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THE ANALYSIS OF SOME LOADING AND PHYSIOLOGICAL VARIABLES ON DIFFERENT INTENSE INTERVAL "FAST-BREAK AND QUICK RETREAT" EXERCISE IN TEAM HANDBALL

1.0 Introduction

In order to successfully execute all the activities during a Team handball match, a planned and systematic preparation for player and also the handball team is required. Preparation is based on learning and upgrading of skills as well as a parallel development and maintaining of all for handball important psychomotor abilities. As a result of its dynamics, pace, unpredictability and the appeal, the game of handball is becoming increasingly more are more popular also from the researching point of view.

According to its structure, the game of Team handball is a complex type of sport. Movements that occur during the handball game are either of cyclical and acyclic nature or the combination of both (Bon, 2001). Studying the structure of loading in Team handball and the optimisation of sports training is very difficult due to the complexity of the game. One of the problems presents the interval loading during the handball match, which occurs as a result of the changes in dynamics and the types of loading (Pori, & Sibila, 2006). In the last few years the fundamental problems, according to the structure and dynamics of loading during the matches (Šibila, Vuleta, & Pori, 2004), as well as evaluation of degree of effort in Team Handball (Loftin et.al, 1996; Pori, 2003) were solved. Certain uncertainties have to be considered when explaining the results of effort variables; namely that the data, particularly the absolute values of heart rate frequency and blood lactate in interval loading could be misleading (Wilmore, & Costill, 2004).

The problem of planning the training is extensive in handball. When focusing on endurance training and training of energetic systems, it can be stated that coaches use various methods and means for their development (Cardinale, 2000). When planning the training units, it is desired for better optimisation of trainings for development of energetic systems to select those exercises, which include both technical skills of handball and development of motor abilities. Different methods (continuous, interval, repeating) can be selected within the selection of situational activities.

For better understanding the response of players on different type and duration of loading during the matches and also training sessions, further analyses of typical specific handball exercises is required. In the study of Pori, et. al (2009) first attempts could be seen. The main goal was to compare and analyse some physiological variables in two different types (methods) of handball session. Particularly, they wanted to find out, which energetic mechanisms dominate in interval and continuous situational handball drills and what kind of effort do players of their sample experience under such loading. It seems that the exercises with the continuous type of activities required less

effort from handball players than exercises with the interval types of activities. In average the interval exercises are similar in effort to that established at the matches. Authors consider interval training easier in order to simulate the match conditions from the aspect of energetic demands on the players.

In the present study we were focused on the interval Team handball exercises. The aim of the research paper was to analyze response of the players in some physiological and loading variables on different intense interval “fast-break and quick retreat” exercise in Team handball. Enhanced understanding will contribute to better and more optimal construction of exercises in the Team handball sessions.

2.0 Methodology

2.1 Sample of measured subjects

A group of fifteen well trained team handball players of the third Slovenian handball league (age: 23,3 ± 3,3 yr, height: 184 ± 2 cm, body weight: 87 ± 7,3 kg, training experience: 7,8 ± 3,6 yr) participated in the present study. All the measured subjects were healthy and uninjured during the study.

2.2 Sample of variables

The sample of variables consisted of:

1. Four physiological parameters obtained by the Interval Fitness Test (IFT) 30-15 (V_{IFT} – last completed velocity stage in 30-15 $_{IFT}$; **HR_rest (b/min)** – rest heart rate values ; **HR_max (b/min)** – maximal heart rate values at the end of 30-15 $_{IFT}$; **VO_2 max (ml.kg^{-1}.min^{-1})** – maximal values of oxygen uptake),
2. Seven parameters which describe load of experimental “fast-break and quick retreat” exercise (**P (f)** – Passes; **S (f)** – Shots toward the goal; **J (f)** – Jumps; **U (f)** – Uncovering to the teammate player in the attach phase; **SU (f)** – Stopping up the player in the attack phase; **A/R (s)** - Duration of activity and rest during the “fast-break and quick retreat” exercises (seconds); **V (f)** – Volume of individual fast-break performances),
3. Two physiological parameters which were followed during the experimental “fast-break and quick retreat” exercises (**HR_abs (b/min)** – absolute values of the heart rate frequencies; **HR_rel (%)** – relative values of the heart rate frequencies).

2.3 Data collection methods

Measurements were carried out in three parts. The first part of measurements was carried out by the subjects themselves, as they were required to monitor their heart rate frequency at rest (HR_rest (b/min)) for ten consecutive days on the radial artery of wrist first thing in the morning and also prior to every activity. They counted heart beats in a minute and recorded the result on special forms. An average heart rate frequency at rest was calculated for every individual from daily records.

The second part of measurements was carried out on the handball court. The subjects were measured according to the Interval Fitness Test (IFT) 30–15 protocol, which was conducted according to the procedures outlined by Buchheit, (2008). Heart rate frequencies during the ITF protocol were measured with the Polar heart rate monitors (Polar Precision Performance SW, version 4.03.040, Finland). An electrode transmitter belt was fitted to the chest and monitors around the wrist of each subject, as in-

structed by the manufacturer. Briefly, after warming up, athletes performed 30 seconds shuttle runs interspersed with 15 seconds of passive recovery, having initial velocity of 10 $km.h^{-1}$, with increments of 0.5 $km.h^{-1}$ every 45 s. The 30-15 IFT was performed over a 40 m shuttle distance, within which the subject had to run back and forth at a pace governed by a prerecorded audio signal. During the 15 seconds recovery period, athletes walked in the forward direction to join the closest line from where they started the next stage from a standing position. Exhaustion was defined as the inability to match the covered distance with the audio signal on three consecutive occasions. The last completed stage (V_{IFT} - last completed velocity stage in 30-15 $_{IFT}$) was used to predict VO_2max using the equation, proposed by Buchheit et al. (2008).

Equation used for prediction the maximal oxygen uptake (VO_2 max ($ml.kg^{-1}.min^{-1}$)):

$VO_2max\ (ml.kg^{-1}.min^{-1}) = 28.3 – (2.15 \times G) – (0.741 \times A) – (0.0357 \times W) + (0.0586 \times A \times V_{IFT}) + (1.03 \times V_{IFT})$

Key: G – gender (female = 2; male = 1); A – age; W = body mass

The third part of measurements was carried out on the training session, 48 hours after measurements of Interval Fitness test (ITF). The subjects were asked to refrain from vigorous physical activities in the 24 hours period before testing. They were also instructed to remain in a fasting state in the 3 hour period previous to the training session, and to not ingest beverages containing caffeine and alcohol in the previous 24 hours. Training session was held in Radovljica Sports hall, in December 2009, at 8 pm. Measured subjects were fitted with the Polar heart rate monitors (Polar Precision Performance SW, version 4.03.040, Finland). The heart rate monitors were switched on at the start of warming up protocol and switched off five minutes after last interval exercise. Trainings were also recorded for further analysis of loading variables.

First of all, the subjects performed a standard warm up which consisted of ten minutes low, middle to high intensity basic running exercises, five minutes of dynamic gymnastic exercises and ten minutes of basic handball warm up with the ball in pairs. Subjects then passively rested for five minutes before the start of testing protocol. Testing protocol was consisted of three, five minutes long interval “Fast-break and quick retreat” exercise with five minutes passive breaks between each type of exercise (1vs1 – one player in the attack against one player in the defense; 2vs2 – two players in the attack against two players in the defense; 3vs3 – three players in the attack against three players in the defense). Because of very similar pattern of movement by all three interval exercises (see Figure 1), we did the detail description only for the first exercise “1vs1 – one player in the attack against one player in the defense”.

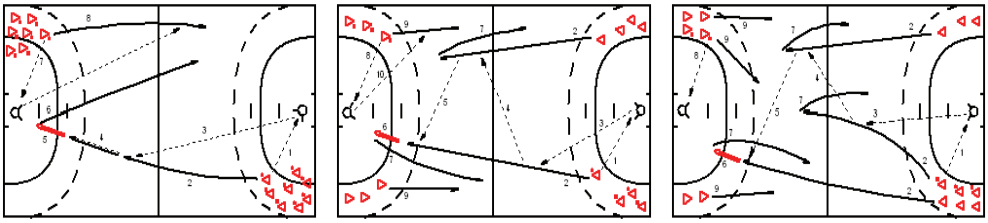


Figure 1. *Selected interval “Fast-break and quick retreat” exercise 1vs1 (1A), 2vs2 (1B) and 3vs3 (1C).*

Description of the exercise “1vs1 – one player in the attack against one player in the defense” (see Figure 1A):

Player with the ball (1) passes the ball to the goalkeeper and quickly breaks from the starting position and sprint directly down the court (2). Upon receiving the ball from the goalkeeper (3), the player accelerates (4) toward the centre of the goal and finishes the fast break with a shot (5). Immediately after the shot, the player starts with a quick retreat in to the defense (6). In between, the player on same side of the court passes the ball to the goalkeeper (7) and quickly breaks and sprints down the court (8). The defense player tries to disrupt and defending the fast-break. In the same way the players continue to repeat the movement on the other side of the court.

2.4 Data analysis

Following procedures and statistical methods were used to analyse and present the data:

1. Data from the heart rate frequency monitors were analysed with the use of Polar Precision Performance SW computer programme (Polar, Finland). Data were transferred from the monitors to the programme with the use of interface.
2. Karvonen model (Fox & Mathews, 1981) was used to calculate relative heart rate frequency, which is based on the calculation of heart reserve (FS % = 100 X (FS ─ FS_rest)/(FS_max ─ FS_rest).
3. Simple descriptive statistics was calculated for all the used variables. Differences between the average arithmetic mean values of loading as well as physiological variables were tested with the General linear model of repeated measures. Statistically significant differences were accepted at the 5% alpha error (two-way testing).

3.0 Results and Discussion

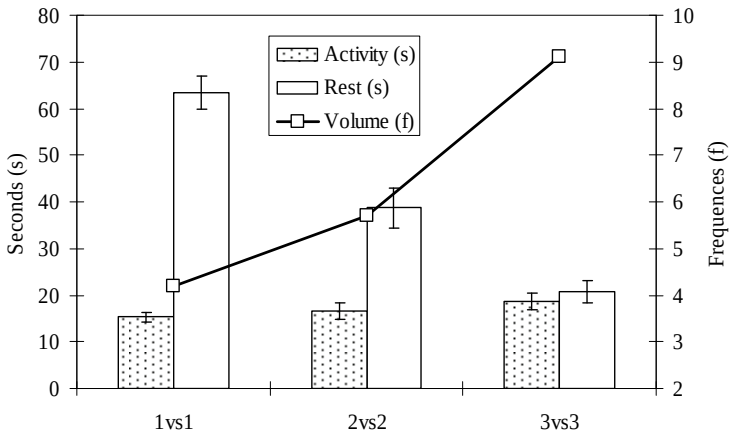
In the Table 1 basics statistical characteristics of the selected parameters obtained by the Interval Fitness Test (IFT) 30-15 are presented. Average values of rest and maximal hear rate frequencies were 55,6 ± 4,7 (b/min) and 190 ± 4,3 (b/min). The last average completed velocity stage of the players of our sample was 19,5 ± 1,4 km/h, while the maximal values of oxygen uptake has on average exceed 50 ($ml.kg^{-1}.min^{-1}$) The obtained data indicates good physical fitness of player of our sample (Vir,P) 2004).

Table 1: *Basics statistical characteristics of parameters followed in IFT 30-15*

	X	SD	min	max	pK-S
V_{IFT} (km/h)	19,5	1,4	18	22	,738
HR_rest (b/min)	55,6	4,7	48	65	,984
HR_max (b/min)	198	4,3	190	206	,902
VO_2 max ($ml.kg^{-1}.min^{-1}$)	50,6	3,1	47	55	,574

Key: V_{IFT} (km/h) – *last completed velocity stage in 30-15 $_{IFT}$;* ***HR_rest (b/min) –*** *rest heart rate values;* ***HR_max (b/min) –*** *maximal heart rate values at the end of 30-15 $_{IFT}$;* ***VO_2 max ($ml.kg^{-1}.min^{-1}$) –*** *maximal values of oxygen uptake;* ***pK-S –*** *significance of Kolmogorov - Smirnov test*

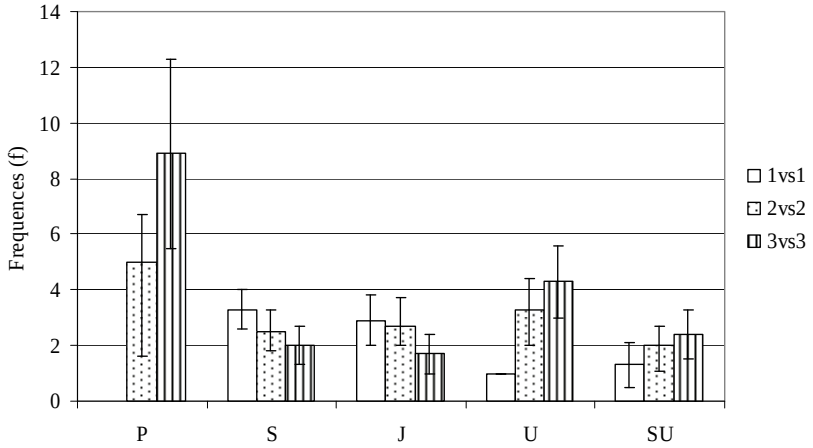
In the Figure 2 we can see the average values of duration of activity and rest periods during selected interval exercises, as well as the average volume of their performances. Average duration of the rest period between single repetitions was highest in the interval exercise 1vs1 (63,4 ± 3,6 seconds) and was statistically significant reduced in exercises where more players were involved ($p<0,05$). Also in average duration of activity phase between selected interval exercises we can confirm statistical significant differences (1vs1 – 15,3 ± 0,9 s < 2vs2 – 16,6 ± 1,8 s < 3vs3 – 18,6 ± 1,7s; $p<0,05$). As a result of reducing the duration of rest periods between different interval exercises (from 1vs1 to 3vc3), were an average increase of volume of “fast-break and quick retreat” exercise performances from 1vs1 to 3vs3 (1vs1 – 4,3 ± 0,7 < 2vs2 – 5,7 ± 0,8 < 3vs3 – 9,1 ± 0,7; $p<0,05$).



Key: 1vs1 – *fast-break and quick retreat exercise 1 against 1;* ***2vs2 –*** *fast-break and quick retreat exercise 2 against 2;* ***3vs3 –*** *fast-break and quick retreat exercise 3 against 3*

Figure 2. *Relations between activity and rest during “fast-break and quick retreat” exercises*

To evaluate the data on loading of players, the average occurrence of selected variables of acyclic activities within interval exercises were included (Figure 3). Statistical significance higher average values in variables “Passes”, “Shots toward the goal” and “Jumps” can be noticed in interval exercise 1vs1 and 2vs2, compared to the interval exercise 3vs3. In the variables “Uncovering to the teammate player” as well as “Stopping up the player in the attack phase” an opposite dynamic of average occurrence of acyclic activities could be seen. The average values of those two variables were statistical significance higher than the average values of the interval exercise 3vs3 ($p<0,05$).



***Key: P –** passes; **S –** shots toward the goal; **J –** jumps; **U –** uncovering to the teammate player in the attack phase; **SU –** stopping up the player in the defense phase*

***Figure 3.** Occurrence of selected variables of acyclic activities within interval exercises*

Physiological response on different intense interval exercises was followed by absolute (HR_abs) and relative (HR_rel) values of heart rate frequencies. Interval “fast break and quick retreat” exercise 1vc1 in average represented less demanding effort (Figure 4). During the interval exercise 1vc1 the average values of HR_abs were calculated on 136,4 ± 8,0 b/min and represented 56,8 ± 6,9 % of maximal heart rate frequencies (HR_max). The results showed that the interval exercise 3vs3 was the most demanding. The average HR_asb was 177,7 ± 5,3 b/min (85,9 ± 5,8 % of HR_max). Differences are statistical significance different ($p<0,05$).

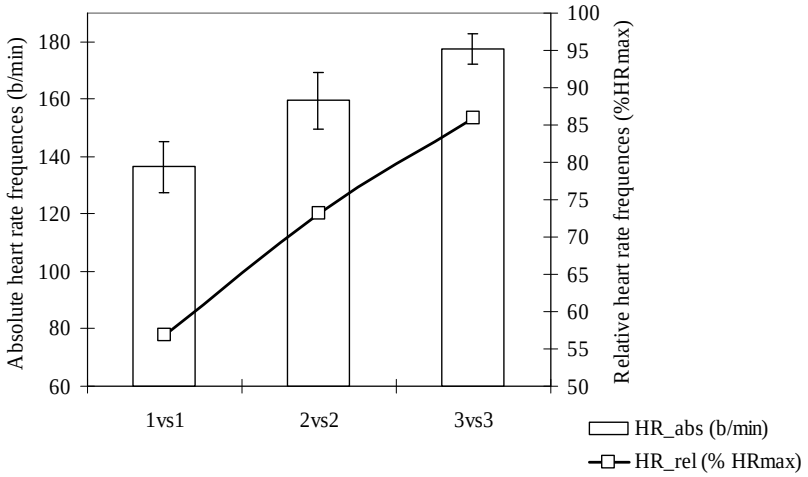


Figure 4. *Absolute and relative values of heart rate frequencies within interval exercises*

For our opinion, the main reason for such physiological response of players lies in the length of the rest intervals between different “Fast-break and quick retreat” exercises. During the interval exercise 1vs1 average rest periods were about one minute long, while the rest periods during interval exercise 3vs3 were reduced to approximately 20 second. As a result of shorter periods of rest between performances, average volume of individual performances increased. During the interval exercise 3vs3 the average volume of players was 9,1 ± 0,7, while playing 1vs1 only 4,3 ± 0,7 fast breaks with quick retreats were performed.

It seems that the physiological response of players during the interval “Fast-break with quick retreat” 3vs3 is the most closely related with the results of similar studies, made on the sample of the team handball players during the handball matches. The average absolutes values of the heart rate frequencies, according to different authors, ranging between 145 – 190 b/min (VIR), while players are on average more 75% of playing time exposed to the effort over 80% HR_max (Cardinale, 2000). Dispersion of the average heart rate values in the various researches can occur as a result of the match importance (friendly, official match), the quality level of the analyses players and the quality level of the opposite team (Pori, 2003).

Team Handball is in fact a fast paced game that requires high-intensity movements to be repeated in very short periods of rest, based upon the technical and tactical situations. Portions between loads and rest periods, according to some previous studies showed, that those two intervals repeatedly exchanged in approximately 20 second long periods, during the handball matches (Kotzamanidis, et.al, 1999).

4.0 Conclusion

Understanding the physiological demands of the specific handball exercises, will help coaches for better optimization of the training plan and more precise manipulating between the volume and intensity of the training sessions throughout the competitive season. It has to be particularly emphasised that loading in the Team handball cannot be as precisely planned as for example in cyclical sports. Nevertheless, for development of handball abilities and despite different practice, the principle of individual approach in the process of handball training is of key importance. The specific interval handball exercises that we use in present study could be very suitable from the endurance preparation aspect. In order for a player to sustain the loading, good working of cardio-vascular system is required and the interval methods have a great influence on the working of this system.

5.0 References

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SUMMARY

The aim of the study was to analyze response of the players in some physiological and loading variables on different intense interval "fast-break and quick retreat" exercise in Team handball. A group of fifteen well trained team handball players of the third Slovenian handball league (age: 23,3 ± 3,3 yr, height: 184 ± 2 cm, body weight: 87 ± 7,3 kg, training experience: 7,8 ± 3,6 yr) participated in the present study. The sample of variables consisted of six physiological and five loading variables. Differences between the average arithmetic mean values of loading as well as physiological variables were tested with the General linear model of repeated measures. It seems that the physiological response of players during the interval "Fast-break with quick retreat" 3vs3 is the most closely related with the results of similar studies, made on the sample of the team handball players during the handball matches. The specific interval handball exercises that we use in present study could be very suitable from the specificsendurance preparation aspect.