | 0,43       | >0,05  |
|                                                                   | EG | 9,20±0,31                          |            |       | 9,44±0,27                    |            |        |
| 2. Back roll over a handstand, points                             | CG | 8,25±0,55                          | 3,64       | >0,05 | 8,25±0,55                    | 9,09       | <0,05  |
|                                                                   | EG | 8,55±0,63                          |            |       | 9,00±0,38                    |            |        |
| 3. Handstand, points                                              | CG | 6,20±0,28                          | 4,52       | >0,05 | 6,96±0,70                    | 8,05       | <0,05  |
|                                                                   | EG | 6,48±0,85                          |            |       | 7,52±0,55                    |            |        |
| 4. Round off, points                                              | CG | 6,40±0,39                          | 1,25       | >0,05 | 7,04±0,56                    | 13,92      | <0,01  |
|                                                                   | EG | 6,48±0,85                          |            |       | 8,02±0,61                    |            |        |
| 5. Flic flac, points                                              | CG | 6,55±0,69                          | 1,07       | >0,05 | 7,12±0,54                    | 13,06      | <0,01  |
|                                                                   | EG | 6,48±0,48                          |            |       | 8,05±0,44                    |            |        |
| 6. Forward salto from jump on, points                             | CG | 5,46±0,61                          | 0,37       | >0,05 | 6,02±0,65                    | 15,61      | <0,01  |
|                                                                   | EG | 5,48±0,47                          |            |       | 6,96±0,19                    |            |        |
| 7. Backward salto from a standing start, points                   | CG | 5,68±0,56                          | 4,23       | >0,05 | 6,36±0,80                    | 20,13      | <0,001 |
|                                                                   | EG | 5,92±0,61                          |            |       | 7,64±0,15                    |            |        |
| 8. Tempo forward handspring from two to two legs together, points | CG | 3,70±1,25                          | 0,54       | >0,05 | 4,60±1,46                    | 46,09      | <0,001 |
|                                                                   | EG | 3,68±0,74                          |            |       | 6,72±0,43                    |            |        |

During the experiment, the dynamics of the process of teaching technical elements of gymnastics to young representatives of artistic gymnastics, who made up the control and experimental groups at the end of the formative experiment, was considered. This allowed to determine the differences in indicators and to assert the effectiveness of the implementation of the experimental methodology in the educational and training process of young athletes at the initial stage of sports training.

During the experimental part of the research we recorded that starting from the middle of the experiment, i.e. from the 5th week, the dynamics of the process of performing control jumps by the experimental group proceeds much more successfully. The analysis of the level of realisation of control attempts shows that during this period in the experimental group about half of attempts out of 10 attempts were realised on average with the grade 'passed', which corresponds to the level «average» (Table 7).

**Table 7. Average results of the control tests «Backward salto from a standing start» та «Forward salto from jump on» (number of attempts counted), ( $\bar{x} \pm S$ )**

| A week of training | Experimental group |            |      |               | Control group   |            |     |               |
|--------------------|--------------------|------------|------|---------------|-----------------|------------|-----|---------------|
|                    | $\bar{x} \pm S$    | $\Delta\%$ | t    | Level         | $\bar{x} \pm S$ | $\Delta\%$ | t   | Level         |
| 1                  | 0,73+0.30          | 7.0        | -    | low           | 0,99+0.22       | 10         | -   | low           |
| 2                  | 2,15+0.20          | 22         | 3,9  | low           | 1,75+0.40       | 18         | 1,8 | low           |
| 3                  | 3,00+0.30          | 30         | 2,5  | below average | 2,30+0.33       | 23         | 1,5 | low           |
| 4                  | 3,92+0.20          | 39         | 2,5  | below average | 3,00+0.33       | 30         | 1,7 | below average |
| 5                  | 4,50+0.20          | 45         | 2,2  | average       | 3,45+0.10       | 35         | 1,3 | below average |
| 6                  | 4,73+0.33          | 47         | 2,05 | average       | 3,95+0.20       | 40         | 1,3 | below average |
| 7                  | 5,86+0.33          | 59         | 1,7  | average       | 3,50+0.10       | 35         | 0,9 | below average |
| 8                  | 7,19+0.30          | 72         | 3,1  | above average | 5,50+0.30       | 55         | 4,4 | average       |
| 9                  | 7,83+0.20          | 78         | 1,9  | above average | 4,93+0.30       | 49         | 0,2 | average       |
| 10                 | 8,00+0.33          | 80         | 0,6  | above average | 5,45+0.40       | 55         | 1,0 | average       |

**Notes.:**  $\Delta\%$  – average group performance on the control exercises from the maximum.

In the control group, this indicator was only about 35% of successful implementation, showing compliance only with the 'below average' level. Thus, at the end of week 5, the experimental group performed the back flip into a somersault on average 1 time more. By the end of the experiment the intergroup difference of technical skill reached significant values according to the calculated values of Student's criterion presented in Table 7. On average, the control standard was performed successfully (i.e., in a perfect hit) in the control group 5.45 times (which was about 55% of the implementation, the 'average' level), and in the experimental group 8 times (80% of the implementation), which corresponds to the 'above average' level.

The analysis of results confirmed that indicators of technical fitness of sportswomen of the experimental group, who learned the offered acrobatic elements in combination with the setting of rational breathing during their performance for 10 weeks, performed tasks more stably and at a higher technical level than their opponents from the control group.

## Discussion

The analysis of publications on the study of the peculiarities of the breathing process of athletes during training in acrobatics, gymnastics and other sports confirms the importance of finding methodological approaches to the organisation of the training process at different stages of long-term training. Based on the results of existing research and generally accepted sports practice, it is likely that the best breathing regime for complex coordination sports will include a balance between maximum oxygen consumption and regulation of abdominal pressure. The basis for this conclusion is the results of numerous studies related to both amateur and professional sports. Among these, we can rely on the works of Pérez-Turpin J.A., et al., (2019); Vanyuk, at al., (2020), Oliinyk, (2021), Kokarev, B., et al., (2023a), (2023b), Kaufmann, at al., (2022), Hardiman, Dorsch, & Vierimaa, (2022).

These studies allow us to take a critical approach to the recommendations of the authors of some methodological manuals on gymnastics, gymnastics and other related sports. In particular, in the professional academic environment, there is an opinion that the relationship between the phases of breathing and movements is determined by the anatomical prerequisites created by a particular body posture for the corresponding phase of breathing. According to this opinion, practitioners recommend that you first determine the specifics of the 'working' body posture, and then distribute your breathing actions (Hnatchuk, Lynets, Khimenes & Pityn, 2018; Pérez-Turpin J.A., et al., 2019; Shankulov, et al., 2020; Hunchenko, 2021; Kokareva, Kokarev & Doroshenko, 2022; Kokarev, Kokareva, Putrov, et al., 2023).

At the same time, special studies have convincingly proven that the combination of muscle effort with exhalation or breath holding is accompanied by a reflexive increase in skeletal muscle tone and strength. This is probably why the combination of high-speed and power movements (which are jumping acrobatic exercises) with exhalation is considered optimal, contributing to the realisation of the body's potential. In this sense, an unstable breathing regime during the exercise (especially during the period of mastering) may be a condition that delays the process of improving sports and technical skills. This conclusion harmoniously coincides with the views of many authors of scientific publications (Hrynchenko, Isaiev, & Tykhonova, 2019; Boichuk, Iermakov, at al., 2020; Hunchenko, 2021; Kokareva, Kokarev & Doroshenko, 2022; Pimenov, 2022; Kokarev, Kokareva, Atamaniuk, at al., 2023; <https://www.aia.com/en/health-wellness/healthy-living/healthy-body/Breathing-exercise-benefits>).

But, once again, it must be stated that theoretical and methodological research in sports is still not always closely interconnected with practice, with tasks that directly relate to sports and technical training. In their work, the authors have tried to solve and comprehensively substantiate one of the real problems of not only children's and youth sports but also sports of higher achievements. This concerns the change of the habitual rhythm of breathing of the tested athletes in the process of performing special motor tasks and technical elements of gymnastics.

Thus, comparing the materials of the preliminary survey of coaches with the results of interviews and observations of the participants of the experiment, it became clear that in most cases, breath holding accompanies the initial part of the elements. For the most part, this approach is due to previous experience gained through unsuccessful landings on a support after performing somersaults. The inaccuracies in the preparatory part of the jump, which the athletes were aware of, could lead to an increased concentration of attention on the accuracy of the following basic actions. This results in reflex inhibition of certain functions, including (for a short period of time) breathing.

It is worth noting that according to the results of special test exercises in gymnastics, there was a rather large intra-group discrepancy between the individual performance of performers in both the control and experimental groups. It ranged in the control group from almost  $V=7\%$  in the simplest elements to  $V=49.55\%$  in the most difficult ones. In the experimental group, this figure ranged from  $V=6.16\%$  to  $V=20.04\%$ , respectively. This indicates that both groups include both performers with a fairly high level of technical skill and frankly weak performers. Although, in general, as the results of the confirmatory experiment showed, after dividing the participants into control and experimental groups, the groups were homogeneous in terms of average statistical indicators (Tables 4-5).

Almost all researchers note that a violation of the usual breathing regime can lead to a violation of the technical structure of movements, to errors of performance. In this connection the study of questions of interrelation of breath with movements acquires special practical value. Thus, analysing the peculiarities of the interrelation of respiratory phases and motor actions, one can make sure that when performing various motor tasks (series of back flips in a group, back flips with a bent over, etc.) gymnasts are able to perform relatively full respiratory movements. It was found that almost all subjects inhale when preparing for a backflip. During pushing off and grouping, breathing is interrupted and ends with an exhalation only after the athlete feels stable at the moment of landing. Occasionally, there are breath-holds in one or another part of the jump, but they can hardly be explained by excessive tension. Most often, gymnasts interrupt their breathing when performing the most difficult jump elements. For example, back flips in a grouping, forward or back flips with spiral rotations (pirouette), etc. (Boichuk, Iermakov, et al., 2020; Hunchenko, 2021; Kokareva, Kokarev & Doroshenko, 2022; Pimenov, 2022, ; Kokarev, Kokareva, Atamaniuk, et al., 2023; Izzo R. et al., 2024).

Our previous experience in training athletes of different ages, genders and sports specialisations shows that when interfering with an athlete's breathing activity, it should be remembered that breathing is an integral component of a breathing skill. An attempt to change the breathing regime is associated with a violation of the established coordination relations with other components of the skill. As a result, discoordination of movements, loss of control over them and, as a result, a violation of the technical structure of the elements performed are possible. In other words, an athlete's respiratory activity is directly related to the technique of performing exercises. Violation of the usual combination of respiratory phases and motor actions can be the cause of technical errors in performance.

The given data on breathing during the performance of acrobatic elements, of course, reflect an objective picture of the relationship between respiratory and motor activity. At the same time, on the basis of the obtained materials it is not yet possible to draw a conclusion about the extent to which the full use of the respiratory apparatus is possible when performing gymnastic exercises and acrobatic jumps. We believe that the volume of the obtained factual data is insufficient to substantiate the role of breathing in the process of forming a rational technique of performing complex coordination exercises, such as acrobatic jumps. One of the important conditions for the effectiveness of the formation of sports and technical skills in complex coordination sports, such as acrobatics and gymnastics, is the need for further research in this direction. The obtained results certainly complement the previous studies of well-known scientists and give optimistic expectations for the further development of this area of research.

*Prospects for further research.* From our point of view, further research should be aimed at finding ways to improve the level of technical fitness of acrobats at different stages of sports training. Including through the study of breathing modes when performing complex coordination elements and their connections.

## Conclusions

1. The analysis of scientific and methodological literature on the research topic has established that the creation of motor potential, mastering by athletes of rational technique of performing complex coordination elements, teaching methods of breathing regulation during various types of training is carried out at the stage of initial training. Thus, theoretical and practical scientific substantiation of the methodology of formation of skills of rational breathing in acrobats of 7-8 years old when performing basic acrobatic exercises, determination of

features of the methodology, which is intended for teaching beginners to rational breathing when studying complex-coordination acrobatic jumps at the stage of initial training, is relevant.

2. The survey conducted at the beginning of the establishing experiment showed that in general coaches, especially in different, though related complex-coordination sports, do not have common views on the structure of breathing during training elements of the classification programme. This element of training is not given due attention in the process of training athletes. More than 90% of coaches who took part in the survey admitted that during the training of complex coordinated motor actions, they practically do not use special breathing exercises or their complexes, despite the importance of this element of sports training.

3. The analysis of results of the formative experiment testifies that the level of technical fitness of the experimental group was much higher in comparison with the control group and has reliable differences at the level of  $p < 0.05-0.001$ . Starting from the middle of the experiment (5-6 week), the dynamics of the process of mastering control exercises by young sportswomen of the experimental group proceeds at a higher level in contrast to acrobats of the control group. The analysis of the quantitative parameter of realisation of control approaches shows that during this period in the experimental group 45 % of 10 attempts were realised with the grade 'passed' on average, and in the control group only 35 %. By the end of the experiment, this difference reached even more significant values ( $p < 0.05-0.001$ ). At the end of the experiment, on average, the control standard was successfully fulfilled in the control group 5.5 times (55% of the implementation), and in the experimental group 8 times out of 10 (80% of the implementation), respectively.

4. Special breathing exercises, chosen by us and recommended for performance by the experimental group in the form of a complex, significantly influence reserve volumes of inhalation and exhalation, proving efficiency of the developed and implemented by us methodology of formation of skills of rational breathing at training acrobatic complex-coordination elements.

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