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Post-Exercise Heart Rate Recovery Pattern and Body Composition In Different Team Sports: Insight of Players Condition

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ABSTRACT

Body composition and post-exercise recovery capacity is a key factor for sports performance. The present study investigates athletes' post-exercise heart rate recovery patterns and body composition in different ball games, aiming to provide valuable insights into their physiological conditioning. The research delves into the relationship between heart rate recovery dynamics and body composition parameters, such as muscle mass, body fat percentage, and overall body mass, among players from diverse ball game backgrounds. In the present research, thirty male university-level football, basketball, and volleyball players participated on a volunteer basis. Out of them, 10 were football players, 10 were basketball players and least 10 were handball players. Post-exercise heart rate recovery time measured in two days. Measurements of weight, height, and two skinfolds (triceps and subscapular) were used to determine the participant's body composition. Where necessary, the LSD test was employed as a post hoc test to pinpoint the precise site of differences. The statistical program SPSS (version 25) was used to do the statistical computation. After 90 seconds, the heart rate (HR) was almost parallel in all three groups of players. The football players have superior HRR time than the handball players, but the HRR time of the basketball players is greater than that of both football and handball players. Football players and basketball players have significantly faster recovery HR than handball players. In total finding the basketball players is superior than that of football and handball players.



1. INTRODUCTION

Playing team sports is a great way to meet the basic human need for movement, cooperation, and competition. It also increases physical, emotional, and mental engagement as players strive to outsmart and outlast their opponents [1]. A game utilizing a ball than it called ball games such as football, basketball, handball, volleyball, baseball and game without ball called non-ball game such as gymnastics, athletics, kabbadi [2, 3]. Present study deigned on football, basketball and handball players all of the ball games are Olympic game.

Now worldwide sports scientists declare that human body is the most studied subject of science [4, 5]. In the time of training plane a physical education teacher or a trainers attention on players talent, capacity and body composition, all are associated with performance in elite sports

person [6]. Physical fitness, often equated with motor fitness, is essential for executing movement-based activities, including sports [7, 8]. Among the key concerns in sports science today is heart rate recovery (HRR), a critical indicator of cardiovascular efficiency and recovery capacity [2].

In order to improve the adaptation cycle during gaming and sports training, post-exercise recuperation is crucial [1]. Heart rate recovery (HRR) is defined as the difference between peak HR during exercise and exactly 1 min or 2 min into the recovery period after exercise and an HRR value less than 12 beats/min or less than 22 beats/min at 1 and 2 min into the recovery period respectively was found abnormal [2, 9]. Athletes can return to their normal physiological and psychological state as soon as possible after training and competition through recovery [2].

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There are two types of heart rate recovery (HRR) firstly active recovery and passive recovery [10]. Another type of recovery is called “training recovery” and training recovery is the recovery between successive workouts or competitions [11].

Body composition determines human body performance. The distribution of bone, muscle, fat, and other components that make up your body is referred to as your body composition [12]. It is frequently stated as the proportion of lean body mass and/or fat in the total weight of the body [12]. It is possible to interpret a person's physical state and performance by knowing their body composition values [13]. In recent times, it has become very clear that there is a great relationship between body composition and athlete's performance [14]. Numerous clues regarding health, fitness, and nutritional status can be gained from body composition [12].

Body composition refers to the component parts of the body. Recovery is a process that helps an athlete adapt to the adaptation of training. Body composition and HRR are closely related to each other for sportspeople and non-sportspeople. The present research study focused on three ball game players (football, basketball, and handball) post-exercise HRR and their body composition. During the research, some limitations were indicated by the researcher, such as the lack of mental preparedness and willingness of the subjects to take part in exercise; sophisticated gadgets and equipment were not available; and finally, time and finances were also constraining factors of the study. Understanding post-exercise heart rate recovery (HRR) and body composition in team sport athletes is crucial for optimizing performance and recovery strategies. While previous research has examined these factors individually, comparisons across football, basketball, and handball players remain limited. Given the distinct physiological demands of these sports, identifying sport-specific differences in HRR and body composition could provide valuable insights for tailoring training and recovery protocols. Additionally, such findings would help coaches and athletes better understand the physical attributes and cardiovascular adaptations required for peak performance.

2. MATERIALS AND METHODS

2.1 Subjects

This study included thirty (30) male university-level athletes (football, basketball, and handball players) who participated voluntarily. The sample consisted of 10 football players (age:

24±2 years; height: 169±1 cm; weight: 58±0.9 kg), 10 basketball players (age: 21±5 years; height: 176±2 cm; weight: 72±2 kg), and 10 handball players (age: 23±6 years; height: 173±7 cm; weight: 65±7 kg). The participants in this event live in hostels at universities, and they are all between the ages of seven and ten when it comes to their particular sports.

The present study measures all participant post-exercise heart rate recovery time and body composition. Some instruments and tools were used for criterion measures, such as a chest strap heart rate monitor (PolarH-10), a stadiometer scale for measuring height, a digital weighing machine for measuring body weight, a digital stopwatch for measuring time, a treadmill for running (K-Power 5798), and a and a skinfold caliper.

2.2 Procedure

Procedure of Post Exercise Recovery Heart Rate

Data were collected in two successive days: on day 1, the subject was explained about the purpose and procedure of the research. The subject was tested for personal information like age, height, and weight, and thereafter, his resting heart rate was measured from the heart rate monitor after a rest period of 5 minutes in the supine position. Thereafter, the subject was taken to find out his heart rate maximum. From this information, the submaximal load for the subject was calculated. The next day, the subject was taken for a warm-up to raise the basic heart rate to 120 bpm, and thereafter, he was taken for treadmill running with a submaximal load. A change in heart rate was noted on the heart rate monitor after every thirty seconds, and it was continued for five minutes. Thereafter, he was taken to rest in a supine position. In this position, the recovery heart rate from the heart rate monitor is recorded every thirty seconds for five minutes.

Procedure of measuring Body Composition

The subjects' body composition was assessed by measuring height and weight using a Personal Scale Balance Machine (Model DMH 15A) and skinfold thickness (biceps and triceps) using a Lafayette skinfold caliper (Model 01128).

Every participant's height is measured by a stadiometer from head to foot. A digital weighing machine was used for body weight measurements in kg. The participant stands in a relaxed arm-hanging position, and the triceps skinfold is

measured at the upper arm mid-point mark on the posterior surface of the right upper arm [15].

2.3. Statistical Analysis

The obtained data, in the form of numerical scores, was analyzed using statistical procedures to get results and draw conclusions. The mean and SD were calculated as the descriptive statistics. An analysis of variance was used to find out the significance of the inter-group difference. The LSD test was used as a post hoc test to find out the exact location of differences wherever needed. The

statistical calculation was done using the statistical software SPSS (version 25).

3. RESULTS

Increase in heart rate from warm up condition with 120 beats/min was measured after ever thirty second with sub-maximal work load up to 300 sec. After, the change in heart rate during post exercise recovery period was analyzed. The results of such analysis for different ball game players have been presented in Table 1.

Table 1. Mean and standard deviation values of heart rate of different ball game players during post exercise recovery period

Time (s)	Football players	Basketball players	Handball players
0	166.6 ± 7.80	173 ± 6.69	181.8 ± 8.31
30	134.2 ± 5.92	140.4 ± 9.29	143.9 ± 9.59
60	113.6 ± 6.11	120.7 ± 10.02	129.2 ± 8.94
90	105.5 ± 5.85	110.3 ± 6.53	119.1 ± 8.86
120	102 ± 7.22	105.9 ± 7.12	113.4 ± 6.50
150	99.8 ± 7.06	103.9 ± 6.55	108.5 ± 5.62
180	96.9 ± 6.69	99.9 ± 5.82	105.5 ± 6.04
210	94.6 ± 6.56	98.6 ± 6.66	103.6 ± 6.75
240	93.4 ± 7.04	96.6 ± 6.83	101.6 ± 6.29
270	91.9 ± 8.00	94.8 ± 7.26	99.2 ± 6.21
300	89.2 ± 7.13	92 ± 6.87	96.5 ± 6.85

It is seen from the Table 1 values that all the groups of subjects started decreasing heart rate in the post-exercise recovery period with a faster rate

for the first 90 seconds, and thereafter the rate of decrease was slow. The mean values of heart rate at different times have been presented in Figure 1.

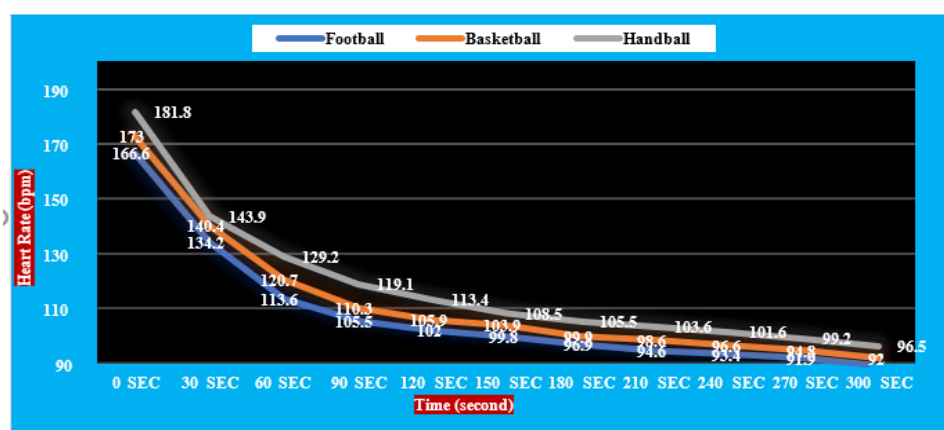


Figure 1. Graphical presentation of post exercise recovery period

In Figure 1, it is also understood that the rate of decrease in heart rate was faster for the first 90 seconds. In order to test the statistical significance of the difference among mean values, the method of analysis of variance (ANOVA) was used for the

first 90 seconds of the post-exercise recovery period and is presented in Table 2.

Table 2. Significant test of first 90 second post exercise heart rate recovery mean values among different ball game players.

	Sum of squares	df	Mean square	F	Significant	Remark
Among Group	951.467	2	475.73	9.178	.001	Significant
Within Group	1399.5	27	51.83			

From the table number 2, calculated 'F' value was significant at 0.001 level. So, it is clear that there was significant difference in recovery heart rate among different group of ball game players. In

order to identify the exact location of the difference the method of least significant difference (LSD) was used. Table- 3 shows the result.

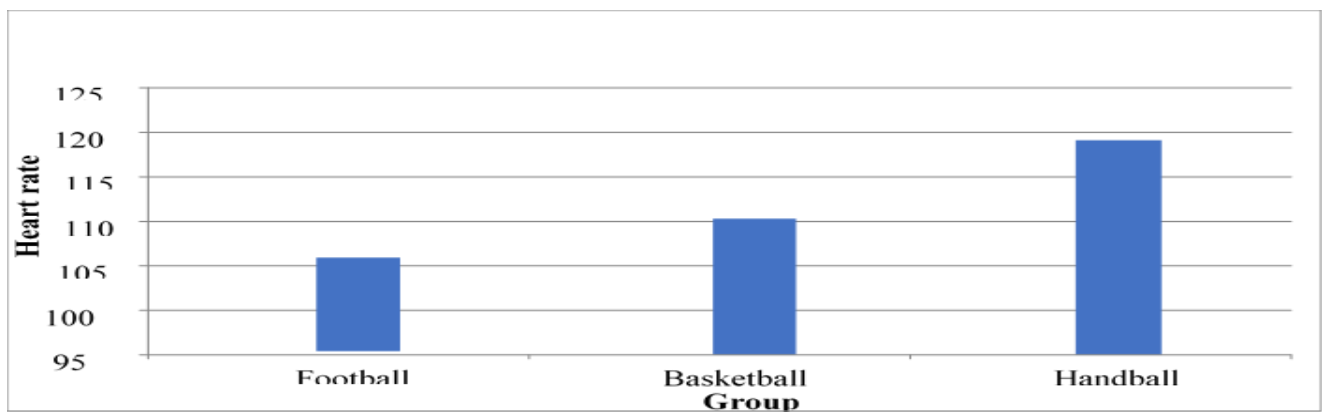
Table 3. Multiple comparisons by LSD in post exercise recovery heart rate for first 90 second.

Group	Between Group	Mean difference	Std. Error	Significant
Football	Basketball	-4.800	3.220	.15
	Handball	-13.600	3.220	.00
Basketball	Football	4.800	3.220	.15
	Handball	-8.800	3.220	.01
Handball	Football	13.600	3.220	.00
	Basketball	8.800	3.220	.01

* The significant level at 0.05

It is seen from Table 3 that the football group of subjects had a significantly faster recovery heart rate than the handball players, but the difference was not significant between the football and basketball groups of subjects. Table 3 also exhibited a significant difference in recovery heart

rate between basketball and handball players. The mean values of post-exercise recovery heart rate for the first 90 seconds of different groups of subjects have been shown in Figure 2. The differences among mean values are clearly understood from the figure.

**Figure 2.** Post exercise recovery heart rate for first 90 seconds for different ball game players.**Table 4.** Mean and standard deviation (Sd) values of different elements of body composition for different ball game players.

Group	Mean and Standard deviation values for			
	Percentage of body fat	Body Weight (kg)	Total body fat (kg)	Lean body mass (kg)
Football	10.91 ± 3.22	58.90±6.20	6.51 ± 2.24	52.37 ± 4.87
Handball	12.87 ± 5.59	65.70±11.10	8.83 ± 5.31	56.86 ± 7.77
Basketball	15.74 ± 5.11	72.18±8.03	11.42 ± 8.83	60.76 ± 7.04

It is seen from Table 4 that the mean values of percentage of body fat for the football, handball, and basketball groups of subjects were $10.91 \pm 3.22\%$, $12.87 \pm 5.59\%$, and $15.74 \pm 5.11\%$, respectively. Table 4 also indicated that the mean values of total body fat for the football, handball,

and basketball groups of subjects were 6.51 ± 2.24 kg, 8.83 ± 5.31 kg, and 11.42 ± 8.83 kg, respectively. Table 4 also revealed that the mean values of lean body mass for the football, handball, and basketball groups of subjects were 52.37 ± 4.87 kg, 56.86 ± 7.77 kg, and 60.76 ± 7.04 kg, respectively.

Table 5. Multiple comparisons by LSD in total body fat

Group	Between Group	Mean difference	Std. Error	Significant
Football	Basketball	-4.914	1.825	.01
	Handball	-2.320	1.825	.21
Basketball	Football	4.914	1.825	.01
	Handball	2.594	1.825	.17
Handball	Football	2.320	1.825	.21
	Basketball	-2.594	1.825	.17

* The significant level at 0.05

It is seen from Table 5 that the basketball group of subjects was significantly heavier in total body fat than the football group of subjects. But

there was no significant difference between the handball and basketball groups in total body fat.

Table 6. Multiple comparisons by LSD in lean body mass

Group	Between Group	Mean difference	Std. Error	Significant
Football	Basketball	-8.427	2.987	.00
	Handball	-4.526	2.987	.14
Basketball	Football	8.427	2.987	.00
	Handball	3.901	2.987	.20
Handball	Football	4.526	2.987	.14
	Basketball	-3.901	2.987	.20

* The significant level at 0.05

It is seen from Table 6 that the basketball group of subjects was significantly heavier in lean body mass than the football group of subjects. But there was no significant difference between the handball and basketball groups in lean body mass.

4. DISCUSSION

Nowadays, the human body is the most researched topic. In recent years, sports training and recovery have been exciting topics all over the world for researchers. Post-exercise HRR included cool-down, periodization, rest, sleep, and many other relaxation techniques. Good body composition and physically fit people are superior in post-exercise HRR to others. Football, basketball and handball players need a high level of physical, tactical and technical skill for better performance.

The present research results clearly show that in all three ball games, players HRR decreased in the first 90 seconds. After 90 seconds, the heart rate (HR) was almost parallel in all three groups of players. As a result, football players and basketball

players have significantly faster recovery HR than handball players. At the same time, post-HRR time between football and basketball players was not significantly different.

Fitness characteristics differed between basketball and football players, and heart rates during recovery time in football players were considerably lower than in basketball players, indicating a preferable adaptation of the cardiovascular system [16, 17, 18].

Some researchers indicated that the differentiation of HRR time among various ball game players depends on differences in playing time, different training methods, and the physical differences that the branch needs [19]. Football players had greater upper-body strength, flexibility, reaction time, and agility than basketball and handball players [17]. Although the metabolic demands of football, basketball and handball games differ, the maximal oxygen consumption did not significantly differ [18]. Soccer players had better reaction time, flexibility, upper body strength, and agility than basketball players, but

basketball players had significantly higher upper body endurance, higher fat percentages, running velocity, grip strength, balance, coordination, explosive power, and jumping power [17]. Basketball players have a greater ability for recovery than football players, as seen by their recovery rating [2]. Our study indicates the mean post-exercise HRR time in the first 90 seconds for football players at 105.5 ± 5.85 bpm and basketball players at 110.3 ± 6.53 bpm. The present research study result and previous study result comply with the relationship between basketball and football players.

Previous research has declared that the aerobic capacity (HRR time) of basketball players is higher compared to that of handball players because of the characteristic features of basketball games and the better physiological capacities of basketball players [19]. At the same time, football players have superior HRR time than handball players. Our study indicates that the mean post-exercise HRR time in the first 90 seconds for handball players is 119.1 ± 8.86 bpm. The present research study result and previous study results are similar between basketball and handball players.

In the body composition part, body fat percentages are not significantly different for all three ball game players. Basketball players total body fat is significantly heavier than that of football players, but there is no significant difference between basketball and handball players. The body mass of football players is significantly lower than that of basketball players; the body mass of handball and basketball players is not significantly different.

The physique characteristics, mainly arm length, forearm length, hand length, tibial length, foot length, and thigh length, are significantly distinct in basketball, handball, and football players' performances [20]. The football players are shorter and have less body weight compared to the basketball and handball players [21]. At the same time, handball players have a greater percentage of fat tissue compared to basketball players [21]. A previous research study concluded that basketball players have superior body mass, body height than football and handball players [22, 23]. In the same study, it was also indicated that handball players have heavier body mass and body height than football players [22]. The present research study evaluated the mean values of lean body mass for football 52.37 ± 4.87 kg, handball 56.86 ± 7.77 kg, and basketball 60.76 ± 7.04 kg. Mean body fat percentage: football players $10.91 \pm 3.22\%$, handball players $12.87 \pm 5.59\%$, and basketball

players $15.74 \pm 5.11\%$. Our study supports the previous research on body composition.

According to the first hypothesis, it was assumed that there would be a significant difference in post-exercise recovery heart rate among the different ball game players. The results of the study indicated that the football and basketball groups of subjects had significantly faster recovery heart rates than the handball group. According to the second hypothesis, it was assumed that there would be a significant difference in body composition among the different ball game players, but the results of the study indicated that the basketball group exhibited significantly higher total body fat and lean body mass than the football group.

This study highlights the importance of physical fitness, particularly heart rate recovery (HRR), for athletes in all three ball games. Handball players, along with their coaches and trainers, should pay special attention to post-exercise recovery time. However, the current study was limited by factors such as the number of participants, budget constraints, time availability, and equipment. Future research should aim to include a larger and more diverse group of ball game athletes, including female participants, to obtain more comprehensive results.

5. CONCLUSION

The present study concluded that all three ball game players decreased their post-exercise HRR time in the first 90 seconds. The football players have superior HRR time than the handball players, but the HRR time of the basketball players is greater than that of both football and handball players. The results of the study indicated that the football and basketball groups of subjects had significantly faster recovery heart rates than the handball players. The results between football and basketball players are significant, but between handball and football players they are not significantly different. This research also concluded that all three ball game players body fat percentages are similar, but the study indicated that the basketball group exhibited significantly higher total body fat and lean body mass than the football group.

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The participants who contributed to this study on an unpaid basis are all appreciated by the researchers.

Conflict of Interest

No conflicting interests have been disclosed by the authors.

Ethics Committee

Ethical standards were adhered to in this study and the participant provided informed consent in the form of a consent form covering research details, risks, benefits, confidentiality and participant rights.

Author Contributions

Study Design YA, TS; Data Collection, TS, FTJM; Statistical Analysis, TS, YA; Data Interpretation, AR; Manuscript Preparation, YA, JFR, TS; Literature Search, YA, TS. All authors have read and agreed to the published version of the manuscript.

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