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Correlative Aspects between Heart Rate, Lactic Acid and Exercise Intensity in the Training of Water Polo Players – Junior III

Gheorghe Marinescu[a], Laurențiu Daniel Ticală[a]*, Ana Maria Mujea[a], Simona Nicoleta Bidiugan[b]

* Corresponding author: Laurențiu Daniel Ticală, ticala_laurentiu@yahoo.com

[a]*National University of Physical Education and Sports, 140 Constantin Noica Street, Bucharest, Romania*
[b]*National Institute for Sport Research, 41A Basarabia Blvd., Bucharest, Romania*

Abstract

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In water polo game, acyclic movements are prevailing, and the dominant energy systems are distributed as follows: 10% alactacid, 30% lactacid and 60% aerobic. The performance-limiting factors are represented by acceleration power, throwing power, etc., all of them relying on a solid aerobic basis. Training monitoring through cardiovascular functional tests (heart rate) at rest and during specific effort or in the recovery period, correlated to biochemical testing of effort/ its hardness (lactic acid) and intensity, allows us to assess the functional and metabolic harmony/disharmony of athletes' body, depending on the dominant energy systems in the game of water polo. Purpose: through this ascertaining pedagogical experiment, we want to present the relationship between different external and internal effort parameters, in order to meet the metabolic standards imposed by the game of water polo. Methods: bibliographic study, metabolic and functional tests, statistical and mathematical method, graphical representation. Results: application of a standard trial designed for the higher aerobic exercise capacity (VO_2max) and assessed through the following parameters: heart rate, lactic acid and exercise intensity reveals the anticipation/ prediction of metabolic cost. Referring to the heart rate, the athlete G.S., with an average value of 205±5 beats/min., falls within the Lactate tolerance effort zone, while work intensity (92%) is situated in the VO_2max effort zone. The amount of accumulated lactic acid (10.2 mmol) frames the athlete's effort in the metabolic VO_2max zone.

Keywords: Water polo; heart rate; lactic acid; exercise intensity.

1. Introduction

In water polo game, acyclic movements are prevailing, and the metabolic characteristic of effort is represented by strength endurance with anaerobic penetrations (Marinescu, Frățilă, & Bălan, 2004: 7). The specificity of effort is given by the muscular characteristic, the metabolic one, and by characteristics related to tempo and rhythm (Marinescu, 2003: 126). Exercise capacity does not sum up the functional capacities of all organs and systems of the human body, being "limited by those organs which, after reaching maximal functional capacity, hinder continuation of the exercise, although other organs and systems still allow it" (Dragnea, quoted by Cordun, 2011: 52).

Training monitoring through cardiovascular functional tests (heart rate) at rest and during specific effort or in the recovery period, correlated to biochemical testing of effort/ its hardness (lactic acid) and intensity, allows us to assess the functional and metabolic harmony/disharmony of athletes' body, depending on the dominant energy systems in water polo game. Specialty literature provides few data about the metabolic cost of exercise in children and juniors - water polo, compared to seniors. Platanou and Geladas (2006) report lactic acid values comprised between 2 and 12 mmol, with an average of 3.9 mmol in a friendly match played by the senior representative team of Greece.

As regards the directly usable markers for controlling exercise intensity, the anaerobic threshold still remains a fashionable training concept (Brunet-Guejd et al., 2006: 11). Given that the anaerobic threshold is qualitatively inferior to maximal oxygen consumption (VO_2) zone, in our research, through the tested training means (higher aerobic zone - VO_2), we want to prove the correlation between an external effort parameter (intensity) and two internal parameters (heart rate and lactic acid).

2. Materials and methods

2.1. Hypothesis

Knowing the heart rate, lactic acid and work intensity during training sessions allows water polo coaches to efficiently manage the effort in order to achieve the objectives established.

2.2. Research methods

This paper represents an ascertaining pedagogical experiment, and the research methods used were: testing method, graphical method, statistical and mathematical method with the following statistical parameters: central tendency indicator (arithmetic mean), percentages (Popa, 2008).

2.3. Period, location and subjects of the research

The experiment tested 4 water polo players registered at three different clubs from Bucharest and competing in the National Championship. The athletes are born in 2002 and are basic players of the club teams to which they belong. Testing was conducted on 15 December 2014 at the "Miramar" Swimming Pool located in Bucharest, sector 2, 6-8 Chisinau Blvd.

2.4. Description of the monitored training

We have chosen a training means for the higher aerobic metabolic zone (endurance/VO_2max), because preparation using this type of exercise also provides direct and indirect indications on improvements of the anaerobic-type exercise (lactate tolerance). We mention that, for acyclic games and sports, higher aerobic capacity improves through mixed training sessions: VO_2max at the central level and AA (anaerobic alactacid) at the peripheral level (Brunet-Guejd et al., 2006: 11).

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Preparing the body to effort (warm-up), with a 30-second break between exercises, I: 50-60%.

- 4 x 33m leg crawl with a float device, break: 10 sec.;
- 4 x 33m gliding crawl, break: 10 sec.;
- 4 x 33m leg crawl with butterfly arm strokes, break: 10 sec.

Fundamental part aims to train the higher aerobiosis zone (VO_2max), I: 90%.

- 3 x (4 x 100m crawl) with a 10-second break between repetitions and 5 minutes between series.

Cooling down after exercise, I: 50-60%.

- 6 x 33m double backstroke, break: 20 sec.

2.5. Device used

Heart rate (HR) monitoring during training was achieved using HOSAND GT. AQUA telemetry system (Fig. 1). Hosand transmitter receives data about the athlete's heart rate from the standard chest strap belt and sends them in real time to the receiver and a PC, where the software displays the heart rate, stores and analyses the data. Athletes wear a specially designed vest, which contains a belt and a Hosand transmitter. The vest is hydrodynamic, and the data caught by the transmitter are transmitted even while the athlete is under water or swimming the backstroke, to a PC unit through a radio frequency. Hosand transmitter is waterproof and is housed in a pouch, on the back of the vest, under the Hosand label.

Blood lactate at the end of training was determined using the LACTATE PRO analyser, through the electrochemical measurement method (dry chemistry method) (Fig. 2).

Work intensity was established calculating the time recorded for every 100m covered and in relation with the time achieved for the same distance in an official competition.

Fig. 1. Component parts of HOSAND telemetry system

Fig. 2. LACTATE PRO - ARKRAY analyser

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3. Results

To better understand the effort dynamics interpreted through the internal parameter (heart rate), we present one single suggestive graph, with its evolution during training, for the athlete L.M. (Fig. 3). He starts training at a HR value of 94 bpm. After the first warm-up exercise, HR reaches 118 bpm, after the second exercise, HR reaches 145 bpm, and at the end of the first part (warm-up), HR attains 180 bpm.

After a 10-minute break, the athlete starts the fundamental part of training, the first series, at a HR of 100 bpm, which reaches 185 bpm after the first repetition and returns, in the 10-second break, to 179 bpm; after the second repetition, HR reaches 189 bpm and returns to 179 bpm; after the third repetition, HR reaches 191 bpm and returns to 185 bpm; after the fourth repetition, HR reaches 192 bpm, and in the first minute of the 5-minute break between series, HR attains 120 bpm – *corresponding to a warm-up pulse.*

In the second series, the athlete starts from a HR value of 120 bpm and reaches 189 bpm after the first repetition, and in the 10-second break, HR returns to 182 bpm; after the second repetition, HR reaches 191 bpm and returns to 183 bpm; after the third repetition, HR reaches 191 bpm and returns to 184 bpm; after the fourth repetition, HR reaches 197 bpm, and in the first minute of the 5-minute break between series, HR attains 124 bpm – *corresponding to a warm-up pulse.*

In the third series, the athlete starts from a HR value of 120 bpm and reaches 186 bpm after the first repetition, and in the 10-second break, HR returns to 181 bpm; after the second repetition, HR reaches 189 bpm and returns to 183 bpm; after the third repetition, HR reaches 193 bpm and returns to 186 bpm; after the fourth repetition, HR reaches 192 bpm, and in the first minute after effort, HR is equal to 120 bpm – *corresponding to a warm-up pulse.*

Cooling down after exercise uses an effort comprised between 120 and 140 bpm.

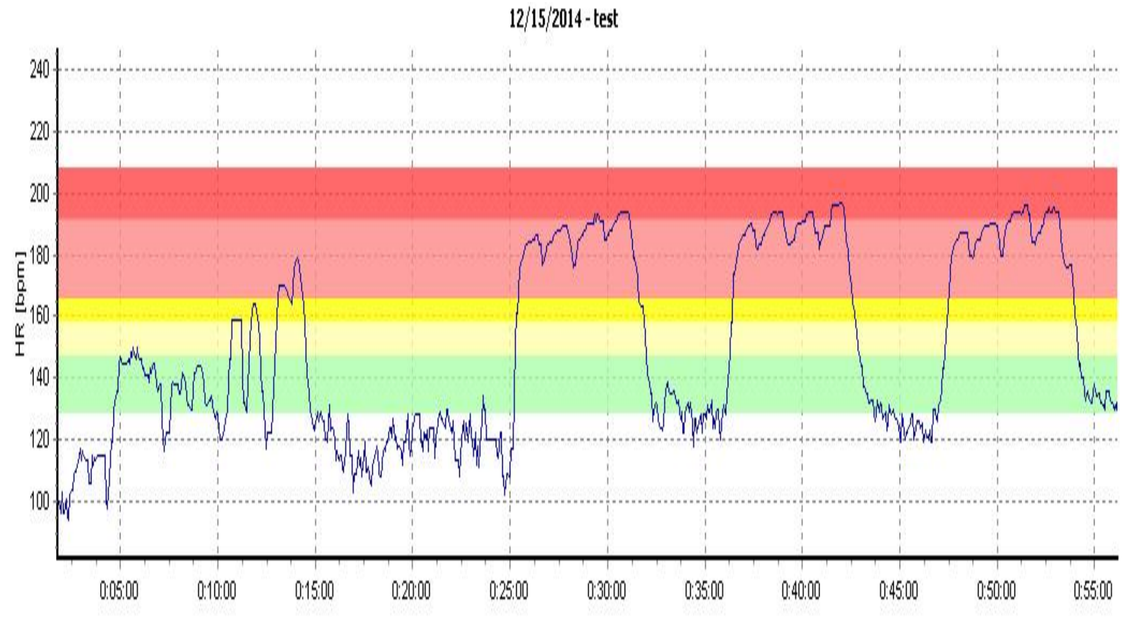

Fig. 3. Heart rate dynamics during training for the athlete L.M.

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Figure 4 shows the times recorded by the 4 athletes at each repetition of 100m swim within the 3 series. Results recorded by the athletes G.S., L.M. and P.E. highlight the linear evolution, the consistent intensity for the parameters required during repetitions (a primordial methodical prerequisite to train VO_2max) and the compliance with the ideal basic rule in approaching the specific tempo and rhythm. The evolution of times on every 100m swim within the series and between them indicates that the athlete V.I. has failed in respecting the tempo and rhythm imposed by the training methods for the metabolic VO_2max zone. In the 3 series, only the first repetition complies with the times imposed; all the other repetitions in the 3 series are swum at an increasingly smaller intensity, which represents an incorrect approach to the race schedule.

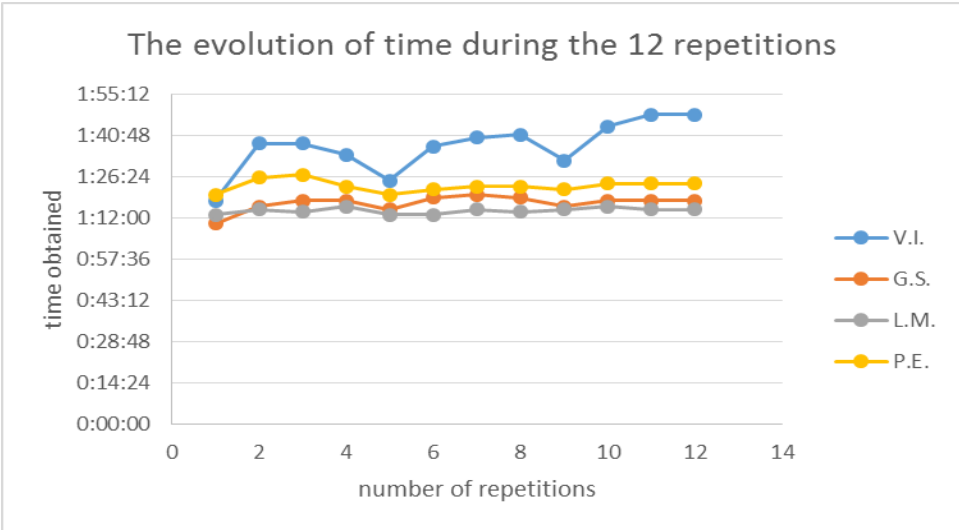


Fig. 4. Times recorded by the athletes during repetitions

Figure 5 shows the heart rate values for the 4 athletes at each repetition of 100m swim within the 3 series. Analysing the graphs, we notice that the athletes have recorded heart rates imposed by both the preparation in VO_2max zone and the anaerobic threshold, in relation to the theoretical maximum heart rate (Spiro, 1977).

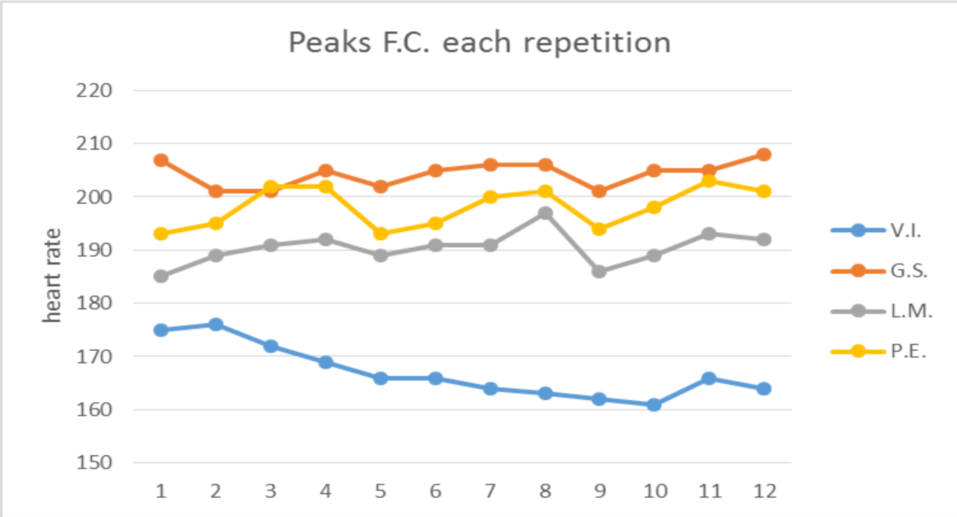
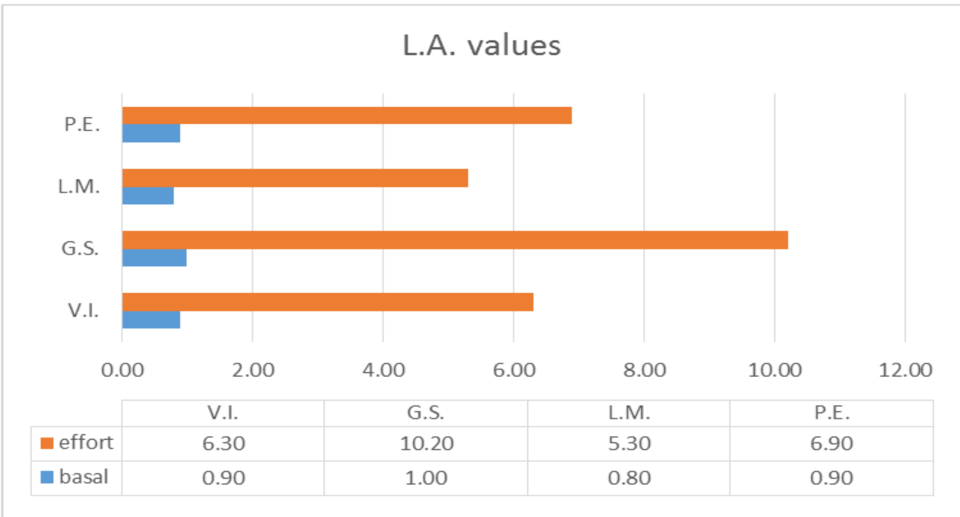


Fig. 5. Heart rate peaks during repetitions

Comparing the heart rates recorded during exercise by the athlete V.I., it can be noticed their correlation with the times recorded during repetitions (Fig. 4), which supports our arguments aforementioned about this athlete: he works at anaerobic threshold intensities (average HR = 167 bpm), without observing the training tasks. The athletes G.S., L.M. and P.E. frame within the heart rate parameter related to the theoretical maximum heart rate in VO_2max zone.



	V.I.	G.S.	L.M.	P.E.
effort	6.30	10.20	5.30	6.90
basal	0.90	1.00	0.80	0.90

Fig. 6. Lactic acid values recorded in basal metabolism and during exercise

In Figure 6, it can be seen that the evolution of lactic acid accumulation during exercise respects the functional condition of higher aerobiosis zone (4 to 12 mmol for the anaerobic threshold and VO_2max zones). The tested athletes start exercising from normal values of basal metabolism (< 2mmol).

Table 1. Average scores of the parameters assessed: intensity, heart rate, lactic acid

	V.I.	G.S.	L.M.	P.E.
Intensity	71%	92%	94%	92%
Heart rate	167	204	190	198
Lactic acid	6.3	10.2	5.3	6.9

Analysing the values of parameters recorded in Table 1, we can assert that there are positive correlations between the three parameters, according to the requirements of higher aerobic metabolic zone, in all 4 athletes. We can exemplify that the athlete L.M. responds to exercise requirements through a very good functional harmony: he works at a VO_2max intensity of 94%, an average heart rate of 190 bpm, and lactic acid has low values - 5.3 mmol. The lactic acid value of 5.3 mmol, at an exercise intensity of 94%, suggests that the athlete has an individual aerobic threshold higher than 4 mmol (standard). Knowing that the anaerobic threshold relates to VO_2max percentages, it can be concluded that the athlete is able to perform with easiness qualitatively higher VO_2max exercises for a longer period of time (about 30 min.). By extension, performing specific VO_2max exercises, the athlete/athletes will accumulate more lactic acid and will improve thus the lactate tolerance zone.

4. Discussions and conclusions

Analysing the correlation between internal and external effort parameters needed to reach VO_2max, we can conclude that the athletes have worked correctly, specifically to the higher aerobiosis zone.

It is possible to express intensity in percentages of the theoretical maximum heart rate, as a prerequisite to reach maximal oxygen consumption.

One cannot make a correct prediction of/ connection between the value of maximal heart rate reached and the performance level.

The decrease in maximal heart rate for one of the athletes during endurance training might be due to the heart output adaptation, increasing the systolic ejection volume.

Knowing the heart rate, lactic acid and work intensity during training sessions allows water polo coaches to efficiently manage the effort in order to achieve the objectives established – *the hypothesis is confirmed.*

Apparently paradoxically, the use of lactic acid output in our research is correlated to higher aerobic processes, and the test results validate the suitability of the means proposed/chosen for the experiment, in a close relation with the effort specificity, the research topic and the hypothesis appropriateness.

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