

Maria Gateva

National Sports Academy (Sofia, Bulgaria)

TESTS TO DETERMINATE THE FITNESS LEVEL IN RHYTHMIC GYMNASTICS

Introduction

Rhythmic gymnastics is not one of the most explored topic by the scientists compared to sports such as football or cyclic sports which are much more analysed and covered by science. What is neglected by coaches and specialists is the physiological side of that sport. The load in rhythmic gymnastics is considered wrongly to be not so demanding but the results show different prospective. The heart rate at the end of the routines goes up to 200 b/min and blood lactate concentration up 12-13 mmol/l (Andonov & Gateva 2014; Gateva, 2008). With the changes in rhythmic gymnastics for the last 2 decades, provoking higher intensity during the routines (Gancheva 2009), we have to follow the principles of the training load even more. Not many authors (Baldari & Guidetti 2001; Douda, 2008; Guidetti, 2000) were found in the literature working on the effect from the training load and changes on the rhythmic gymnast's body. That's why the aim of this study is to implement tests to determine the fitness level of the gymnasts.

Methods

Twelve high level rhythmic gymnasts (some in the Bulgarian national team) aged 15,7 ($\pm 2,1$) took part in this investigation during the preparation period. Every gymnast had her own training regime. A written consent was obtained from all individuals researched.

Two laboratory and three field tests were applied to determine the level of fitness – cardiovascular and specific endurance in rhythmic gymnastics.

1. **VO₂ max**– Increase of the incline of the treadmill with 0,6° (starting from 0°) on each 30 sec. The speed during the test was constant – 8,4 km/h.
2. **2 min Submaximal treadmill test (95% of the maximal test)(authors' test)** –The test requires a 2 min run on a treadmill with a constant speed of 8,4 km/h and individually set up incline of 95% of the maximum for each athlete. The maximal incline is based upon:
 - theoretical maximal pulse,
 - reached HR and incline during the maximal test,
 - extrapolation of the incline as 100% from the theoretical maximal pulse and calculation of the 95% of the incline for each gymnast.
3. **2 min Shuttle test** – set distance of 10 m with two lines. Each time the subject is asked to touch outside the lines. The covered distance in meters (with accuracy of up to 0,5 m) is measured for 2 min. Athletes start in pairs.
4. **2 min Specific Modified gymnastics routine (authors' tests)** – A 2 min routine executed with the typical basic exercises for rhythmic gymnastics.

All of the specific exercise groups are displayed in this routine with low level of difficulty and structure close to the competitive.

5. **Competitive routine** – each gymnasts performed her own routine (average duration 1,28).

Procedure and the protocol of the tests

The individuals undertook a maximal gradual exercise test on a treadmill enabling the assessment of their VO_2 max. The 2 min submaximal laboratory test was performed 24 hours after the maximal one took place. The start of each of the laboratory tests was preceded by a three minute light warm up. After completing each test the subjects were asked to have a passive recovery period for 10 min.

All 3 field tests were done in one day on the same week of the laboratory testing. At the beginning of the field testing session, a basic warm up was performed, followed by a 10 min specific warm up prior to each of the three field tests. After the completion of each test the gymnasts were asked to have a passive recovery period for 10 min. The next field test was done after 20 min. The testing order was:

1. 2 min shuttle test
2. 2 min specific modified gymnastics routine
3. Competitive routine.

The methods used for each of the 5 tests are heart rate monitoring and concentration of the blood lactate. Based on those two indicators it is possible to compare the load during all the tests.

For laboratory testing gas exchange, blood pressure and other associated metabolic and cardiovascular functions indicators were used. Gas exchange and heart rate were monitored during and 10 min after the exercise (load). Breath by breath gas exchange was measured continuously using OxiconPro (Yeger, Germany). Heart rate was recorded by POLAR RCX3. The recording started at rest and continued until 10 min post exercise (recovery period). A drop of blood sample was taken from the fingertip to measure blood lactate using an Accutrend Plus Roche. Lactate was taken before and on the 3rd, 5th and the 9th min during the recovery period.

Descriptive statistics was used to characterize the physiological reaction during and after applying the tests and routines in rhythmic gymnastics. ANOVA was used to identify any differences between the tests and Student's paired t-test was applied to compare the results between the tests. The level of significance of $p \leq 0.05$ was adopted in all cases.

Results

The HR values at the end of the load of each test are summarised in table 1. The lowest values are achieved on the submaximal laboratory test – 186,2 b/min and the highest after rhythmic gymnastics routine – 194,1 ($\pm 4,2$) b/min (excluding the maximal test). The other two tests submaximal and shuttle run test reach midway HR. When the statistical difference in ANOVA was found we applied paired t-test between the tests for greater accuracy (see table 2). We can see that all the tests have significant difference with the maximal test which is normal and we won't comment this as the reason to apply VO_{2max} was to identify the maximum for each gymnast. Submaximal laborato-

ry test with the lowest values also gives differences with the rest of the tests which means that we couldn't meet the expected load as in the gymnastics routine. Basically without difference – similar heart values were reached only in the shuttle run test and the modified gymnastics routine. Competitive routine is still not reached by any other test and seems to be the most demanding amongst the tests.

Table 1. Descriptive statistics of the HR and concentration of the blood lactate after the completed tests

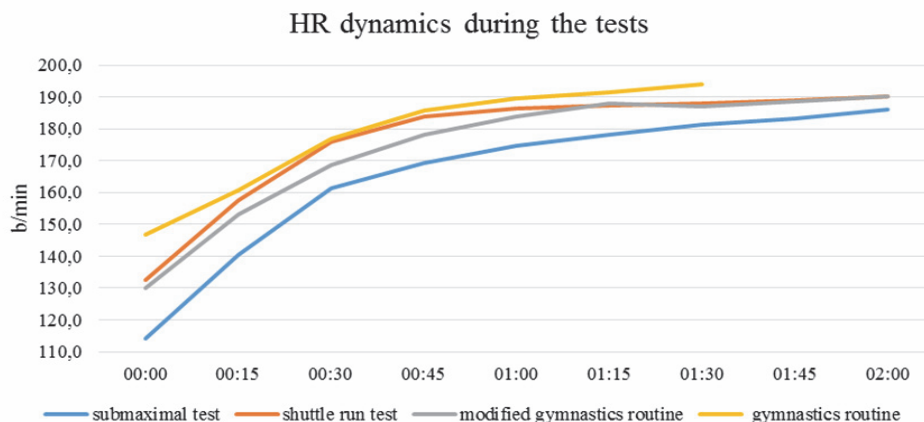
test	HR mean (SD) (b/min)	HR min. (b/min)	HR max. (b/min)	La mean (SD) (mmol/L)	La min. (mmol/L)	La max. (mmol/L)
VO2 max	201,7 (±6,7)	191	211	11,3 (±1,5)	9,4	13,6
Submaximal test	186,2 (±5,8)	178	198	10,0 (±1,6)	7,2	12,3
Shuttle run test	190,1 (±6,6)	181	199	10,9 (±1,8)	8,3	13,4
Modified routine	190,1 (±5,4)	182	200	7,2 (±2,5)	4,6	11,5
Gymnastics routine	194,1 (±4,2)	187	200	8,7 (±2,3)	5,7	12,8
p < 0,05 significant difference between the groups (ANOVA)	F – 13,298; Sig – 0,000		F – 8,317; Sig – 0,000			

Concentration of the blood lactate varies between 7,2 to 11,3 mmol/l. The tests including running provoke higher values compared to gymnastics routines. And this is proven by no significant difference between the maximal, submaximal and shuttle run tests. The two gymnastics routines didn't show any difference between each other and this could explain the similarity and the structure of the tests.

Table 2. Student's paired t-test between tests – HR

	VO2 max	Submaximal test	Shuttle run test	Modified routine	Gymnastics routine
VO2 max		10,476**	5,694**	6,218**	3,939**
Submaximal test	2,105		-2,435*	-2,326*	-6,814**
Shuttle run test	0,868	-1,994		-0,153	-2,686*
Modified routine	4,655**	5,223**	5,235**		-3,411*
Gymnastics routine	3,543**	1,942	2,984*	-1,937	
Student's paired t-test between tests – La					

* p ≤ 0.05/ ** p ≤ 0.01



In the graphic (grap. 1) one can clearly see the cardio-dynamic and fast phases of the heart rate in the begginig of the tests. After the first 30 sec. of the load values continue to rise slowly just with 20 b/min. up to the end of the tests. At that point it is interesting to follow if there any difference. Submaximal test stayed with the lower HR all the way of the load with significant difference. Shuttle run test doesn't show differences with the gymnastics routine up to the last 30 sec of the routine. At the same point gymnastics routine clearly had highest heart rate and modified and suttle run test provoked similar responce of the cardio-vascular system but lower than the gymnastics routine.

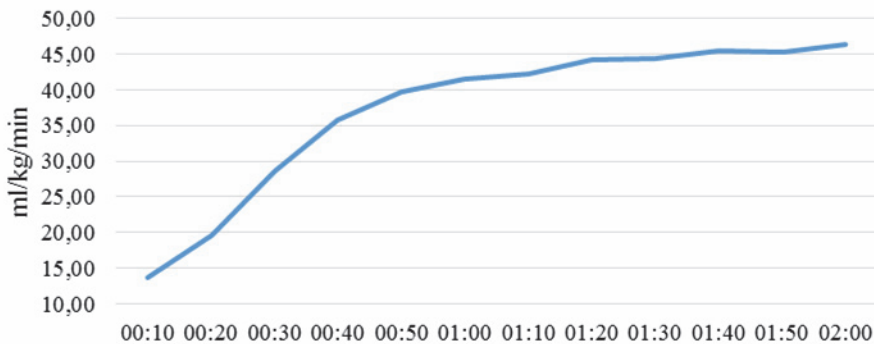
Table 3. Heart rate dynamics during the tests (means \pm SD)

t (min)	Test 2 Submaximal test	Test 3 Shuttle run test	Test 4 Modified routine	Test 5 Gymnastics routine
00:00	114,2 (\pm 16,0)*	132,5 (\pm 17,5) **	129,8 (\pm 17,1)	146,7 (\pm 10,9)**
00:15	140,4 (\pm 13,3)*	157,5 (\pm 13,4) **	153,1 (\pm 15,6)	160,8 (\pm 11,6) **
00:30	161,2 (\pm 11,9)*	176,1 (\pm 7,1) **	168,8 (\pm 9,1)	176,9(\pm 7,5) **
00:45	169,4 (\pm 9,9) *	183,9 (\pm 6,1) **	178,3 (\pm 8,4) **	185,8 (\pm 5,3) **
01:00	174,8 (\pm 8,7) *	186,4 (\pm 6,1) **	184,0 (\pm 6,9) **	189,5 (\pm 4,9) **
01:15	178,1 (\pm 7,6) *	187,3 (\pm 6,2) **	187,9 (\pm 6,0) **	191,5 (\pm 4,2) **
01:30	181,2 (\pm6,6) *	188,0 (\pm6,5)	187,2 (\pm5,5)	194,1 (\pm4,2) **
01:45	183,4 (6,4) *	189,0 (\pm 6,5) **	188,6 (\pm 5,7)	
02:00	186,2 (\pm 5,8) *	190,1 (\pm 6,6) **	190,1 (\pm 5,4) **	

p < 0,05 significant difference between the groups (ANOVA); * lowest of the groups/** highest of the groups

The only test with oxygen consumption registry is the 2 min submaximal laboratory test. The highest consumption achieved at the end of the load is 46,4 ml/kg/min.

Oxygen consumption during the 2 min submaximal treadmill test in rhythmic gymnastics



Graph 2.

Discussion

VO₂max was complete to calculate the individual 90-95% for the 2 min submaximal test. All the other tests were set to response to the same load as the competitive program in rhythmic gymnastics – a routine. It has been proven that in gymnastics the load during competitive routine is submaximal to maximal – in the anaerobic regime of work (Gateva, 2008; Guidetti, 2000; Jemni et al., 2011). That's why some adequate fitness tests responding to the specific load of the sport had to be created. Some other sports also suffer lack of assessment, and an identical study in climbing was found in the literature (Michailov et al., 2014).

The 2 min submaximal test and shuttle run test were likely to provoke absolutely the same load but the values showed other prospective. The curve of the dynamics of the HR appears to be absolutely identical but the field test had higher demands towards gymnasts probably because gymnasts started with maximal or close to the maximal speed, where in the laboratory test the load is limited. The modified routine also had lower HR values up to the first minute of the load compared to the gymnastics routine which is informative to make some changes in order to meet the same load like the competitive routine.

We can assume that the oxygen consumption during the competitive routine will be no far than the oxygen consumption during submaximal laboratory test. This means that, if we increase with 1-2% the values achieved on submaximal, the predicted oxygen consumption at the end of the gymnastics routine will be 47,4 ml/kg/min.

The differences between the tests based on the HR and blood lactate concentration gives us the information that more precise percentage of the maximal should be applied with the tests. The routine still showed higher demands on the gymnasts' body systems' compared to the other three applied tests. The shuttle run tests gave the clo-

sest values of HR to the routine load. Submaximal laboratory test have to be increased 1-2% in order to cause the same reaction to the gymnasts' body as a routine.

In the near future a more detailed comparison between the tests with Bland-Altman plot is planned to be made.

Acknowledgement

Supported by the National Sports Academy and Ministry of Education (Bulgaria).

References

- Andonov, K. & Gateva, M. (2014). Determination and comparison of the energetic work zone during the competitive individual routine in rhythmic gymnastics and competitive routine in aesthetic group gymnastics. *Physical Education and Sport – Competence for life, 9-12 October 2014, Sofia, Bulgaria, Congress proceedings.* (pp. 109-114).
- Baldari, C. & Guidetti, L. (2001). VO₂max, ventilatory and anaerobic thresholds in rhythmic gymnasts and young female dancers. *J Sports Med Phys Fitness.* 41(2), 177-182.
- Douda, H., Toubekis, A., Avloniti, A., Tokmakidis, S. (2008). Physiological and anthropometric determinants of rhythmic gymnastics performance. *International Journal of Sports Physiology and Performance.* 3(1), 41-54.
- Gancheva, G. (2009). Analysis of the difficulty in rhythmic gymnastics. *J. Sport & Science.* 53(4), 18-23.
- Gateva, M. (2008). Examination of the training loading in rhythmic gymnastics and perfecting the training methods. Unpublished doctoral dissertation. National Sports Academy, Sofia.
- Guidetti, L., Baldari, C., Capranica, L., Persichini, C., & Figura, F. (2000). Energy cost and energy sources of ball routine in rhythmic gymnasts. *Int J Sports Med,* 21(3), 205-209.
- Jemni, M., Sands, W., Salmela, J., Holvoet, P. & Gateva, M. (2011). The science of gymnastics. London and New York: Routledge Taylor and Francis Group.
- Michailov, M., Pentcheva, B., Bonova, I., Boyanov, D., Jeynov, B., Mateev & Stefanova, D. (2014). High peak oxygen consumption in rock climbing. *Physical Education and Sport – Competence for life, 9-12 October 2014, Sofia, Bulgaria, Congress proceedings.* (pp. 95-101).

TESTS TO DETERMINATE THE FITNESS LEVEL IN RHYTHMIC GYMNASTICS

The need of implementing new tests for determining the fitness level of rhythmic gymnasts is vast. 12 high level rhythmic gymnasts were tested in preparatory period with 5 tests – two laboratory tests on a treadmill (VO₂max and 2 min submaximal test) and three field tests (2 min shuttle run test, modified gymnastics routine and rhythmic gymnastics routine) to determine the fitness level of the gymnasts. VO₂max was

completed in order to calculate the individual 90-95% for the 2 min submaximal test. All the other tests were set to respond to the same load as the competitive program in rhythmic gymnastics – the routine.

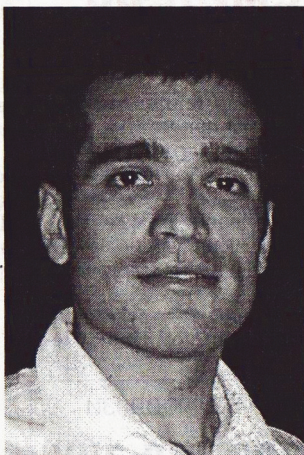
The differences between the tests, based on the HR and blood lactate give us reason to believe that the test loads should be selected more precisely. The routine still displayed higher demands upon the gymnasts' body systems compared to the other three applied tests. The shuttle run tests gave the closest values of HR compared to the routine load. Submaximal laboratory test have to be increased by 1-2% in order to cause the same reaction to the gymnasts' body as the routine.

„Dan“, 23. septembar 2014.

ПУБЛИКОВАН НОВИ БРОЈ СТРУЧНОГ ЧАСОПИСА MONTENEGRIN
JOURNAL OF SPORTS SCIENCE AND MEDICINE

У 25 међународних индексних база

Из штампе је изашао најновији број међународног часописа **Montenegrin journal of sports science and medicine**, који издаје **Црногорска спортска академија** из Подгорице. Уредништво је презело иницијативу у смјеру индексирања часописа и његове што боље видљивости у широким научним круговима. Из тог разлога је формиран тим који је имао задатак да препознаје предности и слабости часописа те их представи уредништву, које је, одмах потом, доносило препоруке које су условиле да се повећају шансе за успешно индексирање. Тренутно, **Montenegrin journal of sports science and medicine** је препознат у 25 међународних индексних база и као такав представља реалног кандидата за добијање импакт фактора, који представља мјерило вриједности, у „Thomson Reuters“-овој бази у којој се још увијек процјењује. Као такав је лидер у Црној Гори, а главни уредник је проф. др Душко Бјелица, који има зајмјенике из пет држава.



Доц. др Стево Поповић

- Група полетних професора са Факултета за спорт и физичко васпитање на Универзитету Црне Горе и чланова Црногорске спортске академије из Подгорице заплвили су путем откривања нових научних законитости у области спортских наука и спортске медицине и основали нови часопис чији је први број изашао у септембру 2012. године, при-

сјећа се доц. др Стево Поповић одговорни уредник часописа. - Током протекле три године, часопис је доживио велике промјене. Дакле, у складу са својим континуираним растом, прије свега је осигурана уредна и правовремена публикација најновијих научних радова. У складу са тим, дошло је до значајног раста престижних чланака за објављивање који указују на све веће занимање научника из свих дјелова свијета за објављивање својих научних рада у нашем часопису. Часопис је у протеклом периоду објавио, просјечно по пет чланака, у сваком од својих бројева који су излазили шестомјесечно, док су досадашњи аутори чији су радови прошли ригорозну евалуацију били из Хрватске, САД-а, Шведске, Португала, Шпаније, Аустрије, Швајцарске, Француске, Чешке, Турске, Индије, Србије, Јапана, Бразила, као и из Црне Горе, рекао је доц. др Стево Поповић.

Т.Б.