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Optimizing Performance in Collegiate Level Handball: A Comparative Study of High-Intensity Interval Training and Fartlek Training on Speed and Aerobic Capacity

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Abstract: This group study aims to compare the effects of High-intensity Interval Training (HIIT) and Fartlek Training in two of the factors critical to performing- speed and aerobic capacity. These were measured through a Speed Test and the VO₂- 1 Mile Test. 32 collegiate male handball players, aged 19 to 25 years, are randomly assigned to two groups: Group I (HIIT) and Group II (Fartlek), with 16 players each. The six-week training program approaches HIIT without added resources, which consists of short bursts of maximal effort (60-minute sessions, three times a week) and Fartlek with a diversity of paces in running (60-minute sessions, three times a week). The Speed Test showed that Group I (HIIT) had a quicker mean sprint time of 4.43 seconds (SD = 0.36) when compared to Group II, who recorded 4.90 seconds (SD = 0.52) for the Fartlek group. The mean difference (MD) was estimated to be -0.47 seconds and was statistically significant ($t = -2.96, p < 0.05$) in Favor of HIIT getting significantly positively enhanced with respect to sprint performance and acceleration. Similarly, in the VO₂ - 1 Mile Test, Group I was found to have a mean VO₂ max value of 13.65 ml/kg/min (SD = 0.43) and Group II with a slight elevation achieved a mean of 14.00 ml/kg/min (SD = 0.62). Such MD (MD=-0.36) and t-value (-1.89) tells that there were trends towards a higher aerobic capacity in Group II though it did not show statistical significance. It appears that HIIT is more efficient than other types of exercise for improving acceleration because it activates fast twitch muscle fibers and engages explosive power. VO₂max could be significantly improved with both forms of training. HIIT can be used by coaches during speed work training, and Fartlek could assist endurance. Future studies could integrate these innovative modes into one research design for more comprehensive athletic performance enhancement.

Keywords: Handball, High-Intensity Interval Training, Fartlek Training, VO₂ max, Acceleration, Collegiate Athletes.

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INTRODUCTION

Being a dynamic team sport, handball has gained worldwide recognition and attracted players and fans from different parts of the world. This sport is of high intensity and requires specific skills and techniques, including ball shooting, passing, dribbling, and tactical positioning, for its Effective offensive and defensive strategies are needed to score and prevent goals. According to (Chittibabu, 2014), the physical demands of the game are high since players engage in multidirectional movements with sharp accelerations and decelerations while running between 4500 and 5000 meters in a normal 60-minute match (Michalsik *et al.*, 2012). The success of the sport depends on neuromuscular abilities-speed, agility, and endurance-highly required for repeated executions of high-intensity actions such as sprints, jumps, and fast-changing direction during long periods of both physical and mental pressure (Dello Iacono *et al.*, 2015). The sport of handball has an intermittent nature, characterized by explosive bouts of activity followed by short recovery periods; thus, it would require extraordinary aerobic and anaerobic endurance. Research shows that more than 1000 directional changes are made by players in a single match, emphasizing the need for rapidity and aerobic

capacity to sustain high performance during a match (Póvoas *et al.*, 2012) (Belka *et al.*, 2016).

VO₂ max or maximal oxygen consumption is one of the most characteristic physiological markers to refer to an athlete's aerobics capability, reflecting the quality of oxygen delivery and utilization during strenuous exercise (Viaño-Santamarinas *et al.*, 2017). This characteristic relates directly to the handball game since players with a high VO₂ max can perform longer activities, postponing fatigue and attaining faster recovery after high-intensity efforts. Just as important is acceleration: it dictates the athlete's ability to reach target speed as quickly as possible-basic need for effective offensive movement and defensive reaction (Han *et al.*, 2023).

Training methods Fartlek or HIIT trainings really do work in improving VO₂ max and accelerations (Han *et al.*, 2023), whereby Fartlek is a Swedish term, which literally translates to "speed play" and is defined as running fast and slow periods alternately, similar to the variable speed pacing used in handball (Póvoas *et al.*, 2012). This adaptation leads to improvements of both aerobic and anaerobic systems and consequently prepares athletes for successful performances according

to the demands of the sport. HIIT deals with short intense burst activity exercises followed by brief recovery periods. All these characteristics of HIIT combine to be very effective in increasing an individual's VO2 max, encouraging recruitment of fast-twitch muscle fibers, and producing explosive power-all essential factors in handball performance (Alonso-Fernández *et al.*, 2017).

While both training modalities have unique advantages; however, their relative benefits in improving VO2 max and acceleration among handball players have yet to be uncovered. Comparisons of these modalities would serve as relevant empirical investigations in terms of optimizing training for the sport. Understand the specific advantages afforded by Fartlek and HIIT so that coaches can create programs according to the specific physiological and tactical demands of handball (Hermassi *et al.*, 2016). This research is all about the comparison between Fartlek training and HIIT training programs with respect to VO2 max and acceleration. This research will analyze the performance values before and after training to find which method might be more effective in improving those vital qualities. The results will contribute to the development of evidence-based preparation strategies allowing players to perform optimally in the face of ever-increasing trials of competitive handball.

METHODS

An experimental study design, two group randomized pre-test and post-test, was then set up. The study recruited 32 males aged 19-25 with BMI ranging from 19-25 kg/m². All these participants are robust collegiate handball players with a minimum of one year experience. The subjects were excluded from the study if they had either recent injuries, psychological instabilities, or any unwillingness to participate.

Grouping and Training Protocols: To form groups for the study, the participants were randomly divided into Group I and Group II. Each of the two groups had 16 players. The groups followed the under-mentioned training protocols for a period of six weeks:

- Group I: High-Intensity Interval Training (HIIT) of 60 minutes per session for three sessions weekly is Group I. Each session included warm-up and cool-down periods.
- Group II: Fartlek training involves continuous running at various speeds for 60 minutes per session, done thrice a week.

Assessments: Before the training intervention as well as after the measure of VO2 max and acceleration of the players were taken using the following tests:

- 30-Meter Sprint Test: Assessment of speed of acceleration and speed over a very short distance.
- One-Mile Run Test: evaluates the endurance capacity of the athletes to ascertain their VO2 max.

Statistical Techniques

Evaluation of the effects of the intervention on training contexts was employed in statistical procedures to analyze results. Mean and standard deviation measures were computed descriptively for VO2max and sprint performance within both groups, presenting a clear picture of how data spread (Öztürk *et al.*, 2023). The independent t-test was applied in testing for differences between the intervention or groups, as explained by (Ilić *et al.*, 2015). At $p < 0.05$, these applied methods helped to determine further observation of the differences in the metric. A paired t-test was then performed to investigate the assessed significant changes that occurred through the various forms of training within a pre-and post-test by being set at 0.05 to show a concerning comparison between the two groups because this might show a differential effect between High-Intensity Interval Training (HIIT) and Fartlek training on performance gains.

Table 1: HIIT Protocol

Stage	I	II	III	IV
S-1	High knee run	Plank Punch	Jumping Jacks	Side Skaters
S-2	Jump Rope	In/Out Boat	Line Jumps	Push-ups
S-3	Burpees	Russian twists	Full Squats	Split Lunges
S-4	Mt. Climbers	Push-ups	Split Squats	Box Jump

Table 2: Fartlek training protocol

TYPES OF RUNNING	DURATION
Jog	15 mins
Trail Run	4 phase - 7 mins
Interval Sprint	120 seconds
Backward Pace Run	30 seconds
Interval Walk	1mins
Repetitive 5 Sets	25 mins

RESULTS

As shown in Table 3, the analysis of data from speed tests for Groups I and II clearly indicates differences between the two groups.

Table 3: 30 Mtrs Sprint Speed Test Performance Data Comparison

SPEED	MEAN	MD	SD	't' Value
G-I	4.43	0.47	0.36	2.96
G-II	4.90		0.52	

When it comes to Group I, it possesses a mean score lower than Group II, that is, $M = 4.43$ and $SD = 0.36$ compared with $M = 4.90$, $SD = 0.52$, with a mean difference (MD) of -0.47 . Besides, the measures of variation in the standard deviation show a slightly higher deviation in Group II compared to Group I. The t-test result states that the t-value is -2.96 , which gives a strong evidence for a statistically significant difference between the two groups. Hence, this result indicates that the

difference observed in performance between Group I and Group II is not likely due to chance. An investigation could also follow this to find the factors that made the

difference between the two groups in performances since the processes must have affected them.

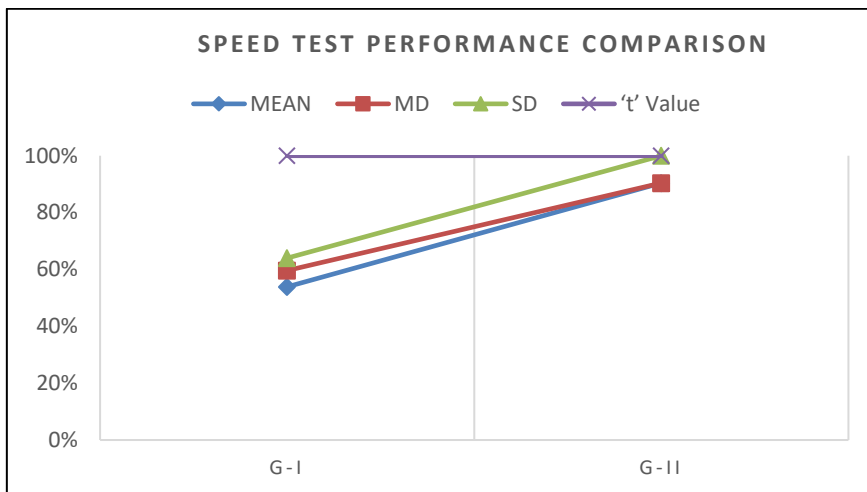


Figure 1: Speed Test Performance Comparison

Table 4: VO2 - 1 Mile Test Performance Data Comparison

VO ₂ Max	MEAN	MD	SD	't' Value
G-I	13.65	0.36	0.43	1.89
G-II	14.00		0.62	

As for the analysis of the VO₂-1 Mile Test results for Groups I and II as outlined in the above table 4, there is quite an observable difference between the two groups. While Group I has a mean score of M=13.65 (SD=0.43), Group II has an M=14.00 (SD=0.62) and an MD -0.36. There is a higher standard deviation for Group II; therefore, the performance variability is greater compared to Group I. A t-test analysis for that significant

difference resulted to a t-value of -1.89. Although it suggests a trend toward difference between the groups, the result may not meet the threshold for a statistically significant outcome depending on which alpha level is applied (e.g., $p < 0.05$). It can be examined further as to other probable causes where this difference in VO₂ performance could lie between the two groups.

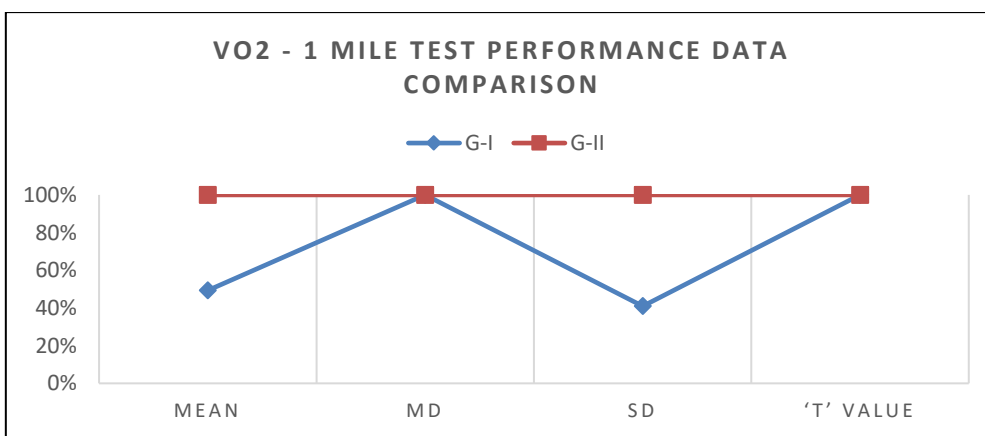


Figure 2: VO2 - 1 Mile Test Performance Data Comparison

DISCUSSION ON FINDINGS

Further, it has been shown that High-Intensity Interval Training (HIIT) is significantly more beneficial in developing acceleration and sprint performance which can be reckoned from the Speed Test results (Alonso-Fernández *et al.*, 2017). Group I (HIIT) presented a better mean sprint time (M=4.43 seconds, SD=0.36) compared to Group II (Fartlek) (M=4.90 s; SD=0.52), providing a

mean difference (MD) of -0.47 seconds. The significant difference is confirmed statistically by a t-value of -2.96 ($p < 0.05$). This is indicative of the capability of HIIT to activate fast-twitch muscle fibers, thus improving explosive strength, which makes it most applicable to sports that require rapid acceleration (Buchheit *et al.*, 2010; Schumann, 2022) and to short-duration speed performances. These results can, however, be inferred to

be of great value in the foreseeable future for an athlete who intends to compete by improving athletic performance on track, soccer, or basketball fields.

In terms of aerobic capacity, as measured at VO₂-1 mile test, both groups recorded slight gains: Group I reached a mean value of 13.65 (SD=0.43) and Group II reached 14.00 (SD=0.62). The mean difference between groups (MD) of -0.36 and t-value of -1.89 suggest an emerging trend favoring Group II (Fartlek); however, according to (Cherif *et al.*, 2012), this was insignificant statistically. This indicates that all forms of training are almost equally efficient in developing VO₂ max except for slightly varied individual performance of Group II. From this point, it is concluded that HIIT is better in terms of speed and acceleration improvement, but AA'T created HIIT and Fartlek equal in terms of aerobic endurance development findings. The results, therefore, are clearly in line with the different phenomena involved in each modality of training which distinguishes between HIIT's high anaerobic, explosive capacity and the sustained aerobic conditioning required by Fartlek.

CONCLUSIONS

The research has concluded that High-Intensity Interval Training is certainly the best among different kinds of training for achieving improvements in speed and acceleration among sprinters, particularly those in the collegiate handball team, shown in the differences in Speed Test results. HIIT also showed slight advantages concerning VO₂ max improvement, although these differences were not found to be statistically significant. Thus, HIIT and Fartlek training could be regarded as equally good for the development of aerobic capacities. Coaches and trainers should consider high-intensity interval training for athletes who want to develop explosive performance and acceleration, and Fartlek training, with its varied paces, would be well considered for using the sustained endurance as a further training tool for general fitness and aerobic development in dynamic sports such as handball. Future research could be done on combining the training methods or determining their long-term effects on sports performance in other physical attributes.

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