Ovidius University Annals, Series Physical Education and Sport / SCIENCE, MOVEMENT AND HEALTH
Vol. XII, ISSUE 2, 2012, Romania
The journal is indexed in: Ebsco, SPORTDiscus, INDEX COPERNICUS JOURNAL MASTER LIST, DOAJ DIRECTORY OF OPEN ACCES JOURNALS, Caby, Gale Cengace Learning

CORELATIVE ASPECTS REGARDING THE FUNCTIONAL EXERTION AND THE TECHNICAL DIFFICULTY ELEMENTS IN HIGH PERFORMANCE AEROBIC GYMNASTICS

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Abstract

Purpose. The purpose of this study is to identify the correlative aspects between the functional exertion and the technical difficulty elements in junior aerobic gymnastics.

Methods. Next to the bibliographical study, the pedagogical observation, we used a heart rate monitor, routines' video, referees' sheets, training programs analysis and statistical processing methods.

Results. Data collected prove high intensity levels for each of the required technical elements, fact which has implications for the selection of the training means.

Conclusions. Aerobic gymnastics requires continuous objectivation of effort parameters expressed in a rationalized training content correlated to the athletes' biological echoes.

Key words: functional stress, technical elements, training, aerobic gymnastics.

Introduction

Fifty years ago knowledge of athletes' preparation was far from complete and the physiological background was based on a relatively small amount of objective research findings. Since then, sport science has experienced tremendous changes in terms of assessing functional processes and states, responsible for the incredible sports results, beyond any imagination.

Generally speaking, aerobic gymnastics is the ability to perform continuous, complex and high intensity movement patterns to music. This originates from traditional aerobic exercises in terms of continuity, but not in terms of energy pathways.

The routine must demonstrate flow, strength, flexibility and the utilization of the seven basic steps with perfectly executed difficulty elements.

In a physiological perspective, combinations of aerobic steps together with arm movements, all performed to music create dynamic, rhythmic and continuous sequences of high and low impact structures. Routines should provide a high level of intensity. All three energy systems contribute at the start of the routine, but the contribution depends on the individual characteristics, the effort applied or on the rate at which energy is used.

The Romanian aerobic gymnastics has been a constant presence in the world elite since 1991 and today we can definitely assert that a modern training methodology was conceived by Romanian renowned specialists, leading to more than 95 medals in World, European championships and World Games. Performance Aerobic Gymnastics is a highly technical-combinative sport, with complex cinematic elements, demanding functional levels closed to physiological limits. Under the circumstances, the training programs requires a special attention directed to reaching a fine motor control requested in most of the technical elements, especially in high intensity routines (R. Schmidt, T. Lee, 2005).

From the training perspective, the focus seems to be directed on two levels: the biomechanical constraints which need to be thoroughly analyzed in order to determine performance proficiency and the functional demands of the 1'30 min. specific effort in the individual events (A. Bota, 2007). The present study will focus on the second approach, our aim being to identify the effort zones for different parts of the routine, expressed by the heart rate values attached to each technical element. One can find relevant the knowledge concerning physiological costs in competition settings, so that the trainers should adjust the training means and methods leading to enhancement of the technical accuracy under functional stress conditions and avoiding trauma or overtraining (J.H. Willmore, D.L. Costill, 1998).

Although research data is not highly consistent, most of the studies reveal that from the energetic point of view, competition effort is included in the short endurance category, considered as a lactic anaerobic type, the energy being supplied by the muscle glycogen (A. Dragnea, S. Teodorescu, 2002, G. Popescu, 2005).

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Received 11.03.2012 / Accepted 02.05.2012

Beyond 30sec., anaerobic glycolysis uses glucose (and glycogen) as a fuel in the absence of oxygen, the consequence of rapid glucose break down being the formation of lactic acid.

In individual aerobic gymnastics composition includes: technical elements, specific steps, arm movements and transitions.

To meet the artistic requirements, a routine and its choreography must demonstrate creativity and sports specific content. It should also show a variety of movements and a high degree of correlation between the music, movements and the competitors expression. The routine must show a balance between airborne, standing and floor-work difficulty elements and between high and low impact aerobic movements. A maximum of ten

difficulty elements for the individual events must be performed by each competitor. Technical elements from the four fundamental groups are rated a difficulty quotient between 0 – 1 point (FIG Code of Points, 2009-2012).

The balance of the upper and lower body movements should be evenly distributed. When both upper and lower limbs movements are performed simultaneously, the routine will become more complex and creative.

All these requirements have an important influence upon the composition of the routine, each coach having the possibility to be creative in valorizing the technical and artistic skills of the gymnast.

Methods

To conduct this study, next to the bibliographical study, the pedagogical observation and the case study, we used a computerized method for assessing the effort zones by means of a Polar ProTrainer 425C heart rate monitor, as well as the routines' video, referees' sheets, training programs analysis and statistical processing methods.

The subject of this research is a 12 years old gymnast from CS UNEFS Bucharest who has highly relevant performances being the best athlete of her age group, at the national level. Her technical skills and body type are considered important clues, relevant for her future development as a senior gymnast. At the same time, we can assert that she is, to a great extent, the result of a consistent training strategy, whose functional approach is emphasized in this case study.

The subject was applied the heart rate monitor, during three consecutive routines, in order to analyze the specific effort curve in the individual event. The effort curve was correlated with the structure of the routine (from the video analyses), allowing us to identify the technical elements with the most demanding functional costs, and therefore susceptible to be optimized both in technical and physical training.

The research took place in October 2011, before the National Championships, in the UNEFS gym hall, during a test training. Given the training period, the gymnast potential was at her peak, fact that sustained our research purpose, that is to correlate the effort intensity levels with the technical elements' performance accuracy.

After the competition, the referees' sheets were analyzed in order to identify which and how many technical elements were validated by the judges, thus proving that proper training content for each of them can lead to excellent performance even if the gymnast does her routine at maximal exertion levels.

Results

The technical elements included in the subject's routine were attached the following heart rate values, as measured with the Polar Trainer:

Table 1 – Correlation between technical elements and functional exertion

No.	Technical element	Difficulty group	Average HR	Effort intensity	Difficulty quotient
1.	Frontal split jump to push up	C - 735	168 - 170	Maximum intensity	0,50
2.	Straddle support 1 ½ turn	B - 105	190 – 192	Above maximum	0,50
3.	1 ½ turn tuck jump	C - 265	192 – 194	Above maximum	0,50
4.	1 ½ turn to vertical split	D - 115	194 – 196	Above maximum	0,50
5.	L support 1 ½ turn	B - 145	194 - 196	Above maximum	0,50
6.	Lifted wenson	A - 144	192 - 194	Above	0,40

	push up			maximum	
7.	Helicopter to wenson	A - 306	196 - 198	Above maximum	0,60
8.	Free illusion	D - 195	194 - 196	Above maximum	0,50

All technical elements included in the choreography, were validated by the judges: frontal split jump to push up, straddle support 1 ½ turn, L support 1 ½ turn, lifted wenson push up, helicopter to wenson, 1 ½ turn tuck jump, 1 ½ turn to vertical split, free illusion.

We mention that the gymnast fulfilled her performance objective, by winning the National Aerobic Gymnastics Championship, in individual, trio and group events.

Discussion and conclusions

The average heart rate in the three consecutives routines registered values between maximum intensity and above maximum intensity for all the technical elements, according to the FIG four corresponding groups:

- Group A dynamic strength (wenson push up and plio push up families, helicopter family)
- Group B Static strength (straddle support family, L - support family)
- Group C Jumps (frontal split family, tuck family)
- Group D Balance (turn family, illusion family)

The graph below shows that the gymnast performed in heart rate intervals between 130 – 198 beats/min., with high cumulated plateaus of 190 - 198 b/min., which according to the Polar software signifies an effort intensity above maximum. In the first part of the routine (0-30 sec.), the composition elements gradually raise the heart rate so that the first difficulty element (sec. 22) is performed with 168 -170b/min., given the fact that the gymnast has not reached the state of fatigue, yet.

Starting from sec. 35, the subject registered above maximum intensities which determined heart rate values not lower than 191b/min., till the end of the routine.

No matter the technical group family requesting dynamic, static strength, jumps or balance, the functional stress remained intense during almost 1 min., this plateau being also enhanced by the specific steps sequences preceding each element.

The specific steps and the transitions, having a duration between 3 and 12 sec., determine heart rate values from 145 (at the beginning of the routine) to 195 beats/min. The transitions are preacrobatic gymnic elements, described as the passages from high positions, to medium and lower ones, explaining thus their slightly lower intensity levels, but also giving the gymnast the possibility to „escape" from the isometric prolonged periods of muscular contraction. In this respect, the FIG Code of points requires specific criteria concerning the technical execution, underlining the position and the stability of the upper body, back, limbs, pelvis, abdominal muscles and the whole proper body alignment. Thus for the leg movements the gymnast must perfectly control the height, angle, plane, range of motion, level length, speed, rhythm change, traveling directions, orientation. For the arm movements, which contribute to a more substantial increase of the effort intensity, athletes will master height, angle, plane, range of motion, level length, speed, rhythm change and unilateral (asymmetrical) /bilateral (symmetrical).

From the effort curve perspective we can assert that the subject's routine is a difficult and stressful one, due to the choreographic vision, which implied a high density of technical elements in the second part of the routine. Thus the most functional stressful (196-198b/min.), but best rated element (0,6 points) is placed at the end of the routine, in min. 1,27. We can also explain high intensities by the doubled steps sequences (in which two movements are performed in one beat).

Regarding the recovery capacity, in the first minute post-effort, the heart rate lowers up to 171b/min. and at the end of the second minute, up to 139b/min.

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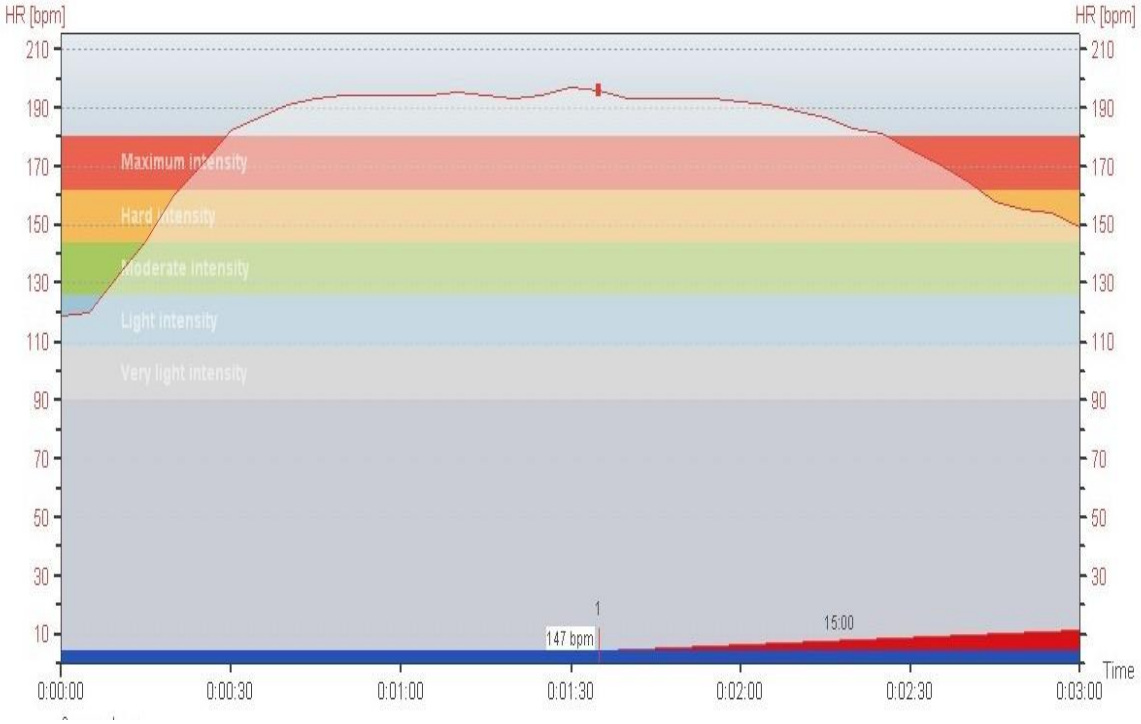

Figure 1 Effort curve during one aerobic gymnastics routine – individual event

The referees' sheets from The National Championships were analyzed in order to emphasize both the technical elements properly performed and the fulfillment of the artistic criteria.

The difficulty quotient in the subject's routine has values between 0,4 and 0,6 points, cumulating a total of 4 points. All eight difficulty elements from the composition were rated, this meaning a percentage of 100%. Still, gymnast committed execution errors in one dynamic strength group elements (helicopter to wenson) and in one B static strength element (L support 1 ½ turn). We might explain these execution errors by an inconsistent neuromuscular control due to the accumulated fatigue. Despite this, her execution score was the best in the competition.

Regarding the execution score, the gymnast obtained 8.65 points out of 10, most of the deductions resulting from an inadequate execution of those two difficulty elements, mentioned before, invalidated by the judges. (helicopter to wenson, L support 1 ½ turn). Also, in the steps sequences the subject does not perform a perfect biomechanics especially in jumping jack, lunch and knee lift.

Concerning the artistic score, the gymnast obtained 8.65 points out of 10, most of the deductions resulting from the insufficient effective use of the competition space and placement of the movement in the routine. Also some of the judges do not rate with excellent scores the presentation and use of the music criteria.

Generally speaking, the gymnast has high scores at the complexity/creativity level, having difficult transitions and linkings between the technical elements.

Summarizing, the gymnast cumulated a total score of 19.300 points, with the highest value for the artistic components and for the difficulty.

Data collected with the heart rate monitor as well as the results obtained in the target competition demonstrate that the trainer has a deep knowledge of the gymnast individual bio-motor profile and a keen understanding of the ratio between the effort parameters throughout the training periods and sessions, in order to meet the functional demands of the competition event.

In this regard, planning documents for the pre-competitive period were analyzed and subsequently, relevant aspects were revealed:

- the effort dynamics meets general criteria for enhancing the performance capacity, necessary for getting peaks performance at the right time; thus, the volume varied between 70% and 50% (of the core trainings' duration) as the competition was approaching, while the intensity had an average increase from 70% to 95% of the maximum levels;
- specific and competition means conceived for the last part of the preseason mesocycle aimed at performing all repetitions in high intensity plateaus (170-190b/min.). The distinctive characteristic of the workouts consisted of coupling/linking technical elements with at least one 1x8 steps sequence, before and after these, according to the choreography. Both steps sequences and technical elements were performed

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at sub-maximal and maximal intensities, without ignoring the technical accuracy demands;
- the preseason mesocycle included even from the first session full and partial routines workouts, fact which lead to a high level adaptation state and to an increased specific endurance.

In the following we present examples of operational means aiming at refining the technical execution as well as reaching a higher level of functional adaptation.

Table 2 Content for the core part of the training lesson – lesson 15

Means	*Effort administration*
Warm – up	20', I - 80%, p - 3'
Core part: - leg balancing while moving + kick 180^0; - vertical jumps from standing position and while moing; - specific steps linked to technical difficulty elements from the trio event: 1 x 8 steps preceding the element + technical element + 1 x 8 steps succeding it (individual event) - first half of the routine (trio) - second half of the routine (trio) - whole routine (trio) - specific steps linked to technical difficulty elements from the trio event: 1 x 8 steps preceding the element + technical element - 1 x 8 steps succeding it (trio event) - first half of the routine (group) - second half of the routine (group) - whole routine (group) *Physical training*: circuit training	 4 L, I - 85% , p - 30" 8 L, I - 85%, p - 30" 5 x 8 secv., I - 90%, p - 1' 2 x, I - 100%, p - 2' 2 x, I - 100%, p - 2' 2 x, I - 100%, p - 6' 5 x 8 secv., I - 90%, p - 1' 2 x, I - 100%, p - 2' 2 x, I - 100%, p - 2' 2 x, I - 100%, p - 6' 3 x, I - 80%, p - 2'
Cool down: stretching	12', I - 50%
	Intensitaty - 93,63%, Total volume - 60,68%

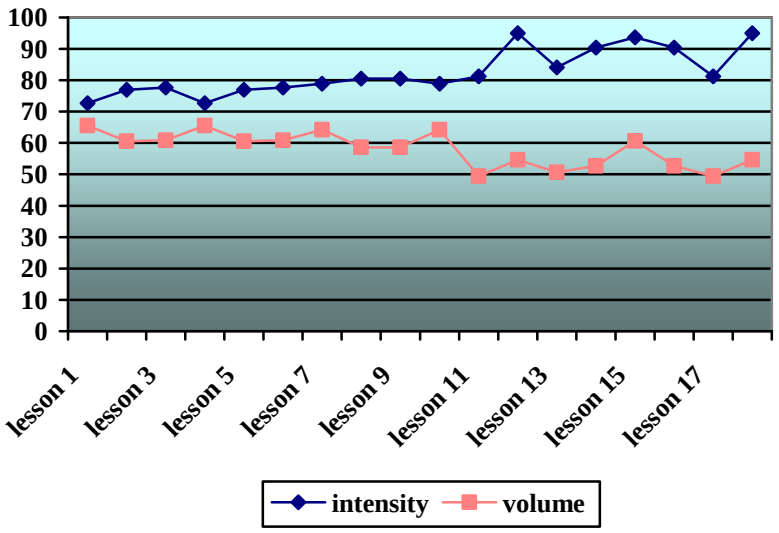

Figure 2 Manipulation of the intensity – volume parameters in the preseason mesocycle

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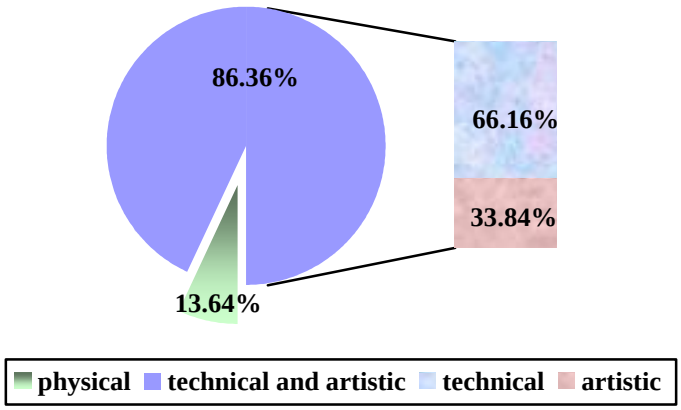

Figure 3 Ratio between training components in the preseason mesocycle

During the preseason mesocycle technical training next to the artistic training are predominant so that 66.16% of the means is directed towards the technical accuracy and 33.84% concerns the artistic abilities.

As one can notice in Table no 2, the investigated subject participates in three events (individual, trio and group), so that the administered means cumulate in volumes at high intensities, fact which represents an advantage in terms of specific endurance.

We conclude that speaking about aerobic gymnastics training program, the coach will always adjust influential components according to the competition model, including the physiological profile of the event. This approach involves a rigorous framework consisting in: the choice of exercises, order of exercises, resistance or load, number of sets per exercise, number of exercises per muscle group, repetition range, type of contraction, speed of movement, rest periods between sets, rest periods between training sessions and nutritional status.

In order to have a complete idea about the functional profile of the individual events in aerobic gymnastics, this study should be continued with the assessment of the oxygen uptake or lactate concentration, information needed for a consistent metabolic training. Measuring heart rate and VO2 max helps professionals to prescribe exercise safely and effectively to athletes

Elite sports specifically requires continuous objectivation of effort parameters especially in events with severe functional costs, expressed in a rationalized training content correlated to the athletes' biological echoes.

To summarize, data emerging from this study confirm an adequate training methodology in terms of technical, physical and artistic components, related to the competition model and the highly demanding criteria leading to sports excellence at international level.

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