

TRANSFORMATIONS AND CONTRADICTIONS IN ELITE AEROBIC GYMNASTICS

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Abstract. Since 2016, aerobic gymnastics has been in continuous creative effervescence, promoting a new trend, namely that of acrobatic elements, to the detriment of implementing structures specific to this discipline, which it would need in its aspirations to the Olympic gates. In search of solutions for dynamism, attractiveness and the accumulation of additional points to climb the world rankings, the 2017-2021 and 2022-2024 FIG Codes of Points have become the most effective tools through which acrobatic elements, as non-specific structures of this sport, have been accepted in the contents of aerobic gymnastics exercises in different formulas for various events. The quantitative and percentage study of this presence was based on the determination and analysis of the acrobatic content of all exercises performed in the finals of the 2019 European Championships. In this scientific approach, only the results for Individual Woman (IW) are exemplified as a reference system attesting to the significant numerical presence of acrobatic elements in exercises, which oscillate between 4 and 9 elements per routine. The arithmetic mean of 6.2 elements reveals the considerable effort of each finalist to introduce this large number of acrobatic elements in the combinations of an exercise lasting $1 \text{ minute } 20 \pm 5 \text{ seconds}$. Besides the exaggerated presence of acrobatic elements in the elite exercises of this beautiful discipline, the current study has also identified important transformations and contradictions that take it away from the specificity, crystallisation and especially the identity that deserves to be emphasised.

Keywords: aerobic gymnastics, transformations, competitions, Code of Points, acrobatic elements.

Introduction

Aerobic gymnastics or sport aerobics is a competitive sport originating from traditional aerobics in which high-intensity complex movement patterns and elements of varying difficulty are performed to music. In addition to aerobics, it combines acrobatic gymnastics, rhythmic gymnastics and often artistic gymnastics elements with music, dance and choreography (Briskin et al., 2016; Chayun et al., 2020). However, sport aerobics has its own characteristics: fast execution, complex coordination, clarity, sudden expressive performance, etc. It is necessary to provide training and competitive activity through scientifically established data and methodological recommendations, taking into account the specificity of this sport (Pityn et al., 2013).

The methods of analysis, construction and improvement of choreography are important aspects of the scientific and methodological direction (Briskin et al., 2016). Due to the fact that the recent trend in the development of this sport is to increase the level of performance, the role of choreographic training for aerobic athletes has increased (Briskin et al., 2014; Romanchyshyn et al., 2015).

Twenty-six years of turbulent transformations, content changes and attempts to crystallise and define elite aerobic gymnastics as a FIG discipline have passed. Unfortunately, this has

not yet been achieved. In each development cycle of this sport-show, efforts have been made to raise its attractiveness at all levels and to objectify the process of evaluation and division of values in three directions, namely Artistry, Execution and Difficulty for each event: Individual Man (IM), Individual Woman (IW), Mixed Pair (MP), Trio (TR), Group (GR), Aerobic Dance (AD) and Step Aerobics (SA). In the pursuit of results and supremacy, many compromises have been made over time.

Several physiological markers vary similarly during training and overtraining (Bosquet et al., 2010). Changes in the content, system of rules and scoring codes every 4 years have greatly transformed aerobic gymnastics. Exercise duration has changed from 1.45 min ± 5 sec to 1.20 min ± 5 sec for individual events and 1.25 min ± 5 sec for group events, which, as a percentage, represents a reduction of 17.25% and 13.80%, respectively, per event. This has led to a significant increase in exercise intensity in the connection of elements.

As reported in some studies, the heart rate often increases to 180 beats per minute (bpm) in newly modified exercises and can sometimes even exceed the 200 bpm threshold. Exercise intensity has also increased because the competition floor area has increased from 7/7 m to 10/10 m in all events for seniors and even juniors aged 15-17, according to the 2022-2024 Code of Points (FIG, 2020).

Major stage changes have also occurred in the level of lifting/construction requirements. Their number and execution structure have gradually changed significantly. Thus, the three original static constructions have generated a series of dynamic constructions based on throws (not lifts!!!) taken from acrobatic gymnastics, ballet or skating. Some of them have even turned into memorable pictures.

On the other hand, new events have appeared in the discipline: Aerobic Dance and Step Aerobics. Also, following the example of rhythmic gymnastics, the number of athletes was reduced in the group event from 6 to 5 members (Figure 1)

FIG AEROBIC GYMNASTICS <Competitions at glance>








	Division	Category	Age *	Composition	Competition Space	Music Length
FIG Official Competitions	Senior World Championships	IM 	18 +	1 male competitor	10m x 10m	1 min. 20 sec. (± 5 sec.)
		IW 		1 female competitor		
		MP 		1 male / 1 female competitors		
		TR 		3 competitors (males / females / mixed)		1 min. 25 sec. (± 5 sec.)
		GR 		5 competitors (males / females / mixed)		
		AD 		8 competitors (males / females / mixed)		
		AS 		8 competitors (males / females / mixed)		
	World Age Group Competition (Junior Division)	IM	15-17	1 male competitor	10m x 10m	1 min. 20 sec. (± 5 sec.)
		IW		1 female competitor		
		MP		1 male / 1 female competitors		
		TR		3 competitors (males / females / mixed)		
		GR		5 competitors (males / females / mixed)		
		AD		8 competitors (males / females / mixed)		
	World Age Group Competition (Age Group Division)	IM	12-14	1 male competitor	7m x 7m	1 min. 15 sec. (± 5 sec.)
		IW		1 female competitor		
		MP		1 male / 1 female competitors		
		TR		3 competitors (males / females / mixed)	10m x 10m	
		GR		5 competitors (males / females / mixed)		
		AD		8 competitors (males / females / mixed)		

Figure 1. Reference elements regarding the amendments of the 2022-2024 Code of Points

Special changes can be found in the organisation, systematisation, value (0.1-1 points), their selection in choreography, recognition (minimum requirements), evaluation and combination of difficulty elements. All components of the choreography must perfectly fit together to turn an exercise into an artistic performance with unique creative characteristics by respecting the specificity of aerobic gymnastics (Khimenes et al., 2016).

In terms of requirements, the number of difficulty elements in the various events of the aerobic gymnastics polyathlon has been theoretically reduced. Initially, 12 elements had to be executed harmoniously, being distributed “up and down” on the floor, sitting or airborne. Currently, according to the 2022-2024 Code of Points for individual events (IW, IM), 9 difficulty elements are accepted, and for group events (MP, TR, GR), 8 elements with special requirements for each of them (FIG, 2020).

The number of difficulty elements ending in Push Up or Sagittal Split has also been reduced, being limited to three in a choreographic composition (FIG, 2020). After a long time, split landing elements have been prohibited for men. Also, male gymnasts participating in individual events must perform at least one element from Family 4 (Group B) (Figure 4) and are not allowed to perform elements from Family 8 (Group C).

Changes have been identified over the years in the way of calculating difficulty by event. The latest Codes of Points have introduced additional values for combinations between difficulty elements but also between acrobatic elements and difficulty elements (Figure 4).

Training cycles have appeared in which the difficulty elements with low value (0.1 points) or stylised execution are neither recognised nor calculated for the Difficulty criterion.

The first step towards introducing acrobatic elements in exercises at different levels and events was done by integrating them as connecting structures. Thus, rolling (forward, backward, with the body outstretched over the shoulder), kip-up (from arm support, from neck support), walkover (slow or dynamic, performed forward, backward, sideways) and jumps (forward, backward, sideways or Danilova-type, with or without return or stylised execution) were included in the choreography of acrobatic gymnastics.

When additional points were awarded, the following combinations of elements have appeared: combinations of difficulty elements, combinations of acrobatic elements and combinations of acrobatic elements with difficulty elements (Figure 4).

The 2017-2020 Code of Points promoted the idea of integrating and capitalising on individual or group acrobatic elements in the scoring system (FIG, 2017).

A new training cycle 2022-2024 will begin with a new system of rules that will regulate for each event the integration of acrobatic elements in the structural universe of exercises in three important directions focused on artistic requirements and raising the value of difficulty elements and “lifts”.

Methodology

Analysing changes in the FIG Code of Points in general and particularly in the last two training cycles, namely 2017-2021 and 2022-2024, the content of the exercises presented in the finals of Individual Woman (IW), Individual Man (IM), Trio (TR), Group (GR) and Mixed Pair (MP) events at the World and European Championships held between 2016 and

2019, as well as the way of transposing choreography in compliance with the requirements for the implementation and integration of acrobatic elements in exercises, structural changes have been identified as a result of recent approaches and deepened contradictions that remove elite aerobic gymnastics from the process of identity and crystallisation of the discipline.

Due to the lack of space and the fact that the situation was the same, the examples with a high number of elements present in choreography will only focus on the IW event.

Results and Discussion

Over time, elite aerobic gymnastics has completely broken with the roots and initial sources of this sport. For many known reasons, it has deviated a lot from the specific area of its definition.

At this moment, the competitive reality of the last years (beyond the image and the show) demonstrates obvious disturbances and contradictions:

- a) Between the name and type of specific effort in aerobic gymnastics events: Aerobic gymnastics - and the type of effort required, mainly anaerobic!

Heart rate values vary between high- and above-maximum intensity levels for all technical elements included in the routines (Bota & Urzeală, 2013). Multiple studies of maximum heart rate, which reaches values between 180-200 bpm in an exercise (Coggan, 2003; Jemni et al., 2006), and the considerable post-exercise lactate production at various ages have shown the importance of training the anaerobic energy chain in aerobic gymnasts.

On the other hand, Kikuchi et al. (2014b) identified that “athletes performed at over 90% HR max during the last 2/3 of the routine” (p. 17), their maximal blood lactate after exercise ranging between 9 and 14 mmol/L.

Here is the first contradiction identified in relation to the name: aerobic gymnastics and anaerobic capacity to be trained for this type of sport that mainly requires anaerobic energy.

The situation has shifted in this direction due to the decrease in exercise duration, in parallel with the dramatic increase in the intensity and density of movements imposed by the new requirements of the 2017-2020 and 2021-2024 Codes of Points.

- IM / IW: 1 minute 20 seconds (\pm 5 seconds)
- MP / TR / GR / AD / AS: 1 minute 25 seconds (\pm 5 seconds)

- b) Between definition and contents

“Aerobic Gymnastics is the competitive discipline based on the performance of variety of AMP (Aerobic Movement Patterns) continuously to the music, which originates from traditional aerobic exercises. The routine must demonstrate perfect execution of AMP, transitions/links and Difficulty Elements.” (FIG, 2021)

According to the 2013-2016 Code of Points (FIG, 2013), “Aerobic Gymnastics is the ability to perform continuous, complex and high intensity aerobic movement patterns to music, which originate from traditional aerobic exercises: the routine must demonstrate continuous movement, flexibility, strength and the utilisation of the seven basic steps, with perfectly executed difficulty elements” (p. 9). Aerobic movement patterns are defined as “combinations of basic aerobic steps together with arm movements: all performed to music to

create dynamic, rhythmic and continuous sequences of high and low impact movements (FIG, 2013, p. 9).

In reality, the content of the current routines confirms that the definitions are anachronistic and partly far from the truth presented. In the essence of constant images, aerobic gymnastics can be defined as an acrobatic mosaic of choreographically performed gymnastic disciplines.

Nowadays, aerobic gymnastics exercises are a choreographic mixture of contents where the elements taken from rhythmic gymnastics (pirouettes, jumps, momentum structures), acrobatic gymnastics (constructions, lifting, carrying, throwing, connecting elements) and artistic gymnastics (acrobatic elements specific to the floor event) predominate as rolls, overturns or jumps to the detriment of aerobic gymnastics elements (combinations of high-impact specific, classic or stylised steps or strength/suppleness difficulty elements). The percentage of time and number given to the specific content of aerobic gymnastics exercises at various events is less than half, especially if the families of movements that rightly belong to classical aerobic gymnastics are avoided when performing difficulty elements.

“Tactics, technique and individual movements can be analyzed to help coaches and athletes to re-evaluate their performance and gain advantage during the competition.” (Raiola et al., 2013, p. 297)

Due to freedom of choice, elements from many families of movements that once belonged to this discipline are no longer encountered in elite exercises. Of course, changes in the Codes of Points have gradually contributed to the emergence of these problems, and some changes that have influenced the evaluation criteria for Difficulty and Artistry hid group interests in the fight for world supremacy.

A careful analysis can identify the upward trend of acrobatic approaches to solving content and evaluation issues for various individual or group routines. The 2017-2020 Code of Points introduced and regulated the evaluation methods for acrobatic elements.

In accordance with the requirements of both the current Code of Points and the one to be implemented, the ways of exploiting acrobatic elements are focused on two of the three directions of evaluating aerobic gymnastics exercises: Artistry and Difficulty, given their combination with artistic movements, difficulty elements or various types of lifts/throws.

In order to have a real picture of the exaggerated use of these structures, it would be wonderful if aerobic gymnastics specialists knew and accepted the classic systematisation of acrobatic elements:

- individual elements, in pairs, in groups;
- static elements (balance, strength, mobility, etc.);
- dynamic elements (rolls, kip-ups, overturns, jumps) (because gymnasts use them all in a single choreography!!!).

To increase the value of the score for Artistry, structurally stylised acrobatic elements including special initial and final positions can be combined with various jumps or transition elements. Thus, for the “General Content” Artistic criterion, which has a maximum value of 2 points, 4 such combinations (marked as G+) must be performed during an exercise. We mention once again that the acrobatic element that is intended for this criterion deviates from its classic form, presenting special but aesthetic, attractive, suggestive turns or positions. To increase difficulty, acrobatic elements can also be combined with difficulty elements or lifts.

Table 1 suggestively illustrates the potential use of these combinations based on acrobatic elements according to the event.

Table 1. Values given for combinations of acrobatic elements with difficulty elements in the 2022-2024 Code of Points

Category	Evaluation	Example (D = Difficulty, A = Acro)
IM / IW	No additional value	A + A
	+ 0.1	D + D / A + D / D + A
	+ 0.2	D + A + D / A + D + A / A + D + D / D + D + A
	+ 0.2 (only 1 set is allowed)	A + A + D / D + A + A
	+ 0.1	D + D / A + D / D + A
MP / TR/ GR	Receive Value and count for the Difficulty elements but No additional Value and Deduction	D + A + D / A + D + A / A + D + D / D + D + A / D + D + D

c) Between the originally conveyed message and the current message

The initial message of aerobic gymnastics in the 1995s started from the desire for health, body harmony, balanced strength and flexibility, complex coordination, communication through body language, energy, positive attitude, enthusiasm and happiness.

The current message of an aerobic gymnastics exercise is focused on the main idea of acrobatic mastery: “We are perfect acrobatic gymnasts trained multidisciplinary in field of gymnastics, with exceptional artistic and choreographic values”.

If before athletes performed on the stage a push-up, a kick with the left and right foot, a square, a fan kick, etc. during an exercise, thus communicating that they had strength and flexibility, were looking very good, were enthusiastic but also that what an athlete was doing could be done by anyone, now things and the message have changed: “Only elite acrobatic gymnasts can jump forward or backward with a 360° turn in combination with other structures, throws, lifts, jumps, etc.”.

Because of this message change, the systemic competitive applications in schools, universities or “challenging” environments will be affected.

d) Between the number and the time allowed during an exercise for acrobatic elements and those specific to classical aerobic gymnastics

Table 2 shows the number of acrobatic elements in the exercises performed in the IW final of the 2019 European Championships.

Table 2. Number of acrobatic elements in the exercises performed in the IW final of the 2019 European Championships

Gymnast no.	Country	No. of acrobatic elements	Dif.
1	ROMANIA	4	3.55
2	SPAIN	5	3.6
3	BULGARIA 1	7	3.7
4	RUSSIA 1	4	3.75
5	BULGARIA 2	9	3.6
6	TURKEY	4	3.4

7	PORTUGAL	9	3.2
8	RUSSIA 2	8	3.85
AVERAGE		6.25	3.58125
MAX		9	3.85
MIN		4	3.55

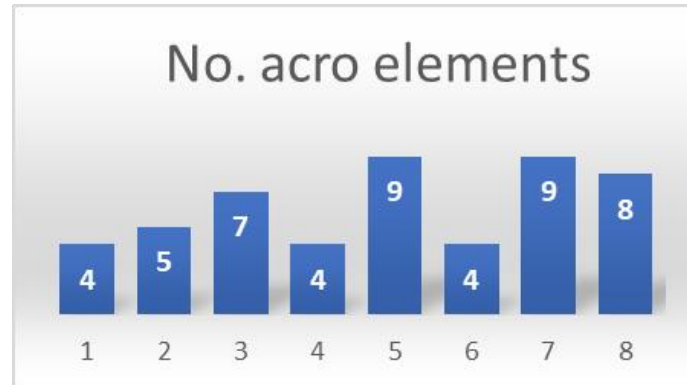


Figure 2. Number of acrobatic elements in the exercises performed in the IW final of the 2019 European Championships

As can be seen in Figure 2, the number of acrobatic elements in the exercises performed in this event is increasing. We identify original interpretations of the cartwheel, round off, walkover, handspring, back handspring, headstand, sideways cartwheel (on one or both outstretched arms), jumps (forward, backward, Danilova, with or without return, kip-up, etc.). An average of 6.25 and a maximum of 9 acrobatic elements per exercise speak for themselves. It is true that their presence makes the routines more dynamic, original and spectacular, but they remove the discipline from the chance to crystallise and find its own identity. Although all these attempts of changes tip the balance of victory towards acrobatic athletes, the differences between the top 3 are very, very small (1.120 points) (Figure 3).

Rank	Country	Name	Score
1	RUS	PYKHTOVA Ekaterina	21.350
2	RUS	KONAKOVA Tatyana	21.350
3	BUL	PASHOVA Darina	21.200
4	TUR	ONBASI Ayse Begum	21.000
5	ESP	GUILLEMOT ESTERLICH Belen	20.800
6	BUL	STOILOVA Ana-Maria	20.800
7	POR	SILVA Sara	20.500
8	ROU	DINCA Sandra Cristina	20.500

Figure 3. Results in the IW final of the 2019 European Championships

- e) Between reorganising the content of difficulty elements and the disappearance or ignorance of some classic elements specific to aerobic gymnastics

The new 2022-2024 Code of Points will bring new requirements and a new organisation of the difficulty elements (Figure 4).

GROUP A (FLOOR ELEMENTS)			
FAMILY 1 Dynamic Strength		FAMILY 2 Static Strength	FAMILY 3 Leg Circle
Base Name	A-Frame	Support	Flair
	Straddle Cut	V-Support	Helicopter
	Explosive High-V	Planche / Straddle Planche	

GROUP B (AIRBORNE ELEMENTS)			
FAMILY 4 Dynamic Jump (Compulsory for IM)		FAMILY 5 Form Jump	FAMILY 6 Split Leap/Jump
Base Name	Air Turn	Tuck	Scissor Leap
	Free Fall	Cossack	Switch Split
	Gainer	Pike	Sagittal Split
	Butterfly	Straddle/Frontal Split	
	Off Axis		

GROUP C (STANDING ELEMENTS)			
FAMILY 7 Turns		FAMILY 8 Flexibility (Not allowed for IM)	
Base Name	Turn	Split	
	Horizontal Turn	Illusion	
		Balance	

Figure 4. The new systematisation of difficulty elements in the 2022-2024 Code of Points

Some elements from different families have been removed from this code, especially those with low value but also those with high value but considered dangerous or unattractive (Tamaro, Capoeira elements reassigned to one-arm push up). Other elements or families of movements have remained, but unfortunately they no longer find their place in the choreography presented in the finals of the last European and World competitions held in the analysed period (2017-2019) and probably in future choreography either. There are fewer and fewer elements from the PUSH UP, L-SUPPORT, Dynamic Jump (AIR TURN) families and not only, because some of them are harder to learn and others have lost their value.

Conclusion

Aerobic gymnastics has become an immediately “constructed”, artificial gymnastic sport that is acrobatic par excellence, is rooted and has possible systemic links to mass-level development in schools, universities or “challenging” sports. The blockage arises from exigencies, the rupture with the sources of its becoming, which makes it difficult to approach.

The intensity is fantastic! Multifactorially determined, it produces considerable efforts to exploit anaerobic power.

Contrary to their names, anaerobic training and lactic training are effective tools for aerobic gymnastics. Kikuchi and Sasaki (2014a) state that “it is very important to get the high capacity of aerobic power for performing the perfect execution” (p. 13).

The image of elite aerobic gymnastics is marked by the preponderance of acrobatic elements and structures that are found everywhere: in connections, transition elements in constructions/lifts/throws and some families of difficulty movements: Dynamic Jump - BUTTERFLY Family, Static Strength - PLANCHE Family, FLAIR Family. On the other hand, other families of movements have their roots in rhythmic gymnastics: SPLIT JUMP Family, Split Leap/Jump, SWITCH SPLIT LEAP, SCISSORS LEAP, Turn Family, Flexibility Family: VERTICAL SPLIT, BALANCE TURN, ILLUSION: *h*, *fi*.

Although the number of events has increased, unfortunately aerobic gymnastics has lost time with its own definition and crystallisation. For this reason, we believe that it will never become an Olympic sport under these conditions.

In our opinion, aerobic gymnastics will continue to be a pleasant, beautiful, spectacular sport with a superlative shift in intensity, but a synthetic, mosaic sport of the branches of gymnastics, a sport with many contradictions that could hardly be solved.

Aerobic gymnastics has turned over the years from a sport for all to an exceptional sport, a sport of gymnastics elites. Because of this and because its message has been changed, fewer and fewer children will choose to engage in competitive aerobic gymnastics, not to mention that the regulation of this sport is systematically amended.

We think that the applications and rules of competitive aerobic gymnastics are no longer compatible with school or mass sports activity.

The selection process will need to be reoriented.

The training methodology will need to be changed, harmonised and complemented in accordance with the new contents. The training objectives will be different and their share in the training process will be changed. The structure and content of the training process will need to be fundamentally changed.

The training sessions will become mainly mosaic, acrobatic, rhythmic, aerobic gymnastics workouts where motor skills and abilities will be developed, where individual or group acrobatic elements will be prioritised.

The methodological, systemic effects of these changes will be deeper and deeper. The operational systemic influences on the school and university environments but also on mass sports activities will be more and more unfavourable.

We are looking forward to the 2022-2024 cycle to trace the effects of changes in the 2017-2021 and 2022-2024 Codes of Points on the content and dynamics of future exercises that will be performed within the aerobic gymnastics polyathlon in the next three years.

Authors' Contribution

All authors have equally contributed to this study and should be considered as main authors.

References

- Bosquet, L., Léger, L., & Legros, P. (2001). Blood lactate response to overtraining in male endurance athletes. *European Journal of Applied Physiology*, 84, 107-114.
<https://doi.org/10.1007/s004210000343>
- Bota, A., & Urzeală, C. (2013). Correlative aspects regarding functional stress and neuromuscular control in high performance aerobic gymnastics - Individual events. *Procedia – Social and Behavioral Sciences*, 93, 2090-2094.
<https://doi.org/10.1016/j.sbspro.2013.10.171>
- Briskin, Y., Pityn, M., Antonov, S., & Vaulin, O. (2014) Qualification differences in the structure of archery training on different stages of long-term training. *Journal of Physical Education and Sport*, 14(3), 426-430. DOI: 10.7752/jpes.2014.03065
- Briskin, Y., Todorova, V., Perederiy, A., & Pityn, M. (2016). Comparative analysis of choreographic training of athletes from foreign and Ukrainian sport aerobics teams. *Journal of Physical Education and Sport*, 16(4), 1352-1356.
DOI: 10.7752/jpes.2016.04216
- Chayun, D., Kletsov, K., & Manzheley, I. (2020). Acrobatics as a new trend in Aerobic Gymnastics. *Journal of Physical Education and Sport*, 20(2), 759-767.
DOI: 10.7752/jpes.2020.02109
- Coggan, A. R. (2003). *Training and racing using a power meter: An introduction level II coaching manual*. USA Cycling.
- FIG. (2013). *2013-2016 Code of Points: Aerobic Gymnastics*.
<https://www.fig-aerobic.com/attachment/407618/>
- FIG. (2017). *2017-2020 Code of Points: Aerobic Gymnastics*.
https://www.gymnastics.sport/publicdir/rules/files/en_AER%20CoP%202017-2020.pdf
- FIG. (2020). *2022-2024 Code of Points: Aerobic Gymnastics*.
https://www.gymnastics.sport/publicdir/rules/files/en_AER%20CoP%202022-2024.pdf
- FIG. (2021). *Definition of "Aerobic Gymnastics"*. https://www.fig-aerobic.com/3-1-DEFINITION-OF-AEROBIC-GYMNASTICS_a1349.html
- Jemni, M., Sands, W. A., Friemel, F., Stone, M. H., & Cooke, C. B. (2006). Any effect of gymnastics training on upper-body and lower-body aerobic and power components in national and international male gymnasts? *Journal of Strength and Conditioning Research*, 20(4), 899-907.
- Khimenes, K., Lynets, M., Briskin, Y., Pityn, M., & Galan, Y. (2016). Improvement of sportsmen physical fitness during previous basic training (based on sport orienteering material). *Journal of Physical Education and Sport*, 16(2), 392-396.
DOI: 10.7752/jpes.2016.02061
- Kikuchi, H., & Sasaki, H. (2014a). A study on the special characteristics athletes. The capacity of aerobic power and isokinetic strength of knee joint. In *Scientific Research in Aerobic Gymnastics: Summary 2010-2014* (pp. 13-15).
<https://aerobic5.com/wp-content/uploads/2021/01/Scientific-13.06.2014-2.pdf>
- Kikuchi, H., Sasaki, H., & Yunoki, T. (2014b). A study on the special characteristics of aerobic gymnastics athletes and movement of blood lactate. In *Scientific Research in Aerobic Gymnastics: Summary 2010-2014* (pp. 16-19).
<https://aerobic5.com/wp-content/uploads/2021/01/Scientific-13.06.2014-2.pdf>
- Pityn, M., Briskin, Y., & Olha, Z. (2013). Features of theoretical training in combative sports. *Journal of Physical Education and Sport*, 13(2), 195-198.
<http://dx.doi.org/10.7752/jpes.2013.02032>

- Raiola, G., Giugno, Y., Scassillo, I., & Di Tore, P. A. (2013). An experimental study on aerobic gymnastic: Performance analysis as an effective evaluation for technique and teaching of motor gestures. *Journal of Human Sport and Exercise*, 8(2), 297-306.
<http://dx.doi.org/10.4100/jhse.2012.8.Proc2.32>
- Romanchyshyn, O., Briskin, Y., Sydorko, O., Ostrovs'kyi, M., & Pityn, M. (2015). Pedagogical college students' readiness formation for sport and recreation activity. *Journal of Physical Education and Sport*, 15(4), 815-822.
<http://dx.doi.org/10.7752/jpes.2015.04125>