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ANALYSIS OF RECOVERY PATTERNS OF HEART RATE AND RESTING PULSE RATE AMONG ATHLETES IN DIVERSE SPORTS AFTER STRENUOUS EXERCISE

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ABSTRACT

This study investigates the recovery patterns of athletes across diverse sports disciplines following strenuous exercise, with a focus on variations in recovery heart rate and resting pulse rate. To achieve this study sixty (N=60) athletes aged 18 to 25 years were selected from the Ramakrishna Mission Vivekananda Educational and Research Institute, faculty of general adapted physical education and yoga, Coimbatore. Representing four sports: basketball, football, handball, and hockey, with fifteen participants from each discipline. All the different sports disciplines treadmill run for 8 minutes. After the exercise between the rest intervals recovery heart rate were checked all the sports disciplines. The pre and post data analysis was conducted using one-way ANOVA to determine significant differences in recovery rates across the among the sports if obtained F ratio is significant the Scheffé post hoc test was employed to identify specific group differences, with a significance level fixed at 0.05.the result of the shows that no significance difference resting pulse rate among four different disciples. There is a significant different between recovery heart rate. Basketball players better recovery heart rate compere with handball players, hockey players, and football players.

KEYWORDS: *Recovery Heart Rate, Resting Pulse Rate.*

INTRODUCTION

Recovery is a vital element in athletic training and performance, as it allows the body to restore physiological and psychological balance following intense physical activity (Kellmann & Kallus, 2001). Two key indicators widely used in evaluating recovery are heart rate recovery (HRR) and resting pulse rate, both reflecting autonomic nervous system responses and cardiovascular efficiency (Buchheit et al., 2009; Borresen & Lambert, 2008). HRR represents the speed at which the heart rate declines after exercise and is directly linked to parasympathetic reactivation (Seiler et al., 2007). A faster HRR indicates superior cardiovascular conditioning and an efficient recovery process (Borresen & Lambert, 2008). Similarly, resting pulse rate serves as a baseline measurement of cardiovascular health and fitness level (Lucía et al., 1999). Sports impose different physical demands on the body. Endurance-based disciplines require sustained aerobic effort, while others involve high-intensity anaerobic bursts or intermittent actions. These differences significantly influence recovery rates among athletes (Impellizzeri et al., 2005; Meeusen et al., 2013).

Analyzing physiological recovery across diverse sports offers insights that can help tailor sport-specific training and recovery protocols. Understanding such patterns is especially important in optimizing training loads and preventing injuries (Saw et al., 2016). Despite advancements in sports science, few comparative studies focus on recovery variations between athletes from different disciplines (Stanley et al., 2013). With the growing importance of individualized training and monitoring, assessing HRR and resting pulse provides a practical approach to track fitness levels and fatigue (Halson, 2014). Recovery evaluation supports decision-making related to performance enhancement, fatigue management, and prevention of overtraining (Smith, 2003; Bishop et al., 2008). The present study explores these variables to contribute meaningful data to coaches, trainers, and sport scientists working across multiple athletic domains.

METHODOLOGY

To achieve this study, a total of sixty athletes in diverse sports players from Ramakrishna Mission Vivekananda Educational and Research Institute- Faculty of General and Adapted Physical Education and Yoga, Coimbatore were selected from four different sports disciplines: Basketball players (15), Football players (15), Handball players (15), and hockey players (15). The age range of the subjects is between 18 to 25 years. Recovery heart rate and Resting pulse rate**.** Four different sports discipline (Basketball players, football players, Handball players and Hockey players)**.** All the different sports disciplines treadmill run for 8 minutes. After the exercise between the rest intervals recovery heart rate were checked all the sports disciplines.

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Table – I
ANALYSIS OF VARIANCE ON RECOVERY HEART RATE OF VARIOUS DIVERSE SPORTS PLAYERS

Dependent Variable	Groups	Mean	Source	Sum of Squares	Df	Mean Square	F
1 - 1.5 min	Basketball	133.84	Between Groups	1215.896	3	405.299	12.058*
	Football	141.853					
	Handball	145.720	Within Groups	1882.273	56	33.612	
	Hockey	143.660					
2 - 2.5 min	Basketball	121.993	Between Groups	1234.225	3	411.408	19.530*
	Football	130.820					
	Handball	134.040	Within Groups	1179.659	56	21.065	
	Hockey	126.507					
3 - 3.5 min	Basketball	81.780	Between Groups	4187.339	3	1395.780	22.314*
	Football	95.053					
	Handball	96.147	Within Groups	3502.928	56	62.552	
	Hockey	105.193					

*significant level of significant 0.05, with table value 2.76 and Degrees of Freedom (3,56)

This analysis of variance (ANOVA) table presents the differences in recovery heart rates across four groups over various intervals (1-1.5 min, 2-2.5 min, 3-3.5 min) and resting pulse rate. The "Between Groups" sum of squares for recovery heart rate intervals increases with time: 1215.896 at 1-1.5 minutes, 1234.225 at 2-2.5 minutes, and 4187.339 at 3-3.5 minutes. This increase indicates greater variability between groups as time progresses, with the mean square values also rising from 405.299 to 1395.780. The high F-values for recovery intervals (12.058 at 1-1.5 min, 19.530 at 2-2.5 min, and 22.314 at 3-3.5 min) are statistically significant ($p < .001$), suggesting significant differences in recovery rates between groups at each interval.

TABLE-II
SCHEFFES'S POST HOC TEST FOR MEAN DIFFERENCE AMONG DIVERSE SPORTS PLAYERS VARIOUS INTERVAL TIME OF RECOVERY HEART RATE

Dependent Variable	Group	Group	Mean Difference	CI
1 - 1.5 min	Basketball	Football	8.0133*	5.74
		Handball	11.8800*	
		Hockey	9.8200*	
	Football	Handball	3.8667	
		Hockey	1.8067	
	Handball	Hockey	2.0600	
2 - 2.5 min	Basketball	Football	8.8267*	4.56
		Handball	12.0467*	
		Hockey	4.5133	
	Football	Handball	3.2200	
		Hockey	4.3133	
	Handball	Hockey	7.5333*	
3 - 3.5 min	Basketball	Football	13.2733*	7.83
		Handball	14.3667*	
		Hockey	23.4133*	
	Football	Handball	1.0933	
		Hockey	10.1400*	
	Handball	Hockey	9.0467*	

From the table – II, the Scheffe post hoc test results indicate significant differences in recovery heart rates across different sports groups. In the 1-1.5 minute interval, basketball players have significantly lower recovery heart rates compared to football, handball, and hockey players, with mean differences of 8.0133, 11.8800, and 9.8200, respectively ($p < .05$ for all). However, no significant differences were observed between football, handball, and hockey in this interval. In the 2-2.5 minute interval, basketball players again show significantly lower recovery heart rates than football and handball (mean differences of 8.8267 and 12.0467, $p < .001$), while the difference with hockey is not statistically significant ($p = .076$). Additionally, handball players have a significantly higher recovery heart rate than hockey players (mean difference of 7.5333, $p < .001$). By the 3-3.5 minute interval, basketball players' recovery heart rates are significantly lower than those of football, handball, and hockey players ($p < .001$ for all comparisons), with the largest mean difference observed between basketball and hockey (23.4133). Football players also show significantly lower

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recovery heart rates compared to hockey (mean difference of 10.1400, p = .010), and handball players show significantly lower recovery rates than hockey as well (mean difference of 9.0467, p = .028). These results suggest that basketball players consistently have the fastest recovery rates, while hockey players exhibit slower recovery, especially in the later intervals.

Figure – 1
BAR DIAGRAM SHOWING THE MEAN VALUES OF RECOVERY HEART RATE AMONG VARIOUS DIVERSE SPORT PLAYERS

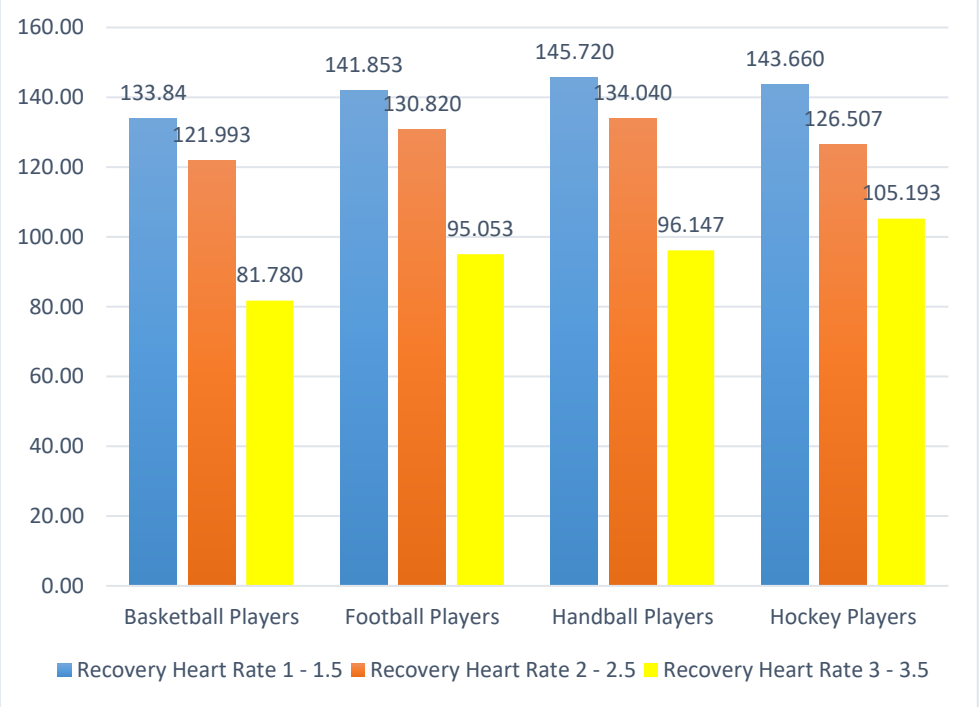

Table –III
DESCRIPTIVE STATISTICS OF RESTING PULSE RATEOF VARIOUS DIVERSE SPORTS PLAYERS

Group	Descriptive Statistics	Resting pulse rate
Basketball	Mean	66.933
Football	Mean	66.133
Handball	Mean	68.000
Hockey	Mean	67.200

Resting pulse rate are fairly consistent across all groups, with mean values ranging from 66.1 bpm (football) to 68 bpm (handball). Basketball players exhibit the widest range of resting pulse rate (16 bpm), while football and handball have narrower ranges, suggesting similar levels of resting pulse rate stability across sports.

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Figure –2
BAR DIAGRAM SHOWING THE MEAN VALUES OF RESTING PULSE RATE AMONG VARIOUS DIVERSE SPORT PLAYERS

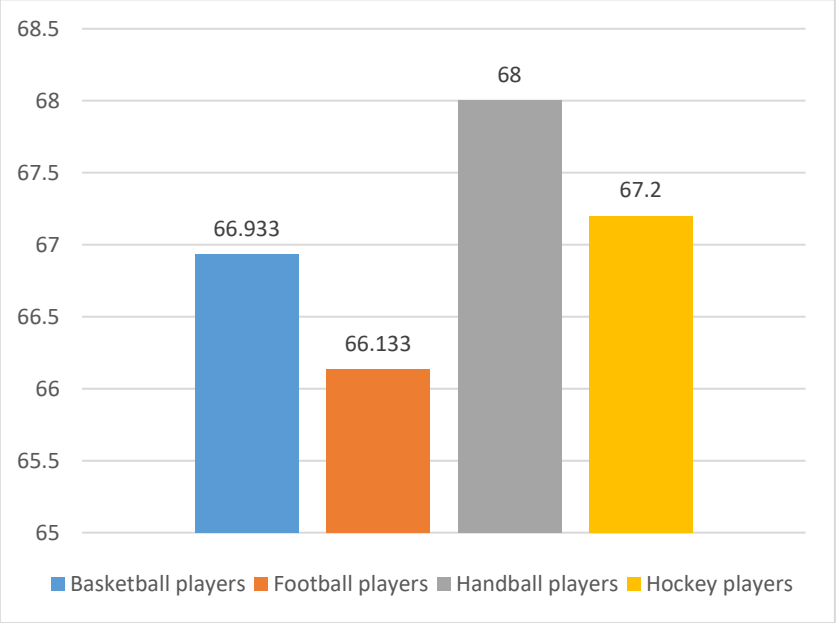

Table-IV
Analysis of variance on resting pulse rate of Various diverse sports players

Dependent Variable	Source	Sum of Squares	Df	Mean Square	F
Resting pulse rate	Between Groups	26.667	3	8.889	.478
	Within Groups	1041.067	56	18.590	

No significant level of significant 0.05, with table value 2.76 and df (3,56)
In contrast, the "Between Groups" sum of squares for the resting pulse rate is only 26.667, with a mean square of 8.889 and an F-value of .478, which is not statistically significant (p = .699). This result suggests that while there are significant differences in recovery heart rates between groups across intervals, there is no significant difference in resting pulse rate between the groups. The smaller mean square and sum of squares values for resting pulse rate, coupled with a high p-value, indicate a stable and consistent resting pulse rate across the groups, unlike the more variable recovery heart rates observed over time.

DISCUSSION ON FINDINGS

The findings indicate that handball players exhibit the highest mean recovery heart rates across intervals, while basketball players consistently show the lowest. This pattern may reflect differences in the physical demands and training intensities associated with each sport. Handball is typically characterized by short bursts of intense activity and high levels of endurance, which may explain the higher recovery heart rates observed in players as their cardiovascular systems work to return to a baseline state after exertion. Basketball, on the other hand, though also physically demanding, involves a mix of aerobic and anaerobic activities that might lead to faster recovery, reflected in the lower mean recovery heart rates. These differences underscore how sport-specific training and play patterns can influence recovery rates among athletes.

Hockey players, however, show the most variability in recovery heart rates, as evidenced by higher standard deviation values and a wider range, especially in later intervals. This variation may stem from the diverse physical conditioning levels and physiological responses among players, possibly due to the sport's reliance on both intense sprints and periods of rest. The larger range could also suggest differences in recovery efficiency and fitness levels among hockey players, indicating that not all players may be at similar endurance and recovery thresholds. In terms of resting pulse rate, similarities across all groups suggest a common baseline of cardiovascular health and conditioning among athletes, regardless of sport. The minor differences in mean and range point to stable resting pulse rate, indicating that while recovery dynamics may vary widely between sports, the athletes maintain comparable levels of resting fitness. This consistency in resting pulse rate reinforces those differences in recovery heart rates are more likely attributable to the nature of each sport and its specific demands, rather than baseline cardiovascular fitness differences among the athletes.

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To interpret these findings in light of existing research, studies have shown that athletes' recovery heart rates often vary depending on the intensity and nature of their sport. Research suggests that sports requiring intense bursts of activity, like handball, lead to higher post-exercise heart rates as the cardiovascular system works harder to return to baseline levels. A study by (Giliard et al. 2022) supports this, indicating that athletes in high-intensity, intermittent sports show prolonged recovery heart rates compared to those in mixed-aerobic sports, such as basketball, where players generally recover more quickly due to a balanced mix of aerobic and anaerobic demands.

Furthermore, variability in recovery heart rates observed in hockey players aligns with findings from research on athletes involved in high-contact sports with irregular exertion patterns. Recovery heart rate is notably faster in basketball players than in soccer and field hockey athletes, suggesting a more efficient recovery process post-exercise (Anjali et al., 2018). The reveal that such variability often results from diverse fitness levels and physiological adaptations among players, reflecting differences in recovery efficiency and conditioning within the same sport. Lastly, the similarity in resting pulse rate across all groups is consistent with studies suggesting that trained athletes, regardless of their sport, tend to develop similar baseline cardiovascular adaptations (Christoph et al., 2018), supporting the idea that observed differences in recovery rates are more closely tied to the sport's specific physiological demands rather than baseline fitness levels.

CONCLUSIONS

The study revealed significant differences in recovery heart rates among athletes from different sports. Basketball players consistently demonstrated faster recovery, indicating more efficient cardiovascular recovery. Handball players showed the highest recovery heart rates, likely due to the sport's high-intensity demands. Hockey players exhibited the widest variability, suggesting inconsistent recovery patterns across individuals. In contrast, no significant difference was found in resting pulse rates across all groups.

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