

PHYSIOLOGICAL RESPONSES DURING COMPETITIVE SPORTS AEROBICS EXERCISE

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ABSTRACT

The aim of this study was to characterize heart rate (HR), oxygen uptake and pulmonary ventilation during competitive aerobic gymnastics routine in a group of elite women athletes. The subjects were Lithuanian aerobic women gymnasts, members of national team (21.6, 4.4) years old). All subjects performed a maximal incremental treadmill test in the laboratory and competitive aerobic gymnastics exercises in group category. Heart rate was continuously recorded using the heart rate measurement equipment Polar ACCUREX-Plus. During the incremental treadmill test HR deflection point and other parameters of aerobic capacity were determined from the relationship of HR to running speed. During the aerobic gymnastics routine pulmonary gas exchange parameters and heart rate were continuously measured using the telemetric equipment Cortex 3B. The changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function.

The results showed that HR values during the competitive aerobic gymnastics routine were higher than HR break point which is near the lactate accumulation threshold (reaching 95.2 (4.2)% of maximal HR). Oxygen uptake during competitive routine reached 81.3 (5.8)% of maximal oxygen uptake. Rather high blood lactate accumulation (7.50 mmol / l) at the third minute after exercise show the high intensity of exercise. These results allows us to consider that aerobic gymnastics is a sport with high cardiorespiratory and metabolic demands, in which aerobic and anaerobic sources are intensely activated.

Keywords: *aerobic gymnastics, aerobic capacity, pulmonary gas exchange, lactate, heart rate deflection point.*

INTRODUCTION

Aerobic gymnastics became a member of the gymnastics family, and thus of the International Gymnastics Federation in 1994. This new kind of sport increased in popularity after 1st Sport Aerobics World Championship, which was held in Paris, in 1995. The competition in aerobic gymnastics includes the routine lasting on average 1 min 45 s. It is a sport with the unique structure of the routine, with a different degree of difficulty elements, complex movements patterns and steps in linking to music. All the time a participant must move in time following the beat of music and musical phrases, it

means — without any phase of rest. All movements, including difficulty elements, must be performed with correct posture and with body alignment (neutral alignment without hyperextension of joints).

The physiological responses of aerobic gymnastics exercise have not yet been widely studied. Only one short study has been published describing physiological characteristics of aerobic gymnasts and physiological responses during competitive routine (Rodriguez et al., 1998). Currently measurements of pulmonary gas exchange and heart rate can be continuously

obtained using telemetric systems (Schulz et al., 1997; Maiolo et al., 2003) and metabolic profile based on the measurement of the blood lactate concentration and oxygen consumption pre, during and post different kinds of acyclic activities can be established (Guidetti et al., 2000; Beneke et al., 2004). As a member of gymnastics family aerobic gymnastics in some aspects can be comparable with other kinds of gymnastics sport. Several studies have been published describing the characteristics of rhythmic gymnasts (Case et al., 1980; Gionet et al., 1986; Alexander, 1991) and energy requirement of ball routine in rhythmic gymnastics (Guidetti et al., 2000).

The aim of this study was to characterize heart rate (HR), oxygen uptake and pulmonary ventilation during competitive aerobic gymnastics routine in a group of elite women athletes.

METHODS

Subjects. 9 Lithuanian aerobic women gymnasts participated in this study. Age and physical characteristics of gymnasts are presented in Table 1. All subjects were members of national team and they were tested during their competitive period before the World Championship.

All athletes' participation in the study was requested through their coaches. The informed consent was obtained from all participants. The study was approved by Regional Ethics Committee for biomedical research.

Experimental procedure. All subjects underwent two testing sessions. Both testing sessions were performed one week apart. All athletes were asked not to train vigorously on the eve before both testings. During the first session (treadmill test) the parameters of VO_2 max, HR deflection point were estimated. In the second session (aerobic gymnastics routine) pulmonary gas exchanges parameters, heart rate and blood lactate concentration were measured.

First test session. All subjects performed a maximal incremental treadmill test in the

laboratory. Before the test each athlete performed a 5 min. warm up, which consisted of walking, easy running and stretching exercises. The treadmill test consisted of each minute increasing running. Starting workload was 6.2 km / h, each minute running speed increased by 0.7 km / h. All gymnasts were encouraged to continue as long as they were able to maintain speed of running. Heart rate was continuously recorded using the heart rate measurement equipment *Polar ACCUREX-Plus*. The HR deflection point and other parameters of aerobic capacity were determined from the relationship of HR to running speed.

Second testing session. Over one week, the athletes performed competitive aerobic gymnastics exercises in group category. During the routine pulmonary gas exchange parameters and heart rate were continuously measured using the telemetric equipment *Cortex 3B*. The changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function. The heart rate was recorded continuously every 5 s using the *Polar* heart rate monitor.

The length of routine was 1 min 46 s. The aerobics gymnastics exercises must be performed under artistic, execution and difficulty criterions. The main artistic criterions are: choreography, sports specific content, musicality and expression, execution criterions — technical execution of all movements including difficulty elements. The main difficulty criterion is the performance of one minimum element (maximum 12 elements are allowed) from each group of element pool (A — dynamic strength, B — static strength, C — jumps, D — flexibility). Each difficulty element is evaluated under the level of difficulty. The subjects performed the routine that consisted of 12 elements with difficulty value of 4.0 points (*Federation Internationale de Gymnastique*, 2002).

Before, during and 10 min after the routine pulmonary gas exchange parameters and HR were continuously measured using the telemetric equipment *Cortex 3B*. Capillary blood samples were obtained before the routine and at the end of, the third and 18th mins of recovery and analysed for blood lactate concentration (Kulis et al., 1988).

Data analysis. During a maximal incremental treadmill test HR deflection point and VO_2 parameters of aerobic capacity were determined from the relationship of HR to running speed.

Table 1. Anthropometric characteristics and age of aerobic gymnasts (mean (SD))

Age, years	21.6 (4.4)
Height, cm	154 (5.0)
Body mass, kg	55.1 (6.2)

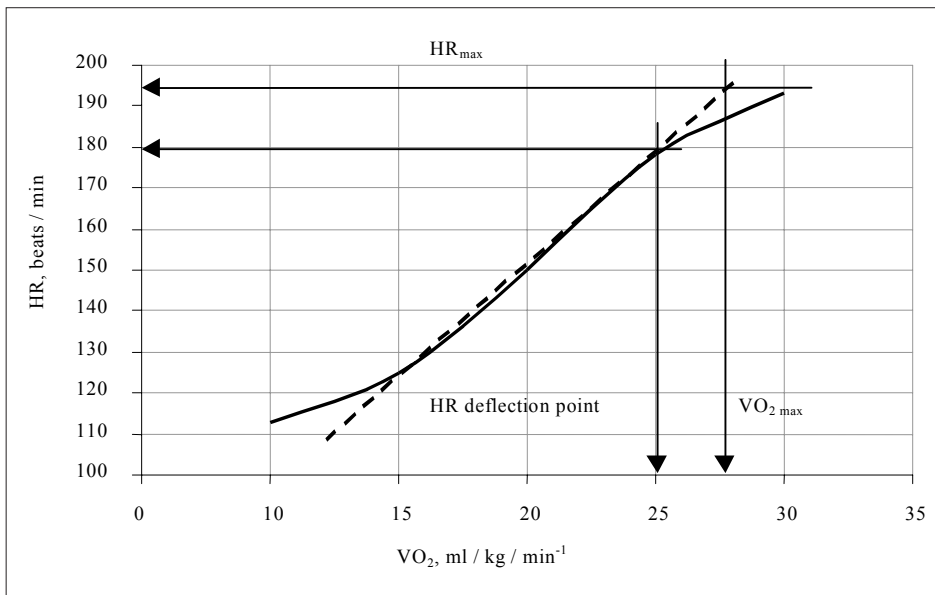


Fig. 1. Relationship of heart rate to running speed in one subject

During the competitive aerobics gymnastics routine the changes of HR, minute ventilation and oxygen uptake were analyzed by adopting monoexponential function.

Statistical analysis. Means' values, standard deviations and correlation were calculated.

RESULTS

Maximal responses during the incremental test on the treadmill are presented in Table 2. Sports aerobics athletes have a moderate maximal aerobic power. The competitive aerobic gymnastics routine are characterized by very intense cardiorespiratory demands, attaining

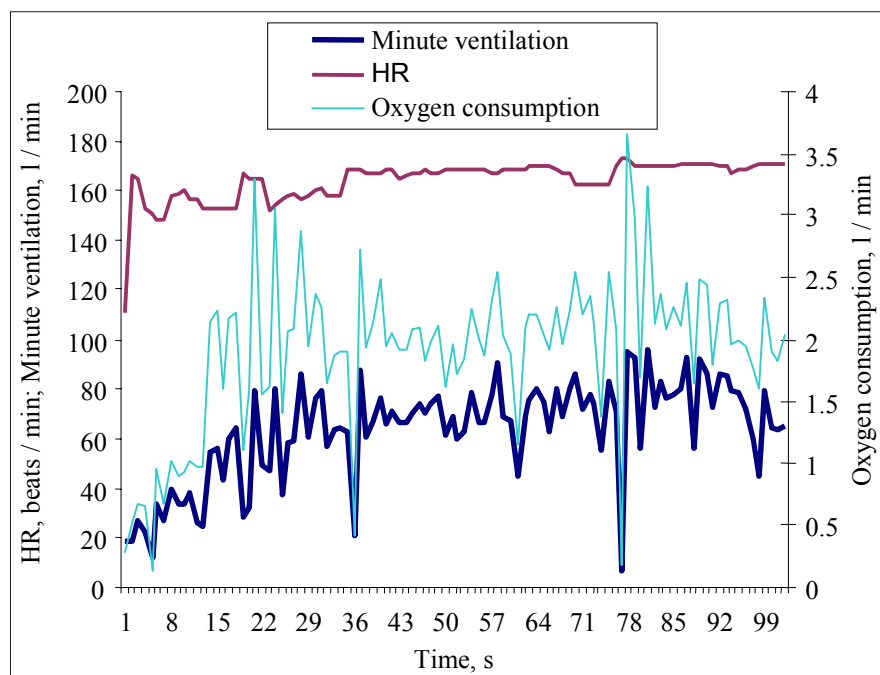
HR _{max} , beats / min ⁻¹	193.3 (7.7)
HR deflection point, km / h ⁻¹	10.9 (0.8)
HR at deflection point, beats / min ⁻¹	171.1 (5.9)
Maximal aerobic speed, km / h ⁻¹	13.31 (0.87)
VO _{2 max} , l / min ⁻¹	2.78 (0.38)
VO _{2 max} , ml / kg / min ⁻¹	50.38 (1.51)

Table 2. Maximal responses in aerobic gymnasts during an incremental treadmill test (mean (SD))

HR asymptote, beats / min ⁻¹	182.1 (7.5)
HR time constant, s	16.5 (5.6)
Minute ventilation asymptote, l / min ⁻¹	82.4 (17.8)
Minute ventilation time constant, s	49.4 (17.7)
VO ₂ asymptote, l / min ⁻¹	2.34 (0.22)
VO ₂ time constant, s	30.9 (15.7)
[Lactate] at 3 rd min after exercise, mmol / l	7.50 (2.09)
[Lactate] at 18 th min after exercise, mmol / l	4.99 (2.30)

Table 3. Cardiorespiratory values during a competitive aerobic gymnastics routine (mean (SD))

Fig. 2. Heart rate, minute ventilation and oxygen consumption during competitive gymnastics aerobic routine in one subject



average maximal values 81.3 (5.8)% of maximal oxygen uptake and reaching 95.2 (4.2)% of maximal HR and overstepping the HR break point which is near the lactate accumulation threshold (Table 2, Fig. 1). A high correlation was observed between VO_2 max determined in the laboratory and VO_2 measured during the routine ($r = 0.872$; $p < 0.05$).

DISCUSSION

The aerobic capacity and physiological responses during competitive routine in well trained aerobic gymnasts were analyzed. Also, the correlation between all parameters mentioned above was assessed.

Maximal responses during treadmill test in Spanish athletes have been published (Rodriguez et al., 1998). HR_{max} in their study was similar. Absolute VO_2 peak data were higher in F. A. Rodriguez's et al. (1998) study in comparison with our calculated data. Spanish gymnasts were of elite international level while ours only of moderate one. This also might be due to different body composition. Our gymnasts were taller and heavier than Spanish ones. In addition, Spanish athletes seem to have higher anaerobic capacity since they achieved higher blood lactate concentration after competitive routine.

Anaerobic thresholds had not been previously evaluated in aerobic gymnasts, but they were evaluated in rhythmic gymnasts (Baldari, Guidetti, 2001). In the present study we did

measure only HR deflection point which is related to blood lactate accumulation threshold.

Only maximal values of physiological variables during competitive routine were presented in the Spanish study (Rodriguez et al., 1998), so all variables in there study were higher in comparison with our asymptotic values. The single and trios were tested in the Spanish study and it is known that this kind of aerobic gymnastics is more intensive. This might be the reason of higher lactate concentration in F. A. Rodriguez's et al. (1998) study.

In this study HR during the quasi-steady state of competitive exercise was higher than at HR deflection point. This may be associated with rather high blood lactate levels (7.50 at the 3rd min after exercise). The marked activation of the cardiorespiratory system may be associated with the involvement of whole body muscles during aerobics exercise. Aerobics can be considered as continuous exercise involving different types of contraction by different muscle groups. The specific training of aerobic gymnastics appears to yield a fitness structure with relatively more developed aerobic and anaerobic alactic capacities and less developed anaerobic lactatic capacity.

CONCLUSIONS

Competitive aerobic gymnastics exercise can be considered as a sport with high cardiorespiratory and metabolic demands, in which aerobic and anaerobic sources are intensely activated.

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