



STUDY ABOUT THE ENERGY EXPENDITURE ASSESSMENT IN RHYTHMIC GYMNASTICS

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Abstract

Purpose. Determining the effort functional demands in the rhythmic gymnastics activity, in order to optimize the relation between the training stage requirements and the female athletes' specific individual support; drawing up a model focused on the competitive situation characteristics, starting from the involved energetic processes and the achieved specific technical actions.

Methods. The experiment was conducted on a group of 10 female gymnasts, components of the Romanian national squad. The used methods aimed at measuring/ assessing the oxygen consumption and the other physiological indicators, under lab, training and simulated competitive conditions.

Results. The obtained results emphasize the following aspects:

- the team gymnasts present relatively homogeneous aerobic capacities ($VO_2 \text{ max } 52.7 \pm 2.29$), by having in view their morphological characteristics and their age (15 to 17 years old);
- the mean lactate and its peak, registered after 1 minute of effort, confirm the fact that, in competitions, gymnasts work under conditions close to their maximal aerobic power;
- the registered lactacidemia highlights the same hierarchy within the team in both of the group events, except for the substitute gymnasts, who are in difficulty to supply the requested effort;
- the lactic acid higher concentration explains the important exertion of the lactacyd anaerobic system;
- a higher lactacidemia is registered in the group titular gymnasts performing with 2 hoops and 3 ribbons ($x = 11.31 \pm 1.54 \text{ mmol.l}^{-1}$) and in the rope individual event ($x = 11.08 \pm 2.37 \text{ mmol.l}^{-1}$), as compared to the values obtained in the 5-ball group event ($x = 10.33 \pm 1.45 \text{ mmol.l}^{-1}$). This might result from the requirements imposed by the FIG Code of Points as for the number, the degree of technical difficulties and the corporal group specific to each apparatus.

Conclusions. The repeated analysis of the heart rate evolution registered during the training lesson, in different preparatory stages, enabled us to objectively determine the characteristics of the demands and of the supplied effort. To accomplish the top-level technical-artistic content in group events, gymnasts must cope with higher energy expenditure, therefore with a strong exertion of the lactacyd anaerobic system, which can become the source of technical errors and can influence both coordination and emotional balance. To lessen this part of the metabolic process in the energy input needed by the effort sustaining in rhythmic gymnastics, it would be necessary to develop first of all gymnasts' aerobic potential, so that they become able to cope with the training effort, to increase their recovery possibilities and delay the lactic acid production.

Keywords: sports exercise, rhythmic gymnastics, performance sports.

Introduction

The requirements of the new Code of Points issued by the International Gymnastics Federation (FIG) emphasized, after the first international contests in the present Olympic cycle, that gymnasts have been more exerted as a result of the increased number of technical exigencies specific to competitive events. The increased number of technical difficulties in the composition of competitive routines involves an extremely great effort for the gymnasts, with negative consequences on the difficult technical productions. At the same time, this can generate a confusing and less esthetical image, a lack of concordance between the corporal movement and music during some compositional sequences.

Because of the created situation, the President of the Rhythmic Gymnastics Technical Committee recommends the coaches "to compose the exercises according to gymnasts' real capacities, in order to

protect their health, their passion for this sport, by facilitating thus the obtaining of high scores and, last but not least, to assure a quality show, which is very important to enjoy the media appreciation and support" (E. Abruzzini, 2004).

The energetic potential measurement depends on the accurate standardization of the testing protocols that should rely on scientifically proved objective criteria (P.O. Astrand, K. Rodahl, 1986). The tested parameters have a certain specificity and data interpretation and assessment should be made in the context of a sports behavior specific to rhythmic gymnastics (RG).

The aerobic power measurement relies on the premise that the significant differences between maximal aerobic power (MAP), lactate threshold (LT) and anaerobic power - determined by gender, age and genetic factors, can be influenced by training, are interdependent and their importance varies depending

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on the performed sport (J.M. Hagberg, 1980).

The MAP direct measurements and their correlation with other easier to quantify variables (heart rate - HR) engendered a diversity of approaches for the aerobic fitness estimation. However, the correlation between the recovery HR and the aerobic effort objective measurements is too weak for the creation of some normative charts useful to the MAP assessment (J.L. Ivy, R.T. Whitlers, P.J. Vanhandel, D. Elger, D.L. Costill, 1980). But the MAP and the recovery capacity repeated testing over a certain training period could provide useful information about the approached training program efficacy.

The concept of "lactate threshold" represent a much debated topic on the phenomenon in itself and the technology used to identify it. Some authors have divergent opinions about the concept practical applications to sports (G.A. Brooks, 1985; 1991, J.A. Davis, 1985), but others assert that the blood lactate provides valid information with applications to sports (N.L. Jones, R.E. Ehram, 1982). However, the test utilization requires precision when describing the measurements of the absolute and relative power values achieved by the athlete, but also the effort threshold duration and the modalities for the LT identification (B.W. Kinderman, G. Simon, J. Keul, 1979; W. Kinderman, M. Schramm, J. Keul, 1980; H.J. Green, R.L. Hughson, G.W. Orr, D.A. Ranney, 1983; J.L. Ivy, R.T. Whitlers, P.J. Vanhandel, D. Elger, D.L. Costill, 1980 and others).

Purpose

- Making a comparative study between the demands specific to the rhythmic gymnastics activity and the tested gymnasts' individual functional possibilities, then drawing up a profile significant from the methodological point of view.
- Defining the effort orientation, in order to formulate a physical training program adapted to RG training, for the gymnasts competing both in individual and group events (vs. team events).

Hypotheses

If the gymnasts' competitive work takes place under conditions close or superior to their maximal aerobic power and if their training effort intensity corresponds to the competition demands.

If the energetic expenditure for an exercise composed according to the requirements imposed by the new Code of Points differs depending on the corporal group specific to each apparatus (jumps, pivots, balance, flexibility elements/ wave) and on the quantity of difficult technical elements used by the gymnast.

Methods

The used methods aimed at measuring/ assessing the oxygen consumption and the other physiological indicators, under lab, training and simulated competitive conditions.

The experimental plan was meant to:

- determine the physiological indices in the lab;
- assess the energetic expenditure (oxygen consumption), starting from the biological indices registered in the gym;
- analyze the technical content performed in training and competition.

Subjects: 10 female gymnasts aged 15 to 17 years old and distributed as follows: 6 components of the national group squad and 4 individual performers.

Results

The results obtained after the assessment of the three mentioned situations were the following:

- Lab physiological indicators (table 1).
- Physiological indicators in a simulated competition, after the application of the new Code of Points requirements related to the maximum number of technical difficulties in the competitive exercise composition (table 2).
- Physiological indicators in a simulated competition, in relation to the lab indicators (tables 3, 4 and graphs 1, 2).

Table 1: Mean values of the lab physiological indicators

Event	VO ₂ max ml.min ⁻¹ Kg ⁻¹	Lactate mmol.l ⁻¹	Max HR beats/ min	Aerobic threshold ml.min ⁻¹ Kg ⁻¹	Anaerobic threshold in % of the VO ₂ max
Individual	41.27 ± 4.47	8.53 ± 1.56	182.8 ± 3.21	32.65 ± 5.38	76.08 ± 6.52
Group	55.20 ± 2.29	11.65 ± 2.87	185.66 ± 2.30	37.65 ± 6.54	75.65 ± 7.25

Table 2: Mean values of the physiological indicators in a simulated competition

Event	Exercise	VO ₂ max ml.min ⁻¹ Kg ⁻¹	Lactate mmol.l ⁻¹	Max HR beats/ min
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Senior individual	ball	50.27 ± 2.35	8.35 ± 1.58	180.6 ± 1.52
	hoop	51.58 ± 4.25	9.65 ± 0.51	184.3 ± 2.21
	rope	55.36 ± 3.69	11.08 ± 2.37	186.2 ± 0.45
	clubs	53.10 ± 2.56	8.82 ± 3.24	186 ± 1.32
Senior group	5 balls	52.40 ± 4.22	10.33 ± 1.45	182.2 ± 4.99
	3 ribbons + 2 hoops	54.10 ± 4.36	11.31 ± 1.54	186.3 ± 10.4

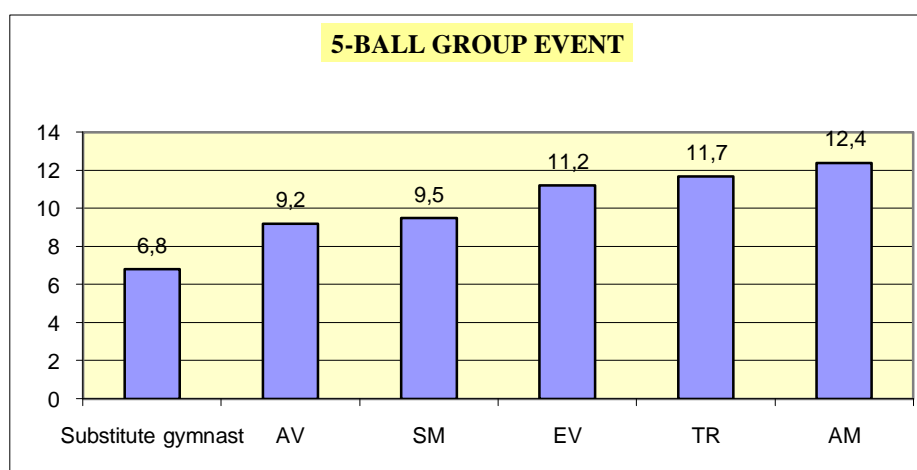
Table 3: Mean values of the effort indicators under lab and simulated competitive conditions

Physiological indicators Simulated competition	Individual routines	Group routines
max HR % max HR – lab	184.2 ± 10.5 95.5%	184.2 ± 6.07 95.5%
mean HR % max HR – lab	171.4 ± 5.59 88.9%	168.2 ± 4.59 88%
maximal lactate lactate peak after the effort	> 6.58 ± 1.94 after 1 minute	7.34 ± 1.7 after 1 minute

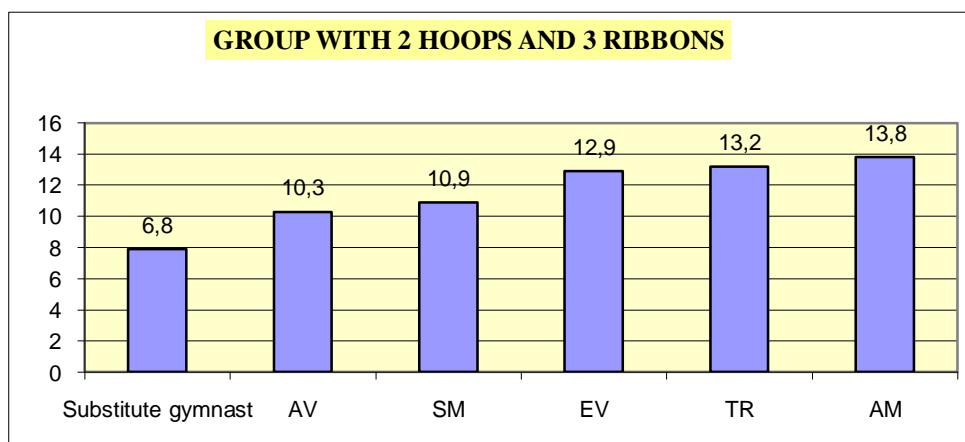
Table 4: Physiological indicators registered under simulated competitive conditions in both of the group events (mean values)

Simulated competition	5-ball group event	Group performing with 2 hoops and 3 ribbons
max HR – field % max HR – lab	182.2 ± 4.99 95%	186.3 ± 10.4 96.7%
maximal lactate	10.7 ± 1.45	12.2 ± 1.54

Graph 1: Maximal lactate measured in competition in the 6 gymnasts – 5-ball group event



Graph 2: Maximal lactate measured in competition in the 6 gymnasts performing in the group event with 2 hoops and 3 ribbons



Results emphasize the following aspects:

- the team components present relatively homogeneous aerobic capacities ($VO_2 \text{ max } 52.7 \pm 2.29$), by having in view their morphological characteristics and their age (15 to 17 years old);
- the mean lactate and its peak (table 3), registered after 1 minute of effort, confirm our predictions according to which, in competitions, gymnasts work under conditions close to their maximal aerobic power (MAP);
- the registered lactacidemia (fig. 1) for each team component highlights the same hierarchy in both of the group events, except for the substitute gymnasts, who are in difficulty to supply the requested effort;
- the lactic acid higher concentration explains the important exertion of the lactacyd anaerobic system;
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Physiological indicators registered under training conditions (table 5).

Table 5: Mean values of the physiological indicators registered under training conditions

Training physiological indicators	Group routines
min HR	75.4 ± 5.6
max HR	179.8 ± 5.7
% max HR	93.2% integral routines
mean HR	130.1 ± 6.2
% max HR	67.4%
% HR < 50% MAP	65.9% ± 12.4
50% < HR % aerobic threshold	27.9% 11.7
% HR < aerobic threshold	93.8%
aerobic threshold < % HR < aerobic threshold	5.85%
% HR > aerobic threshold	0.38% 0.45
lactate at rest mmol/l	0.59% 0.23

Table 5 shows us that the training intensity is not sufficient to maintain the MAP in this competitive period, a heart rate high percentage being below the aerobic threshold (< 95%). The maximum heart rate values registered under training conditions, during the integral evolutions in the group event (179.8 ± 5.7), are pretty close to those obtained in the simulated competition (184.2 ± 10.5).

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The repeated analysis of the heart rate evolution registered during the training lesson, in different preparatory stages, enabled us to objectively determine the characteristics of the demands and of the supplied effort (table 6).

Table 6: The HR mean values registered in the lessons with a technical and choreographic content. Pre-competitive period

Before the effort	Improvement of the apparatus handling technique	Combinations of difficult technical elements	Exercise parts	Half-integral exercises	Integral exercises	Recovery after 1 minute	Capacity of recovery
(BE)	(AHT)	(Dif TC)	(EP)	(H-IE)	(IE)	(R1)	-4.2
78	125	130	140	152	180	114	Very good

External indicators

By analyzing the technical content of the competitive events (table 7), we shall notice a great variety of the performed elements. This is not surprising if we consider the exigencies of the new Code of Points that clearly establishes the requirements regarding the number and the degree of technical difficulties.

But, if we compare the exercises presented by the World top gymnasts (Russia, Belarus, Ukraine), we shall see that the density of corporal elements performed by them is greater for an approximately identical duration of the competitive routines (2'20" to 2'30"), while the Romanian gymnasts mostly use combinations of three elements in order to increase the difficulty value, which doesn't change the problem data

Table 7: Technical content of the group routines – Romanian team vs. Russian team

Group routines (technical content)	Romanian team Ranked 3 rd at the European Championships Ranked 10 th at the World Championships	Russian team Ranked 1 st at the European Championships Ranked 1 st at the World Championships
Number of corporal elements	57.81%	65.9%
Jump difficulties	mean diff. 8; higher diff. 6	mean diff. 6; higher diff. 10
Pivot difficulties	mean diff. 5; higher diff. 2	mean diff. 3; higher diff. 5
Balance difficulties	mean diff. 5; higher diff. 2	mean diff. 3; higher diff. 5
Flexibility difficulties	mean diff. 5; higher diff. 2	mean diff. 4; higher diff. 6
Mean duration of a difficulty	14"3	12"7
% diff. time/ mean duration	17.4%	14.4%
Combinations of 2 elements	5 value diff. 1 point 58%	7 value diff. 1 point 72.4%
Combinations of 3 elements	6 value diff. 1 point 35.2%	7 value diff. 1 point 17.6%
Apparatus exchange with corporal difficulty	9 value diff. 0.60 points 8.4%	7 value diff. 0.60 points 3.4%



Conclusions

1. To accomplish the top-level technical-artistic content in group events, gymnasts must cope with higher energy expenditure, therefore with a strong exertion of the lactacyd anaerobic system, which can become the source of technical errors and can influence both coordination and emotional balance.
2. To lessen this part of the metabolic process in the energy input needed by the effort sustaining in rhythmic gymnastics, it would be necessary to develop first of all gymnasts' aerobic potential, so that they become able to cope with the training effort, to increase their recovery possibilities and delay the lactic acid production.

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