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The influence of high-intensity interval training on the health-related physical fitness components of children who are currently enrolled in school

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Abstract
High Intensity Interval Training (HIIT) is a kind of exercise that consists of short, intense bursts of action followed by brief intervals of recuperation. This pattern of exercise may be repeated several times. Because of this, they started looking for methods that were efficient, didn't cost a lot of money, and could burn a lot of calories in a short period of time to establish a home-based weight reduction programme that is successful via the use of HIIT. The primary purpose of this research is to investigate the effects of HIIT on a participant's physical fitness components. 60 schools were chosen, and individuals were selected for this study and being randomly allocated to either the experimental group (n = 30) or the control group (n = 30). The High Intensity Interval Training (HIIT) programme was implemented 30 seconds of each exercise followed by 10 seconds of recovery. This routine was repeated by all of the individuals for a total of 12 weeks. The number of exercise repetition was also increased in staircase method. The pre- and post-treatment mean values showed a significant result in experimental the groups (<0.05) and control group did not show any improvement. This study provides the evidence that HIIT is proved effective in improvement of health-related physical fitness components among school going children

Keywords: HIIT training, school children, health related components

Introduction
When it comes to the treatment of childhood obesity, physical activity is absolutely essential. Historically, moderate-intensity continuous training (MICT) has been the most popular type of exercise that has been recommended to enhance both cardiorespiratory fitness (CRF) and body composition. When it comes to altering body composition or other health indices in obese children and adolescents, High Intensity Interval Training (HIIT) has been shown to be more time efficient than moderate intensity continuous training (MICT) in recent years, according to expanding evidence gathered in controlled laboratory settings (Sharma *et al*., 2022) [6]. It is critical for parents to ensure that their children have a positive experience both during and after high-intensity interval training (HIIT). In children who are overweight, a lower intensity of physical activity was found to have a negative association with exercise adherence, according to a previous study. However, Malik and his colleagues stated that affect reactions during HIIT are based on the intensity of the work-interval and are not wholly negative (unpleasant feelings). They said this in their study. The HIIT protocol with a greater intensity (85% peak power) produces the same amount of enjoyment as the HIIT protocol with a lower intensity (70% peak power), but only the HIIT protocol with 85% peak power generates enough HR stimulation to facilitate potential health benefits. Schools are the perfect places to carry out programmes that encourage students to engage in physical activity (Meng *et al*., 2022) [5]. The purpose of the study was to investigate the effect of 12 weeks of HIIT effect of health-related physical fitness components.

Methodology
He study was conducted in Kendriya Vidyalaya No.1, Gwalior (Madhya Pradesh), India. Both parents and their children provided informed consent. The research data was collected in the school playground.

BMI and performances on five motor fitness tests were measured by research assistants experienced with the protocols for anthropometry and for each fitness test and associated equipment. Testing was coordinated by physical education teachers at the schools.

Participants: The participants were included 60 males (Mean ±SD; height= 163.87±7.24 cm, weight= 47.55±10.79kg BMI= 17.96.±3.12 kg/m2 and age= 14-16 years). Height and weight were measured using, respectively, a prestige stadiometer and an electronic weighing scale (Omron).

Procedure: A 10-minute general warm-up consisting of general exercises was administered by the researcher prior to testing. The six fitness tests were administered i.e., Cardiovascular endurance; muscular strength, muscular endurance, flexibility, and body composition have been included after thorough discussion and going through the related researches done in this area. To measures these health-related physical fitness components the following test was conducted before and after the HIIT training intervention.

1. 600 meters (Cardiovascular endurance**)-** Run and walk the test was measured in minutes and seconds. Adequate warm-up exercise was advised before the test. When the investigator said, ‘‘take your marks,’’ subjects in a group of six to eight stood behind the starting line; when the investigator said, ‘‘go,’’ the subjects began the 600-m run/walk. The participants were advised to maintain a consistent pace and complete the run as soon as possible. If a subject was unable to continue running, they were allowed to walk (Das & Jhajharia, 2022a) [2].

2. Push-up (Muscular endurance**)** The test begins with the participant's hands and feet on the floor and his body in a plank stance, with feet apart and hands below the shoulder line. The participants were required to lower the body until formed a 90º angle between the arm and the forearm and then return to the starting position. This action was repeated until they give up. The number of times each participant correctly performed this push-up was counted.

3. Muscular strength (Muscle Dynamometer)
Participants’ leg strength was measured with the Back & Lift Dynamometer, which is a simple and popular device to test back, and legs strength with a sensitivity up to 300 kg. The device features an adjustable length chain to accommodate for height differences or to vary the point of force application. An LCD screen on the front of the dynamometer had been applied in order to display the results. Each participant had to perform 4 pulling trials. Two of which realized with the leg contacted to the dynamometer's grab-handle and, the other two which were without leg contact. The best performances were recorded for each trial. Although back & leg dynamometer test procedure can be defined as follows according to literature, there is no current evidence if it needs to contact or not with the leg during the testing procedure.
Ten Hoora *et al*. and Tamer have described the test procedure as follows:

- Make sure the dial is reset to zero before the participant starts. He/she stands upright on the base of the dynamometer with the feet shoulder width apart. He/she should let his/her arms hang straight down to hold the centre of the bar with both hands, and with the palms facing toward the body.
- The participant should adjust the chain so that the knees should be bent at approximately 110 degrees. In this position participant’s back should be bent slightly forward at the hips, head should be held upright, and he/she should look straight ahead. Then without bending his/her back, he/she pulls as hard as possible on the chain and tries to straighten legs, keeping arms straight.
- The participants should pull against the weight steadily (No jerky movements), keeping the feet flat on the base of the dynamometer. Maximum performance will result when his/her legs are almost straight at the end of the lift. If not, he/she has to adjust the chain length and starting position.

4. Sit and Reach (Flexibility) The purpose of this test is to evaluate flexibility. For the flexibility measurement, the subject sat on the floor with legs extended and feet flat against a bench designed for this purpose, which had a ruler attached. The subject flexed their trunk and extended their fingers along the scale, holding the position for 3 seconds. The knees remained extended throughout the test. The distance was measured in centimetres, and a plus sign was recorded if the distance was beyond the feet, while a minus sign was recorded if the subject could not reach their feet. Three trials were conducted after the subject had completed a thorough warm-up.

5. Skin fold caliper (Body Composition)
Measurements were taken to assess subcutaneous fat at various anatomical sites using specific procedures as described by Harrison *et al*. [3]. The sites measured were the suprailiac (SI), subscapular (SE), triceps (TR), biceps (BI), medial calf (MC), thigh (TH), chest (CH), abdominal (AB), and midaxillary (MA). A single evaluator performed the measurements with a test-retest coefficient of over 0.95 for each site and technical measurement error of ± 0.8 mm and ± 1.0 mm for Cescorf and Lange calipers, respectively. When necessary, measurements taken with the Lange caliper were adjusted using linear interpolation of 0.5 mm. Measurements were taken on a rotation basis and repeated three times with each caliper, and the median of the three measurements from each site was adopted as the reference value. The evaluator changed calipers at the end of each of the three measurement sequences. The measurement sequence for the study was AB, SI, SE, TR, BI, CH, MC, TH, and MA, and measurements were taken on the right side of the body while the subjects wore a bathing suit. From the skinfold thickness, body density was calculated using the predictive equations proposed by Durnin & Womersley, Jackson & Pollock, and Petroski (Cyrino *et al*., 2003) [1].

Training procedure: HIIT training programme was implemented 4 days in a week and 2 days rest was given for the complete recovery. The training intensity was gradually increase for the better result. The following exercise was given jumping jack, sit-up, push-up with shoulder touch, 10-meter shuttle run, flutter kick, and power plank walk.

Statistical analysis: Descriptive analysis was done to evaluate the Mean and Standard deviation of the following tests. to check the normality of the data for the normality of the data Kolmogorov- Smirnov and Shapiro-Wilk test used (Das *et al*., 2023; Das & Jhajharia, 2022b) [4, 3] in order to check the status of pre and post of health-related physical fitness components paired t-test was applied and the level of significance was set at 0.05 and all the calculation was performed on IBM SPSS (Version 26.00)

Results

Table 1: Paired T-test of Experimental Group

		Mean	Std. Deviation	df	Sig. (2-tailed)
Pair 1	Pre-Muscular endurance - post-Muscular endurance	-2.90	2.39	29	.00
Pair 2	Pre-Back Strength - Post-Back Strength	-24.00	18.32	29	.04
	Pre-Leg Strength - Post-Leg Strength	-26.75	23.90	29	.03
Pair 3	Pre-Flexibility - Post-Flexibility	-2.38	6.30	29	.04
Pair 4	Pre-Cardio Vascular Endurance-Post cardiovascular endurance	0.45	0.34	29	.05
Pair 5	Pre-Body Composition-Post-Body Composition	-3.28	5.32	29	.03

Table 1 presents the findings demonstrating that the implementation of High-Intensity Interval Training (HIIT) as a training intervention yielded significant improvements in various health-related physical fitness components. The statistical analysis revealed that the p-values for pre- and post-intervention measurements of muscular endurance, muscular strength, flexibility, cardiovascular endurance, and body composition were all below the critical threshold of 0.05.

Table 2: Paired T-test of Control Group (No Training)

		Mean	Std. Deviation	df	Sig. (2-tailed)
Pair 1	Pre-Muscular endurance - post-Muscular endurance	-0.80	2.01	29	.07
Pair 2	Pre-Back Strength - Post-Back Strength	-1.40	18.32	29	.08
	Pre-Leg Strength - Post-Leg Strength	-12.25	33.40	29	.06
Pair 3	Pre-Flexibility - Post-Flexibility	-0.38	5.37	29	.07
Pair 4	Pre-Cardio Vascular endurance -Post cardiovascular endurance	0.15	0.54	29	.08
Pair 5	Pre-Body Composition- Post-Body Composition	-1.28	4.36	29	.03

Table 2 present the findings demonstrating that the control group did not show any significant improvement in health-related physical fitness components.

Discussion

The present study revealed that HIIT can significantly improve muscular endurance, muscular strength, flexibility, cardiovascular endurance, and body composition, with the effect of HIIT.

The results suggested that 12 weeks of HIIT training while the cardiovascular endurance was increased. These findings were consistent with Rowan *et al*. (2012) [13], Soori *et al*. (2012) [22], Kordi *et al*. (2013) [9] and Khodaei *et al*. (2014) (15-19). Rwoan *et al*. (2012) which suggested that five weeks of HIIT training increased the cardiovascular endurance in female soccer players. They stated that two training sessions a week of HIIT can be a good stimulus for increasing cardiovascular endurance. In Sandvei *et al*. (2012) [15] study, eight weeks of speed interval training which is similar to HIIT training, increased the cardiovascular endurance in healthy young men. The effect of HIIT exercises on body composition and some metabolic hormones in young men. Khodaei *et al*. (2014) reported that two weeks (five sessions a week) of HIIT training increased cardiovascular endurance in active women. It was found in this study that HIIT training had no significant effect on E-selectin and P-selectin levels. In agreement with our result, Saetre *et al*. (2011) [14] analyzed the effect of eight weeks (two sessions per week) walking workout on the levels of E-selectin and intercellular adhesion molecule 1 in 29 male and female patients with peripheral artery disease and reported the reduction of the variables [8]. In a study, Bjornstad, *et al*. (2008) [1] reported the positive effect of 20 weeks of resistance and endurance training on P-selectin levels in patients with chronic heart failure. Pizza *et al*. (2001) [12] reported that four weeks of eccentric training did not make any significant changes in the level of E-selectin [20]. Tonjes *et al*. (2007) [23] suggested that four weeks of intense physical activity, not only reduce the fat percentage and weight, but also cause the reduction of E-selectin, vascular adhesion molecules 1 and intercellular adhesion molecule 1 in patients with diabetes. Lim *et al*. (2015) [10] reported that a combination of aerobic, resistance and traditional Korean dance exercises for 12 weeks (three days a week) decreased the E-selectin and vascular adhesion molecules 1 in old women. In a study by Jalaly *et al*. (2015) [7], 12-week aerobic exercise reduced the levels of intercellular adhesion molecules 1 and E-selectin in patients with angina pectoris [23]. In a study, Hamedinia and Haghighi (2007) [6] investigated the effect of endurance and resistance exercise on circulating soluble adhesion molecules in obese men. The endurance exercises included running with the intensity of 75% to 85% of maximum heart rate (HRmax) and resistance training included 11 stations of weight training and each session was done with four sets of 12 repetitions and the intensity of 50% to 60% of one maximum repetition. The results showed that both types of exercise decreased the E-selectin levels and intercellular adhesion molecules 1. Various studies have demonstrated that HIIT training improve health related physical fitness components.

Conclusion

High-Intensity Interval Training (HIIT) proves to be a practical and time-efficient method for enhancing muscular endurance, muscular strength, flexibility, cardiovascular endurance, and body composition among school going children. Through our review of related literature, we have gathered compelling evidence demonstrating statistically significant enhancements in health-related physical fitness components among school going children who under goes with HIIT interventions.

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