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The effectiveness of 5 weeks of high intensity interval training on cardiovascular endurance in karate players: An experimental study

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Abstract

Purpose: Karate is one of the most popularly practiced Combat Sports across the globe and it is characterized by high-intensity activity, including explosive and intermittent actions. Cardiovascular endurance plays an important role in Karate. It prevents fatigue between two bouts, between 2 matches and between the fights High Intensity Interval Training It is a form of interval training, a cardiovascular exercise strategy alternating short periods of intense exercise with less intense recovery periods. It is one effective way of improving the cardiovascular endurance. This research studies the effect of High Intensity Interval Training on Cardiovascular endurance in Karate Players.

Method: In this study, 30 samples were collected according to the inclusion and exclusion Criteria. The exercise protocol was explained to them in details and ascent/consent was taken. The protocol was then administered for 5 weeks, on alternate days in each week. Pre and Post data collection was done using 20m Shuttle Run Test.

Results: After 5 weeks of intervention, results showed that the HIIT had significant improvements in the scores of 20m Shuttle run test indicating a significant improvement in Cardiovascular Endurance of Karate Players (Difference 7.06 to 9.8, $t=14.752$, $p<0.001$)

Conclusion: This study concludes that High Intensity Interval Training significantly improves Cardiovascular Endurance in Karate Players.

Keywords: karate, HIIT, cardiovascular endurance, aerobic capacity

Introduction

Combat sports: A combat sport, or fighting sport, is a competitive contact sport that usually involves one-on-one combat [1]. Karate is one of the most popular and practiced martial arts in India. It developed from the indigenous under the influence of Kung Fu. Karate is now predominantly a striking art using punching, kicking, knee strikes [2]. Karate is characterized by high-intensity activity, including explosive and intermittent actions that last between 0.3 and 2.1 seconds which requires great technical and tactical skill. High cardiorespiratory fitness, including oxidative predominance via the ATP-PC pathway and, to a lesser extent, the glycolytic system is needed to cope with the metabolic demand during combat and recovery [3].

Importance of Cardiovascular Endurance in Karate: It can be shown that cardiovascular endurance in karate training is closely tied to the execution of a technique and the skill required to perform it.

Cardiovascular endurance has been reported to play a major role in karate performance. It prevents fatigue during training and ensures the recovery processes during rest periods between two subsequent bouts of fighting.

One of the most important factors governing an athlete's performance is their level of cardiorespiratory endurance [3].

High Intensity Interval Training: It is a form of interval training, a cardiovascular exercise strategy alternating short periods of intense exercise with less intense recovery periods.

Benefits of HIIT over traditional Cardio exercises

Improves Cardiovascular endurance: Aerobic fitness and cardiovascular adaptations because of greater and maximal oxygen intake, increased stroke volume and increased mitochondria number, superior to traditional cardio exercises leading to greater $\dot{V}O_{2\max}$.

Shorter Duration: One study published in *The Journal of Sports Science and Medicine* showed that as few as three 10 minute sessions a week can make body more efficient at delivering oxygen to body as well as improving metabolic health.^[5] HIIT exercise sessions generally consist of a warm up period, then several repetitions of high-intensity exercise separated by medium intensity exercise for recovery, then a cool down period. The high-intensity exercise should be done at near maximum intensity. The medium exercise should be about 50% intensity^[6]. A common formula involves a 2:1 ratio of work to recovery periods, for example, 30–40 seconds of hard sprinting alternated with 15–20 seconds of jogging or walking^[6].

HIIT is a specific training method for sports in which energy is obtained by the interaction of the oxidative and glycolytic systems such as in karate. HIIT induces adaptations to aerobic and anaerobic characteristics and functional performance variables required in Karate, which favor execution of explosive motor patterns^[7].

The magnitude of improvement depends on exercise intensity. The effects after high-intensity aerobic exercise training at 85%-90% of $\dot{V}O_{2\max}$ are twice those of moderate exercise intensity at 65%-70% of $\dot{V}O_{2\max}$ ^[8]

Need of Study

1. Karate is a high intensity sport. The factors governing a Karate Players performance are Aerobic Capacity, Muscle Power, Maximal Dynamic Strength, Flexibility and Reaction time. One of the most important factors governing an athlete's performance is their level of Cardiorespiratory endurance^[3].
2. Cardiovascular endurance prevents fatigue during training and ensures the recovery processes during rest periods between two subsequent bouts of fighting activity within a fight and between two consecutive matches^[4].
3. Research suggests that $\dot{V}O_{2\max}$ improvements with HIIT are superior to those with endurance training. This is referred to as an increase in mitochondria density. Mitochondria use oxygen to manufacture ATP at high levels through the breakdown of Carbohydrates and Fat during aerobic exercise. HIIT also increases maximum oxygen intake leading to increased $\dot{V}O_{2\max}$ ^[12].
4. Currently, training and physiological testing has become progressively adjusted to the specific physical and physiological requirement of the sport^[7].
5. There is limited research on effect of HIIT on cardiovascular endurance in Karate Players.
6. Hence studying the effectiveness of HIIT on cardiovascular endurance in Karate Players is necessary.

Aims

To study the effect of 5 weeks of High Intensity Interval Training on cardiovascular endurance in Karate Players.

Objectives

To study the effect of 5 weeks of High Intensity Interval Training on Cardiovascular Endurance in Karate players

between the age group of 8 to 20 years using 20m Shuttle run test.

Review of Literature

Vasconcelos, BB, Protzen, GV, Galliano, LM, Kirk, C, and Del Vecchio, FB conducted a study on Effects of high-intensity interval training in combat sports: A systematic review with meta-analysis. J Strength Cond Res XX(X): 000–000, 2019

The aim of this study was to perform a systematic review and meta-analysis about chronic effects of HIIT in CS athletes. No differences on anaerobic peak power for striking were found, and a statistical improvement for grappling athletes was found. Seven studies analyzed anthropometric variables, with differences for body mass in striking and no differences for grappling (MD 520.09 kg; CI 95% 522.80 to 2.62; p 5 0.95). Differences in body fat percentage in striking and no differences in grappling were found. It was concluded that HIIT positively influences maximum oxygen uptake and anaerobic power in combat sport athletes, with a minor impact on body composition.

Emerson Franchini, Department of Sport, School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil; conducted a study on High-Intensity Intermittent Training Positively Affects Aerobic and Anaerobic Performance in Judo Athletes Independently of Exercise Mode (2016)

Thirty-five subjects were randomly allocated to a control group (n = 8) or to one of the following HIIT groups (n = 9 for each) and tested pre- and post-four weeks (2 training d-wk-1): (1) lower-body cycle-ergometer; (2) upper-body cycle-ergometer; (3) uchi-komi (judo technique entrance). All HIIT were constituted by two blocks of 10 sets of 20 s of all out effort interspersed by 10 s set intervals and 5-min between blocks.

Results

For the upper-body group there was an increase in maximal aerobic power in graded upper-body exercise test (12.3%). The lower-body group increased power at onset blood lactate in graded upper-body exercise test (22.1%).

Conclusion

Thus, short-duration low-volume HIIT added to regular judo training was able to increase upper-body aerobic power, lower- and upper-body HIIE performance.

Chaabene, H., Negra, Y., Capranica, L., Prieske, O., Granacher, conducted a study on A needs analysis of karate kumite with recommendations for performance testing and training, Strength & Conditioning Journal: June 2019 - Volume 41 - Issue 3 - p 35-46

Conclusion: An effective training program needs to be customized to the specific demands of the respective sport. Therefore, it is important to conduct a needs analysis to gain information on the unique characteristics of the sport. The objectives of this review were (a) to conduct a systematic needs analysis of karate kumite and (b) to provide practical recommendations for sport-specific performance testing and training of karate kumite athletes.

Nicholas H. Gist • Michael V. Fedewa • Rod K. Dishman • Kirk J. Cureton conducted a study on Sprint Interval Training Effects on Aerobic Capacity: A Systematic Review and Meta-Analysis; Sports Med DOI 10.1007/s40279-013-0115-0 (2013)

The objective of this study was to perform a systematic review. Seventeen effects were analyzed from 16 randomized controlled trials of 318 participants. Conclusion: SIT improves aerobic capacity in healthy, young people. Relative to continuous endurance training of moderate intensity, SIT presents an equally effective alternative with a reduced volume of activity. This evaluation of effects and analysis of moderating variables consolidates the findings of small-sample studies and contributes to the practical application of SIT to improve cardiorespiratory fitness and health.

Amit Batra, Marek Zatoń conducted a study on Effect of high intensity interval training on cardiopulmonary function in Taekwon-do ITF athletes; Journal of Combat Sports and Martial Arts © MEDSPORTPRESS, 2016; 1(2); Vol. 7, 73-79 DOI: 10.5604/20815735.1225636

The purpose of the study was to investigate the effect of high intensity interval training on cardio pulmonary function of Taekwondo ITF athletes. Material and methods. The study recruited 20 male ITF-style taekwondo practitioners. Conclusions: The administration of 8-weeks of glycolytic-based interval training enhanced maximal oxygen uptake (VO₂max) in our sample of ITF taekwondo practitioners.

Methodology

Sample size: 30

Study design- A pre and post experimental study

Sampling method - Purposive sampling

Study population - Karate players

Study setting - Karate coaching institutes in and around city

Study duration - 6 months

Criteria

Inclusion criteria

1. Grade 'Average' according to 20m shuttle run test ^[11]
2. Both male and female
3. Must play between 1-2 sessions per week
4. Age group between 08 to 20 years old

Exclusion Criteria

1. Hypertensive
- 2) Hypotensive
3. Diabetic individuals
4. Recent fractures (Up to 6 months)
5. Soft tissue injuries (Patellar Tendonitis, Sprain, Strain, etc)
6. Cardiorespiratory pathologies (COPD, Asthama, etc)
7. Neurological conditions (Cognitive impairments, etc)

Materials and Tools

1. Consent form
2. Ascent Form
3. Pen
4. Paper
5. Evaluation Sheet
6. Measuring tape
7. Audio Speaker
8. Watch

Outcome Measure

The 20 Meter Multistage Fitness Test: The 20m multistage fitness test (MSFT) is a commonly used maximal running aerobic fitness test. It is also known as the 20 meter shuttle run test, beep or bleep test among other names.

Equipment required: Flat, non-slip surface, marking cones, 20m measuring tape, beep test audio, audio player, recording sheets.

Procedure: This test involves continuous running between two lines 20m apart in time to recorded beeps. For this reason the test is also often called the 'beep' or 'bleep' test. The participants stand behind one of the lines facing the second line, and begin running when instructed by the recording. The speed at the start is quite slow. The subject continues running between the two lines, turning when signaled by the recorded beeps. After about one minute, a sound indicates an increase in speed, and the beeps will be closer together. This continues each minute (level). If the line is reached before the beep sounds, the subject must wait until the beep sounds before continuing. If the line is not reached before the beep sounds. When the subject can no longer follow the pace, the last stage number announced.

Scoring: The athlete's score is the level and number of shuttles (20m) reached before they were unable to keep up with the recording. Record the last level completed not necessarily the level stopped at.

Table: Grades of 20m Shuttle Run Test

Grade	Men	Women
Excellent	> 13	> 12
Very good	11 – 13	10 - 12
Good	9 – 11	8 - 10
Average	7 – 9	6 - 8
Poor	5 – 7	4 - 6
Very poor	< 5	< 4

Reliability coefficients were 0.89 for children (139 boys and girls 6–16 years old) and 0.95 for adults (81 men and women, 20–45 years old) ^[11].

Procedure

1. The Study began with the presentation of synopsis to an ethical committee at PES Modern College of Physiotherapy, Shivajinagar, Pune. An approval was obtained.
2. Various Karate coaching institutes were visited in and around the city.
3. The participants were selected on the basis of their inclusion and exclusion criteria.
4. The participants were explained about the study before starting the procedure. Consent was taken from the subjects who wished to participate in the study. Ascent form was taken.
5. 20M shuttle run test was taken on the participants and the data was recorded.
6. The participants underwent High Intensity Interval Training sessions on alternate days for 5 weeks.
7. At the end of 5 weeks the subjects were re assessed using 20m shuttle run test and the data was recorded again. Data analysis was done.

Protocol for the high Intensity Interval Training

Sprint Training

Protocol

- Warm-up: 10 mins of light running.
- Interval: 20-second sprints at maximal running speed.
- Rest interval: 10 seconds of rest between each sprint. Light jogging or walking.
- Work/Rest ratio: 2 to 1 ratio. The work interval will be 20-sec and rest interval will be 10-sec.
- Frequency: 3 groups or sets of 10-15 intervals by taking 4 min of rest between each set.
- Cool Down: 10 min easy jogging.
- Note: This was sprint workout. The first few intervals will be slower allowing muscles to adapt to the workout. It is important to be safe and careful avoiding muscle damage during maximal sprinting exercise. The warm-up session is very important [12]
- Progression: Over every week the protocol was progressed by increasing the speed of running and by increasing the number of laps hence ensuring that the subject is putting in maximum effort during the workout and not getting adapted to the intensity.



Participants performing the HIIT protocol.



Participants performing the HIIT protocol.

Data Analysis

- The improvement in cardiovascular endurance was analyzed using the 20m Shuttle Run Test scoring.
- The data was entered in Excel spread sheet, tabulated and subjected to Statistical Analysis.

- The data passed the normality test when the data was analyzed.
- Female participants were more than male participants when gender wise data analysis was done
- Participants between the age group of 10-15 years were more than 15-20 years old.

Statistical Analysis

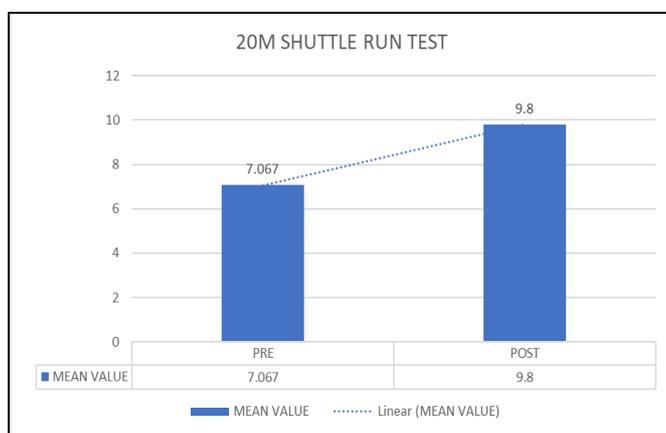
- Statistical Analysis was done for the group using the outcome measure 20m Shuttle Run Test.
- Pre and Post analysis for 20m Shuttle Run Test for the group was done by Paired t test by using Instat 3.10 software.
- The data passed the normality test.

Results

20 Meter Shuttle Run Test

Pre and Post Values of Mean and Standard Deviation

Outcome Measure	Mean	Standard Deviation
Pre	7.067	0.9803
Post	9.8	1.2269



Pre and Post Mean values

- The difference between PRE and POST 5 weeks were compared and analyzed using Instats for the readings.
- Mean values for 20m shuttle run test were 7.067 and 9.800 for pre and post intervention respectively.
- Paired t-test was used to compare the values.
- The difference between the Pre and Post score mean obtained was 2.733 respectively.

p and t values

P Value	t Value	Significance
<0.0001	14.752	Considered extremely significant

- The statistical analysis shows that the t value is 14.752 with 29 degrees of freedom.
- The statistical analysis shows that the p value is <0.0001 which is significant and hence 5weeks of High Intensity Interval Training is effective in improving cardiovascular endurance in Karate Players.

Discussion

Karate is a high intensity Combat Sport and one of the popularly practiced Martial Arts across the globe. Cardiovascular endurance in karate training is closely tied to

the execution of a technique and the skill required to perform it. It is considered as an important variable in a player's performance because it may delay fatigue and accelerate the recovery process. This would result in a faster recovery between rounds and between high intensity interactions during bouts.

The present study was conducted to study the effectiveness of 5 weeks of High Intensity Interval Training on cardiovascular endurance in Karate Players.

In this study, total 30 participants (both male and female) were included with age group of 8-20 years old with mean age of 15.677

The group was given 5 weeks of High Intensity Interval Training in the form of Sprint training protocol on alternate days in a week.

The Pre score and Post score analysis was done with Paired t test which revealed significant improvement in Cardiovascular endurance in the participants.

Martin Gibala *et al.* stated in their study that the High Intensity Interval Training improves aerobic fitness and cardiovascular adaptations because of greater and maximal oxygen intake, increased stroke volume and increased mitochondria number, increased mitochondrial density, superior to traditional endurance exercises leading to greater vo_{2max} [13].

Emerson Franchini *et al.* stated in their study that HIIT improved overall performance of lower limbs combined with increased aerobic capacity of upper limbs along with power in Judo athletes due to training induced increase in testosterone cortisol ratio and Improvement in aerobic power related variables are normally attributed to increases in oxygen delivery (i.e., elevated cardiac output) and to oxygen utilization by active muscles (i.e., arteriovenous difference) [14].

In another study, Amit Batra *et al.* in their study stated that HIIT significantly improved aerobic capacity in Taekwondo Players due to increase in Glycolytic Capacity. This study was focused on the enhancement of Glycolytic Capacity which helps to increase the maximal oxygen intake [15].

In the study on effects on HIIT, Weeprapong Chidnok *et al.* I stated that the HIIT protocol provided an optimal stimulus to enhance both maximal cardiovascular and peripheral adaptations in HIIT. Previous studies have been shown that high-intensity training exerts a significant effect on vascular endothelium. Shear stress during repeated exercise augments endothelium-dependent vasodilation through the increased production of nitric oxide. In addition, the increased production of nitric oxide also promotes vascular function by decreasing vascular tone, smooth muscle cell proliferation, leukocyte activation, and platelet aggregation [16]. Hence due to all of these underlying mechanism High Intensity Interval Training is effective to improve cardiovascular endurance in karate players.

Conclusion

This study concludes that 5 weeks High Intensity Interval Training is effective in improving cardiovascular endurance in Karate Players.

Limitations

This study was done using small sample size

Future Scope of Study

Further studies with larger sample size can be done.

Long term effects of the intervention can be checked with timely follow up by increasing the duration of the study.

The effectiveness of this protocol can be checked on other important factor affecting the performance of Karate Players.

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