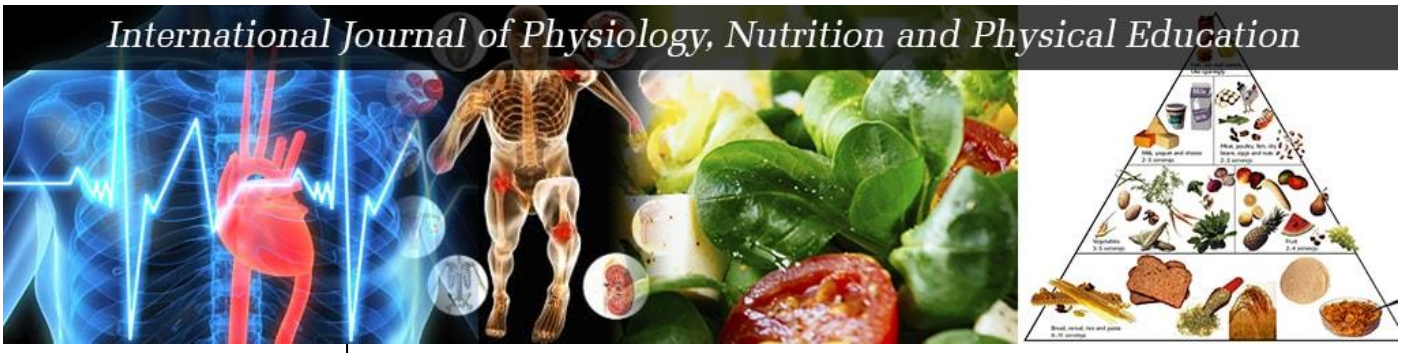


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# Cardiovascular responses to pyramid interval training and basic interval training in male handball players

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**Abstract**
The aim of this study was to compare the acute physiological responses to five bout of high intensity interval exercise within and between pyramid interval training group (PITG) and basic interval training group (BITG) in university male handball players. Twelve (12) male handball players were selected at random as subjects, who volunteered to participate in this study. The result of the study showed that interaction effect of maximum heart rate (HRmax) displayed significance, $F$ = 5.58, $p$ = 0.000, $\eta_p^2$ = 0.203 - large effect but average heart rate (HRave) showed no significance, $F$ = 0.531, $p$ = 0.713, $\eta_p^2$ = 0.024 - small effect. Further, result showed that Pyramid interval training (PIT) found higher than basic interval training (BIT) and both PIT and BIT showed significant difference within the group. It is concluded that PIT had comparative physiological impact like BIT and increasingly valuabl e for the coaches or strength and conditioning coaches to adopt pyramid interval training.

**Keywords:** Maximum heart rate, average heart rate, polar heart rate monitor

## Introduction

High intensity interval training constitutes repeated bouts of high intense exercise and followed by passive or active recovery [1, 2]. Bouts of high intensity stresses both anaerobic and aerobic metabolism that is observed during a handball match [3]. Previous findings show that high intensity interval training enhanced endurance capacity and muscle oxidative capacity in active individuals [4]. During the high intense bout athletes experiences physiological changes which occur as a result of demands imposed on various systems. Therefore, exercise is potent to activate sympathetic nervous system which increases cardiac output, stroke volume, and heart rate to accomplish the demands of the working muscle.

The intensity of the high intensity interval training can be accessed through heart rate (HR), blood lactate and rate of perceived exertion (RPE). However, heart rate is the most common phenomenon for monitoring training intensity during training [5], and several studies have shown heart rate to be a valid indicator of exercise intensity in several major games and individual sports [6, 7].

The high intensity handball specific training revealed improvement in aerobic capacity and repeated sprint ability [8]. High intensity interval training seems to be a popular alternative to the continuous exercise modes traditionally employed for the improvement of fitness. In high performance sports, it has been well documented that the maximum benefits are achieved when the training stimuli are similar to competitive demands [9]. The intensity of the exercise has typically been assessed via heart rate (HR), blood lactate concentration and rating of perceived exertion (RPE). Indeed, heart rate is the most common measure used for objectively monitoring training intensity in many sports [5], and several studies have shown heart rate to be a valid indicator of exercise intensity in several major games [10, 11]. The mean HR and oxygen consumption ($VO_2$) relationship have been reported to be similar during treadmill based intermittent exercise that reproduced the demands of a game [10]. Similarly, several studies have shown that the HR/$VO_2$ relationship established in the laboratory is similar to the HR/$VO_2$ relationship measured at different intensities during different game specific small sided games [11, 6, 7]. Collectively, the findings indicate that HR is a valid measure of exercise intensity during an activity.

Therefore, the aim of this study was to compare the acute physiological responses to five bout of high intensity interval exercise within and between pyramid interval training group (PITG) and basic interval training group (BITG) in university male handball players.

## Methods

### Subjects

Twelve (12) male handball players were selected at random as subjects, who volunteered to participate in this study. These players were selected from the Department of Physical Education and Sports Sciences, Annamalai University, Chidambaram, Tamilnadu during the academic year 2017 – 2018. The selected subjects gave their willingness to participate in this study. The physical characteristics of the handball players are Age: 21.95±1.19 years; Weight: 77.29±4.86 kg; Height: 179.25±4.88 cm; experience: 5.45±1.14 years; percent body fat: 9.14±2.40 %; fat mass: 7.02±2.04 kg and fat free mass: 70.26±4.57 kg.

### Variables and tests

The dependent variables selected in the present study are maximum heart rate and average heart rate which are measured using Polar heart rate monitor. The independent variable selected in the present study was Pyramid interval training (PIT) and basic interval training (BIT). Handball players HR max was calculated using Yo-Yo intermittent recovery level II from this percentage of HR max was calculated.

### Design of the study

Acute physiological responses of PIT and BIT were assessed. PIT was tested followed by one week of active rest BIT was tested. Details of PIT and BIT (Figure 1) are presented. Both PIT and BIT had 5 bouts of exercise with work rest ratio of 1:1 (duration of work is 3 minutes and active recovery between bouts is of 3 minutes duration). The PIT had pyramid shape of work load and BIT had normal work load.

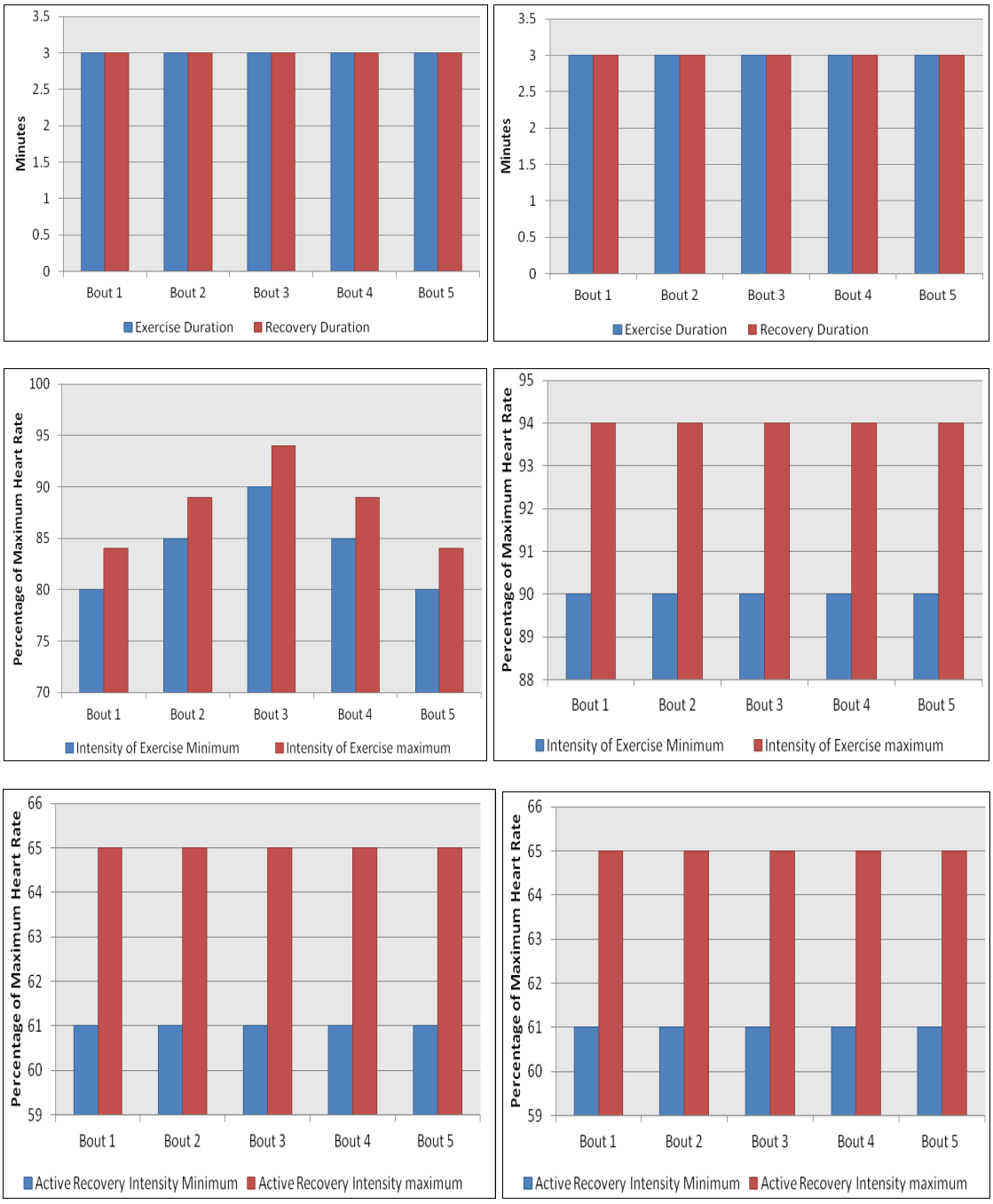


**Fig 1:** Description of exercise and training for PIT and BIT

**Statistical technique**

The acute effect of PIT and BIT on HRmax and HRave were statistically analysed to examine the changes within and between the two procedures. A two-way repeated measure ANOVA with both factor repeated was applied to examine the difference between two procedures and testing conditions. When the interaction was significant simple effect was applied and Bonferroni Post hoc test was applied to examine the paired mean difference between different testing conditions. To elicit differences between the means more meaningful it was expressed with reference to the effect size (ES, Cohen's *d*).

**Results**

***HR max***

The two way repeated measure ANOVA reveals that there is a significant difference between groups (PITG and BITG) in HRmax ($F$ = 16.92, $p$ = 0.000, $\eta_p^2$ = 0.435 - large effect). It is also noted that within PITG and BITG also displayed significant changes in HRmax ($F$ = 42.61, $p$ = 0.000, $\eta_p^2$ = 0.660 - large effect). The interaction between group and bouts showed significance, $F$ = 5.58, $p$ = 0.000, $\eta_p^2$ = 0.203 - large effect. Since the interaction is significant simple effect was calculated between and within PITG and BITG.

The simple effect was calculated between the groups at various bouts on HRmax. Bout 1: $F$ = 1.869, $p$ = 0.185, $\eta_p^2$ = 0.078 - Moderate effect; Bout 2: $F$ = 4.966, $p$ = 0.036, $\eta_p^2$ = 0.184 - Large effect; Bout 3: $F$ = 12.63, $p$ = 0.002, $\eta_p^2$ = 0.365 - Large effect; Bout 4: $F$ = 13.94, $p$ = 0.001, $\eta_p^2$ = 0.388 - Large effect and Bout 5: $F$ = 18.08, $p$ = 0.000, $\eta_p^2$ = 0.451 - Large effect.

The simple effect was calculated within PITG between the bouts on HRmax showed significance $F$ = 12.30, $p$ = 0.000, $\eta_p^2$ = 0.721 - Large effect. The Bonferroni Post hoc test between the bouts showed significance in PITG. Similarly, simple effect was calculated within BITG between the bouts on HRmax showed significance $F$ = 33.76, $p$ = 0.000, $\eta_p^2$ = 0.877 - Large effect. The Bonferroni Post hoc test between the bouts showed significance in BITG.

***H Rave***

The two way repeated measure ANOVA reveals that there is a significant difference between groups (PITG and BITG) in HRave ($F$ = 4.539, $p$ = 0.045, $\eta_p^2$ = 0.171 - large effect). It is also noted that within PITG and BITG also displayed significant changes in HRave ($F$ = 3.207, $p$ = 0.017, $\eta_p^2$ = 0.127 - moderate effect). The interaction between group and bouts showed no significance, $F$ = 0.531, $p$ = 0.713, $\eta_p^2$ = 0.024 - small effect. Since the interaction is not significant simple effect was not applied.

**Discussion**

The present study displayed significant difference between PIT and BIT in HRmax were PIT had greater HRmax compared to BIT. However, PIT and BIT showed significant difference within five bouts and bout 1 recorded greater HRmax in both group. Earlier, Hoff *et al*. [6] found that maximum heart rate is a reliable ways of establishing the exercise intensity carried out on high intensity interval training. In this study, exercise intensity is determined by maximum heart rate during the 5 bouts of the PIT and BIT. The results demonstrated that the PIT recorded significantly higher HRmax than BIT. Furthermore, significant differences were also found in HRmax within five bouts of PIT and BIT.

It can be suggested therefore that both PIT and BIT attained high cardiovascular stress which may provide improvements in $VO_2max$. In addition, considering limited time is spent high intensity exercise in a pyramid and basic interval training, the cardiorespiratory system may be stressed to a sufficient level to stimulate substantial central adaptations [12]. Taken together, these data possibly indicate that improvements in exercise capacity following PIT and BIT are the result of enhanced $O_2$ utilisation at the muscle rather than enhanced $O_2$ delivery through increased stroke volume. It could be deduced that improvements in $VO_2max$ are therefore due to an increase of the arteriovenous oxygen difference, rather than increased maximal cardiac output. It can therefore be suggested that enhanced exercise capacity reported following PIT and BIT programmes is the result display a central adaptations [12].

**Conclusion**

It is concluded that acute responses of PIT and BIT show significant cardiovascular stress for handball players. The acute physiology confirms that central adaptation would occur on aerobic capacity and performance adaptations. Our recommendation, is that integration of PIT had similar physiological effect like BIT and more useful for the coaches to adopt pyramid interval training.

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