DIFFERENCES IN PHYSIOLOGICAL LOAD ON HANDBALL PLAYERS DURING THE STRAIGHT LINE RUNNING AND SPECIFIC HANDBALL POLYGON

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Abstract
The aim of this study was to determine the differences in the physiological load of the straight line running test (400 meters) and the specific handball task. The samples of entities were 10 healthy amateur handball players. The subjects (mean aged: 22.50 ±1.35 years; body weight 87.9±4.31 kg and body height 184.00±5.29 cm) ran 400 meters on athletic track as well as handball ground path in three attempts. Maximum heart rate and perception of exertion (Borg scale) were measured after every repetition, while the blood lactate concentrations were measured after the last repetition. The results showed no statistically significant difference in maximum heart rate (p = 0.06), subjective perception of exertion (p = 0.90) and blood lactate concentration (p = 0.17) between 400 meters running and specific handball task. The conclusion is that there are no major differences in the physiological load of 400 meters running and specific handball task. Both activities can be used in glycolytic anaerobic endurance training of handball players, but specific task with its greater relation to the specific conditions is more appropriate.

Key words*: anaerobic capacity, handball task, blood lactate, Borg scale*

Introduction

Handball as a team sport is a complex activity with lots of different movements (sprints, jumps, changes of directions, throws, shots, etc.). Several studies have examined the physiological characteristics of both elite and nonelite adult teamhandball players (Rannou et al., 2001; Sibila et al., 2004; Gorostiaga et al., 2005; Gorostiaga et al., 2006), but according to authors knowledge only one offers data on heart rates (HRs), blood lactate concentrations, and other physiological parameters during typical games (Souhail et al., 2010). Top level players possess a wide range of physical skills that include jumping and throwing with power, diving, blocking, sprinting, ball control, and agility (Wallace et al., 2007). Although playing handball itself can improve many of these skills, elite players must be involved in additional handball-specific conditioning (Hermassi et al., 2011). A combination of speed and explosive strength training are needed to improve peak running speed and jump height (Christou et al., 2006; Chelly et al., 2009) and bouts of high intensity running are needed to develop maximal anaerobic power and explosive capacity (McMillan et al., 2005; Buchheit et al., 2008; Buchheit et al., 2009).

Complexity is the reason that one handball player needs to be on high level in physical condition. Dominant places take aerobic and anaerobic capacity, explosive power, speed and accuracy (Cervar et al., 2004). Anaerobic energy is essential to performance in sprints, high-intensity runs, jumps, shots, duel plays, all of which may contribute to the final outcome of the game. Development of glycolytic anaerobic endurance is based on using the energy gained by anaerobic degradation of glycogen (Guyton et al., 2003).

That kind of training in handball is usually used in preparation and pre-competition period, while in competition period training of anaerobic capacity is used for sustaining the achieved level. The most common activity which is used for developing the glycolytic anaerobic endurance is straight line running distances between 200 and 600 meters (Sporis et al., 2010). For that purpose are also used tasks with specific and situational activities that lasts between 60 and 120 seconds. Intensity is maximal with maximal physiologic reactions of organism. Glycolytic anaerobic trainings are very stressful for the athletes in physical and psychological demands. Also, motivation for those trainings needs to be on high level which is not easy to accomplish for team sports athletes if activity is straight line intensive running. Therefore the aim of this study was to examine the difference in physiological load between straight line running and specific handball task.

Methods

Physiological load was examined with heart rate, perception of exertion and blood lactate concentration. There has been considerable research on exertional perception during exercise, and the findings are reviewed elsewhere (Mihevic et al., 1981; Roberts et al., 1982; Carton et al., 1985). Although the previous studies have proven the effects of high-intensity runs on anaerobic capacities (Laursen et al., 2002; Psotta et al., 2005), there is a need for scientific studies examining effects of specific handball task on anaerobic capacities and their implementation in glycolytic training. Previous study showed that there were no statistically significant differences

between the players' positions when measuring blood lactate and maximal heart rate (Sporis et al., 2010), which means that the same activity can be useful for every player regardless his position in the game. It can be hypothesized that there is no significant difference in physiological load between straight line running and specific handball task of similar duration time.

Subjects

The subjects in this study were 10 healthy amateur handball players from Croatian first and second league, aged 22.50 ±1.35 years, with 10.80±2.53 years of active training who volunteered the experiment. Average weight was 87.9±4.31 kg and height 184.00±5.29 cm. All subjects were informed about procedures. The measurement procedures and potential risks were fully explained to each subject prior to obtaining a written informed consent according to the Helsinki Declaration. The study was approved by the Ethics Committee of the Faculty of Kinesiology, University of Zagreb. None of the subjects were injured 6 months before the testing. Players did not use any nutrition supplements. In addition, subjects were not taking exogenous anabolic-androgenic steroids and other drugs that might be expected to affect physical performance or hormonal balance during this study.

Procedures

The data collecting was done by fifth year Kinesiology students and experienced medicine doctor for blood lactate concentration measurement. Each subject got the instructions 3 days before testing. Subjects were instructed to abstain from alcohol drinks and anaerobic training 2 days before the experiment with considering the regular eating and sleeping. Before the experiment each subject had the exact warming up protocol which consisted of 10 min of warm up running, 10 min of stretching, and 5 x 30m of running exercises. Experiment was done in 2 days at 10am with 72 hours of rest between days in which subjects were instructed to abstain from any training activity and alcohol drinks. In that period subjects were instructed to eat regular mixed food with at least one carbohydrate meal per day and to have regular sleep. In first day of experiment subjects were running 400 m straight distance on the track and field stadium "Mladost" in Zagreb, with outside temperature of 21°C. Collection of data (400m distance running time, Heart Rate and Borg Scale) were immediately after running, while blood lactate concentration (LAC) was measured 1 minute after the running from fingertip of the left hand. In the second experimental day subjects were tested in specific handball polygon on the handball court in the gym of Faculty of Kinesiology in Zagreb (Figure 1). The Lactate Scout analyzer (LS, SensLab GmbH, Germany) was used for lactate analysis.

The sample of variables

Sample consists of three variables: *heart rate (HR)*, *Borg scale (BS)* and *blood lactate concentration (LAC)*. Heart rate (HR) data were collected with hearth rate monitors *Polar RS400,* (Polar- Electro, Kempele, Finland) and results are expressed in beats per minute (b/min). Variable Borg scale (BS) is subjective stress level estimation by subjects after the activity, expressed in 1 to 13 degrees. Degree 1 means *very, very low intensity*, while 13 means *maximum intensity without no energy to continue activity* (2). Blood lactate concentration (LAC) was measured by experienced medicine doctor via a fingertip blood drop with Lactate Scout analyzer (LS, SensLab GmbH, Germany).

Polygon description:

1. *Lateral agility* – subject moves laterally between 4 m distanced lines with maximum speed. Start is on mark "go", moving is laterally without crossing the legs. Outside leg must cross or touch the line and distance between lines must be six times crossed.
2. *Sprint 20 meters* – after the lateral agility subject sprints 20 meters to the basketball backboard
3. *10 two-legged vertical jumps* – when reaching basketball backboard subject does 10 two-legged vertical jumps with touching the backboard with both hands
4. *Jump shot* – after task 3, subject takes the ball from the marked place on the floor and shoots with jump on the goal from 9 m line. After the jump shot subject moves to the mark on the 7 m line
5. *Sprint* – the task is to sprint on the other side of the court to the 6 m line
6. *"Eights"* – the task consists of running around 4 marks which makes rectangle of dimensions 4 m length and 3 m wide located with longer side on the 6 m line. Subject runs two rounds and one more diagonal before running to the next task
7. *Dribble with changes of direction plus jump shot* – after task 6, subject takes the ball from marked place and starts dribbling around 6 marks "zig-zag" positioned 5 m from each other and 3 m wide.
8. *Jump shot* - when dribbling is done, subject shoots on the goal from the 9 m line with jump shot
9. *Sprint with turn in the middle of the court* – after jump shot subject sprints to the other side of the court with turn in the middle and continuing backwards running to the 6 m mark on the other side of the court and starts over again from task 1 if there is time left considering subjects 400 m running

Statistical analysis

The collected data was analyzed by standard statistics software (Statistica for Windows 7.0). Descriptive statistics were calculated for all experimental data. Kolmogorov-Smirnov test was calculated for all variables before analysis to prove the normality of distribution. A t-test for dependent variables was used in order to determine statistically significant differences between the tested variables. The statistical significance was set at $p < 0.05$.

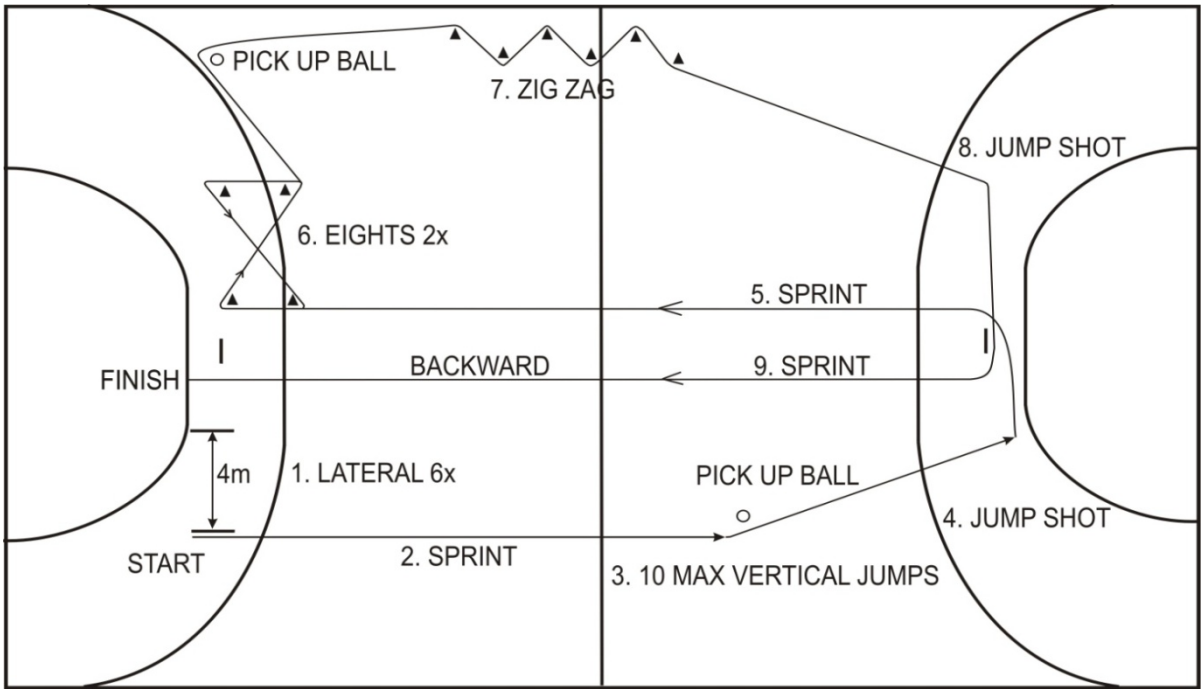

Figure 1. Sheme of the specific handball polygon

Results and discussion

The Kolmogorov-Smirnov test has shown that data was normally distributed. Mean heart rate for 400m straight running was similar as specific handball polygon 187.60±7.40 and 185.80±7.85, respectively. These values show that subjects did the testing with high level of motivation and proper intensity of running. There was no statistically significant difference (p=0.06) in heart rate between straight line running and specific handball polygon (Table 1). Also, there were no significant differences (p > 0.05) between 400m straight running and specific handball polygon in blood lactate concentration (14.60±0.98 mmol · L^{-1} vs. 15.09±0.96 mmol · L^{-1}, respectively) and Borg scale (11.82±1.47 vs. 12.23±1.39, respectively).

Table 1. Differences between straight running and specific handball polygon

	Straight running	Handball polygon	p
Heart rate (beats/min)	187.60±7.40	185.83±7.85	0.06
Borg scale	11.82±1.47	12.23±1.39	0.90
Blood lactate (mmol/L)	14.60±0.98	15.09±0.96	0.17

Based on the results of the experiment and according to the T-test for dependent samples, there were no statistically significant difference between straight running values and specific handball polygon for amateur Handball players.

Comparisons between handball and other team sports are limited by differences in rules, field of play, and duration of the game, but some useful comparisons can be made with other team sports that demand intermittent types of activity (Rebelo et al., 1988). In earlier study (Sporis et al., 2008) authors concluded that more improvement in anaerobic capacity in football players can be accomplished with specific training than with straight line running intervals. They measured heart rate and lactate blood concentration after 300 yard test in two years after different training periods. In first year sprinting intervals were used to improve anaerobic capacity, while in second four minutes situational practice was used. Borg scale is a common physiological tool used to assess perception of effort (Purvis et al., 1981; Baechle and Earle, 2000). In this study according to results in Borg scale, subjects experienced testing as stressful and hard. The estimated levels of stress after 400 m running were between 7 and 13, while after polygon between 5 and 13. Comparing average levels, subjects experienced polygon more stressful and hard than 400 m running. In Table 1 t-test show that there is no statistically significant difference between those two variables (p = 0.82), so it can be confirmed that intensity of anaerobic glycolytic running can also be replaced with specific polygon if goal is improving anaerobic endurance. Differences between lactate blood concentration after 400 m running and polygon were not statistically significant (p = 0.17). Comparing research results with other researchers there is relatively high lactate concentration (14.60 and 15.09 mmol · L^{-1}). Anaerobic endurance was tested among rugby league players with triple-120 meter shuttle test and average blood lactate

concentration was 13.2 mmol L^{-1} (15). Lower concentration was probably due to the longer time (3 minutes) of resting before measurement protocol than in this research. Average lactate concentration among football players of first Croatian football league was measured after 300 yard test (16). Value 15.00 mmol · L^{-1} is similar to the value after specific handball polygon used in this study (15.09 mmol · L^{-1}) which means that intensity in polygon can be similar to the straight line running intensity in 300 yard test which is proven anaerobic endurance test. The HR in handball match remains above 85% of maximum for an average 83% of playing time and the player is engaged in very vigorous physical activity for >80% of a game. In addition and compared with other sports such as basketball, soccer, and rugby, the HR rarely falls below 150 b·min^{-1} (Chelly et al., 2011). The high blood lactate concentrations confirm a great use of anaerobic energy (McInnes et al., 1995), which substantiates the fact that team handball is physically very demanding, with an anaerobic demand greater than that in many team sports. Physiological demands during handball match contributes to finding the right tests for elite and subelite players.

The purpose of this study was to determine is there statistically significant difference in physiological load between straight line running and specific handball polygon. In every variable used in research statistically significant difference was not found. Average blood lactate concentration and average Borg scale stress level was higher after polygon while average heart rate was higher after 400 m running. But, gained differences were too small to be statistically significant.

Activities during Handball game alternate between high intensity sprints and low level aerobic activity coupled with jumping, throwing, and blocking. These physical demands translate into considerable metabolic stress, both aerobic and anaerobic, as exemplified by the elevated lactate and heart rate responses during a match (Cuesta, 1991). Developing anaerobic capacity and its related performance component of strength, power, and speed is integral to success in team handball. Specific handball test is more related to the situational demands than straight line running and it gives more information about specific anaerobic endurance. Use of that kind of activity is better than straight running, especially for top level players.

Conclusion

It can be concluded that both activities can be used in order to improve anaerobic glycolitic endurance in Handball players. Coaches need to decide what is better for their teams or individuals considering the period and fitness condition of their players. Preparation period is more appropriate to use straight line running more than polygon because player's body is not prepared for specific movements at that time. In competition period polygon is more acceptable because it simulates activities during the Handball game. Properly done situational and specific Handball elements in maximum intensity during polygon tasks means that player needs to be concentrated to dribble, shoot, jump and run even the fatigue is getting bigger and conditions are stressful and hard. This kind of training should result with more efficiency in the real conditions of the handball game.

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RAZLIKE U FIZIOLOŠKOM OPTEREĆENJU KOD RUKOMETAŠA ZA VRIJEME PRAVOCRTNOG TRČANJA I KOD SPECIFIČNOG RUKOMETNOG POLIGONA

Sažetak

Cilj ovog istraživanja bio je utvrditi razlike u fiziološkim opterećenjima kod testa trčanja na pravcu (400 metara) i kod posebne rukometne zadaće. Uzorci su bili 10 zdravih osoba amaterskih rukometaša. Ispitanici (uzrasta 22,50 ± 1,35 godina, tjelesne težine 87,9 ± 4,31 kg, a visina tijela 184.00 ± 5.29 cm) trčali su 400 metara na atletskoj stazi kao i na rukometnom terenu u tri pokušaja. Maksimalni broj otkucaja srca i percepcija napora (Borg skala) su mjereni nakon svakog ponavljanja, dok su koncentracije laktata izmjerene nakon zadnjeg ponavljanja. Rezultati su pokazali statistički značajnu razliku maksimalnog broja otkucaja srca (p = 0,06), subjektivne percepcije napora (p = 0,90) i laktata (p = 0,17) između 400 metara i izvođenja posebne rukometne zadaće. Zaključak je da ne postoje velike razlike u fiziološkim opterećenjem od 400 metara i specifičnih rukometnih zadaćak. Obje aktivnosti mogu se koristiti u analizi anaerobni treninga izdržljivosti kod rukometaša, ali specifičan zadatak je prikladniji obzirom na situacijske uvjete..

***Ključne riječi**: anaerobni kapacitet, rukometne zadaće, laktati u krvi, Borgova skala*

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