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Effect of Twelve Week Hypergravity Training on Sprinting Speed of the Cricketers

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ABSTRACT

Background: Sprinting speed as a derivative of lower-body power is considered to be the most vital component of physical ability of the players. Traditional training methods fail to improve sprinting speed of the experienced players up to a certain limit that demands newer training means for further development of speed. *Hypergravity Training* (HT) has been identified as such a new type of training that was used by few researchers for the improvement of sprinting speed and power of the experienced rugby and soccer players. But it has still not been implemented on the cricketers for the development of sprinting speed. **Objective:** Therefore, the current randomized control trial was directed to assess the development of sprinting speed of the cricketers through the implementation of HT in comparison with the *Normalgravity Training* (NT) condition. **Method:** The present study was a quasi-experimental research work. One hundred and five (N=105) state cricketers were selected as subjects. The participants were split into three equal groups (n=35 each) viz. i) Normalgravity Training Group (NGTG), ii) Hypergravity Training Group (HGTG) & iii) Control Group (CG). NGTG & HGTG groups underwent the same exercise protocol for the periods of twelve weeks in normal & hypergravity conditions respectively whereas CG was free from the training intervention. Sprinting speed of the cricketers was measured by a 30m run test. ANCOVA preceded by Tukey's LSD test were performed for data analysis. Statistical significance was examined at $p<.05$ level. **Results:** Significant F-value ($F=61.122$; $p < 0.001$) was observed. Sprinting speed of both training groups (NGTG & HGTG) improved significantly (Mean Diff=1.28 & 0.86; Critical Diff =0.41) in comparison to the CG. HGTG also differed significantly (Mean Diff =0.42; Critical Diff =0.41) when compared with NGTG in sprinting speed. **Conclusions:** The sprinting speed of HGTG improved better than NGTG. Therefore, HT is found as an effective training means for developing sprinting speed.

Key words: Weight-Bearing Exercise Program, Resistance Training, Sprint Interval Training, Hypogravity, Velocity, Acceleration.

INTRODUCTION

Among different fitness components, sprinting speed is considered to be the most important one in modern day's cricket. Sports scientists and researchers are always involved in inventing improved methodologies of sports training targeted towards the optimum development of the musculoskeletal functioning of human beings. A conventional sports training method becomes futile after a certain level of development in human performance (Haugen et al., 2019). Among various performance components, improvement of speed for the players having extensive training experience becomes most challenging to the coach and trainer. In this direction; the coaches who are working with traditional training methods faced a plateau (Barr et al., 2014) called speed barrier for further improvement of sprinting speed after reaching up to certain level eliciting no further training adaptation (Barr et al., 2015).Very often, a well-trained athlete has reached a speed plateau, in which his or her training no longer yields faster speeds. This stabilization of the athlete's speed qualities is the speed barrier. In order to break this speed barrier, training conditions and means should be replaced with a new one.

Therefore, sports scientists are constantly involved in inventing such a new type of training means that will help to overcome the speed barrier. While testing the effectiveness of various new training means for further improvement of sprinting speed of the elite players, sports scientists have identified a simulated *Hypergravity Training* (HT) that produces a nonspecific chronic stress, beyond the habituation of the specificity of training stress produced by a conventional training means followed by a recovery, required to produce further adaptation for the improvement of sprinting speed. In a simulated hypergravity training the players wear weight jacket that increases the feelings of body weight due to gravity produces an improvement of lower body power to cope up with the new increased weight condition (Bosco, 1985) that is almost similar to the high-altitude acclimatization of the endurance athletes (Lancaster & Smart, 2012). Thus, in

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simulated hypergravity training, wearing additional weight produces additional stress to the antigravity muscle groups that forces the musculoskeletal system to adapt with the enhanced gravity condition. The pioneer of the concept of hypergravity condition as a means of sports training is Bosco et al. (Bosco, 1985). They investigated the effect of hypergravity condition in their research works that showed a drastic improvement of the lower-body power against gravity of the elite track and field athletes who were suffering from speed barrier in spite of the involvement in extensive traditional training means (Bosco, 1985; Bosco et al., 1984). Before the initiation of the concept of hypergravity training they were engaged to improve the lower-limb muscle power of five international Scandinavian athletes, on whom they implemented intensive and systematic training (weekly 10-12 training sessions lasted for 120-180 min each) for almost one year, but no significant changes were observed. However, immediately after this year-long unsuccessful training programme they implemented a simulated hypergravity condition on those subjects for just three weeks through wearing a weight jacket (weight vest measures were 11% of their body mass). Surprisingly, they observed 10% improvement in mean power measurement of those subjects (Bosco, 1985; Sands et al., 1996).

The term '*gravity*' or '*normalgravity*' is basically defined as the force acting towards the center of the Earth due to the acceleration on Earth's surface (it is expressed in SI units as g, g = 9.81 m.s^{-2} at sea level). This is the actual weight of a body on Earth's surface and is usually expressed as $w = m.g$, where 'm' stands for mass of the body, 'w' stands for weight of the body or the force of gravity. When the gravity level goes above 1 g it is called '*Hypergravity*' and when it is less than 1 g then it is called '*hypogravity*', sometimes it is also called '*partial gravity*', and seldom it is also called '*reduced gravity*'. Thus, '*hypergravity*' is defined as a force higher than gravity, and it is the primary force at the action when increasing your body weight during exercise. If the mass of the body increases then the gravitational force of attraction i.e. weight also increases. An external load (weight) as a means of a weighted vest worn by an athlete during training is referred to as hypergravity training (Scudamore et al., 2016). It is already proved that with the increase of resistance in weighted vest HT workouts there is some positive impact for the improvement of speed, agility, power, strength & endurance by increasing resistance. On the surface of the earth, if the body weight is increased, consequently, the gravitational force of attraction also increases. This condition is called 'hypergravity'. By using this fundamental principle, a hypergravity workout is arranged in field settings by incorporating additional weight on the body. In sports training, a weighted vest is so arranged that putting on a weight jacket fits like a shirt on the body while working out. That helps to improve fitness more in an easy effort in less possible time. It is an effective training technique for developing sprinting speed that produces nonspecific chronic stress on the human organism through over-adaptation. Resisted sprint training can increase muscle activation, specific strength & explosive power of the legs required in sprinting (Haugen et al., 2019). In HT, through weighted vests by artificial means (wearing weight jacket) the athletes feels as if an increased force against gravity is acting on their body that helps to develop the power of the lower limbs (Barr et al., 2015; Bosco et al., 1984; Bosco, 1985; Sands et al., 1996). Several studies have shown that an increased power of the lower limbs will aid to improve the sprinting speed of the players and vice versa (Barr et al., 2015; Cormie et al., 2010). Excellent improvement of muscle power of the athletes, more than 10% were recorded, through the implementation of nonconventional weighted vest HT in just three to ten weeks (Bosco et al., 1984; Bosco, 1985; Rantalainen et al., 2012; Rusko & Bosco, 1987; Sands et al., 1996).

Hypergravity training (HT) can be considered as a specific workout with externally added body weight through wearable load on different limbs of the players. Externally, added load increases the feelings of body weight or gravity of the body on the earth's surface. These types of weighted vest workouts have proved beneficial for the development of speed, strength, agility and endurance of the players by manipulating additional load in different games and sports like rugby and soccer. As the load externally is added on the body of the players, the required force for the initiation and execution of a movement increases due to the increased gravity condition of the players on the earth's surface, therefore it is known as Hypergravity training. The player feels himself weightier than normal gravity while working out and generally requires more effort than normal gravity. This type of wearable load is put on the player's body in a skin tight manner to minimize the feelings of discomfort and to make them feel like a shirt he has worn during the workout. In hypergravity training, sometimes this type of wearable resistance is also applied on the organism during daily life activities to make the weight adaptation quickly and smoothly to get better results in less possible time. This type of workout with externally added warble load is called HT.

Sprinting speed as a derivative of lower-body power is considered to be a most vital component of physical ability for the cricketers especially at the time of batting and fielding. Improvement of sprinting speed for the players with an extensive training experience through traditional training methods is really challenging to the coaches and trainers that actually demands specific and acute training stress followed by a recovery in a constant cyclic manner. *Hypergravity Training* (HT) implemented through weighted vests has been identified as such a new type of training that has been used by few researchers for the improvement of speed and power of the experienced players in rugby and soccer. But no studies have still attempted to investigate the effect of HT on the sprinting speed of the cricketers. The researchers of the present study searched various sources and found the limitations, gaps of previous research work and confirmed that still no study had been conducted for the development of sprinting speed of the cricketers through the implementation of Weight Vest HT. In this context, the present researchers planned to implement one HT program through WV on the Indian cricketers with a view to examine the effect of this nonconventional training means on the improvement of sprinting speed. Thus, the aim of the present investigation was to examine the effect of twelve week hypergravity training on the sprinting speed of the cricketers. Earlier many researchers investigated the effect of hypergravity training on sprinting speed and they found improvement of sprinting speed of the players of different games and sports (Clark et al., 2010; Macadam, Simperingham, et al., 2017; Picerno, 2021; Sands et al., 1996; Simpson et al., 2020). Therefore, it was hypothesized that the sprinting speed of the cricketers would also improve considerably due to the implementation of twelve weeks HT through WV. If it is possible then many cricketers of this country will be benefited for developing sprinting speed in a considerably less time through HT.

METHODOLOGY

Study Design

In this study a quasi-experimental design was adopted (shown in Figure.1) to evaluate the effect of twelve weeks Hypergravity Training (HT) and *Normalgravity Training* (NT) for the development of sprinting speed of the cricketers from a comparative standpoint.

Initially, a research proposal was placed to the Departmental Research Committee (DRC) of the University of Kalyani to get approval for the present research work. The DRC approved the research work after satisfying in all aspects vide letter No.Ph.D/Phy.Edu./PR/2021 dated December 15, 2021. The dependent variable that was taken into consideration in the present study was *sprinting speed* in $m.s^{-1}$ and measured through a 30m sprint run test. The independent variables were two different condition sprint training i.e. sprint training in hypergravity condition commonly known as hypergravity training (HT) and sprint training in normal gravity condition mentioned as *Normal-gravity Training* (NT).

Participants

One hundred and twenty (N=120) state level cricketers having a training age of at least eight years with chronological age ranged between (17-22) years were chosen as subjects for this study. The cricketers were selected from West Bengal- a state situated in the east side of India. After initial se-

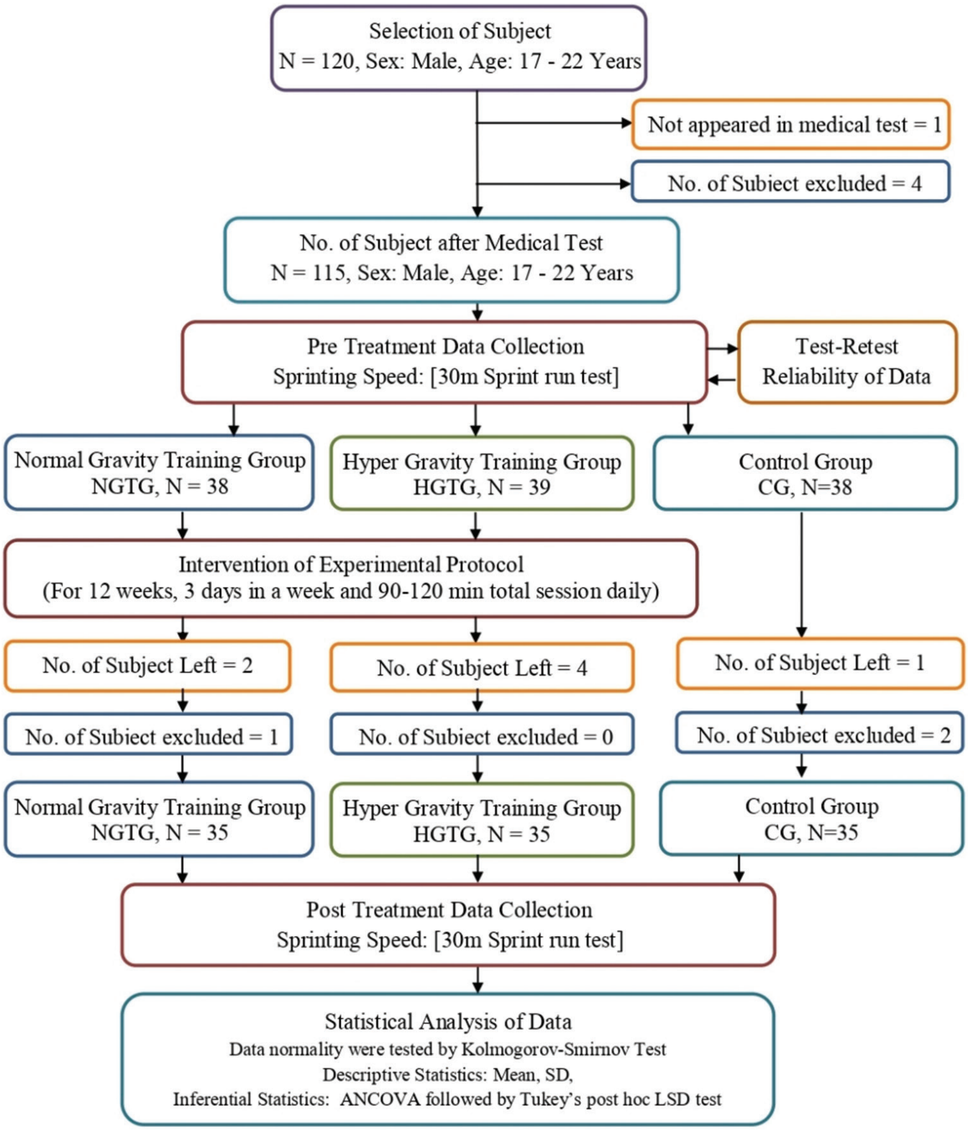

Figure 1. Experimental design

lection of the cricketers, mandatory medical check-ups were performed by an experienced medical practitioner. One subject failed to attend the check-up process and four players were found medically unfit, thus those five subjects were eliminated from the study. In this stage, after elimination, a total one hundred and fifteen cricketers were informed to submit written consent. After getting the signed consent form (candidate & Guardian both) prior to the commencement of the present research work, they were finalized as subject (N=115) and they were grouped into three –among them two were experimental groups (HGTG, N_{HGTG}=39 & NGTG, N_{NGTG}=38) and a single control group (CG, N_{CG}=38) in the study. The structured sprint training under the imposed conditions was manipulated for twelve weeks where two experimental groups (HGTG & NGTG) underwent *normalgravity training* (NT) and *hypergravity training* (HT) respectively on grassy turf. In HT, subjects wore a specially designed weight jacket having the scope of varying the weight through which pre-settled progressive load was implemented on the subjects in various training weeks. But the CG wasn't exposed to any of the above training and became free from the training intervention. A short orientation camp was organized with all subjects along with their guardians where the research aim, importance and entire procedures were explained over there to encourage and motivate the participants so that they become active and serious throughout the course of the study. Pre-experimental (baseline) data were collected one week before starting the sprint training. One week rest was provided to the subjects between baseline and the start of the intervention program. Seven subjects left the study, two from NGTG; Four from HGTG & one from CG and three were excluded from the study due to discontinuation. Finally, one hundred and five (N=105, N_{HGTG}=35, N_{NGTG}=35 & N_{CG}=35) cricketers completed the training sessions successfully and the groups became equated after exclusion of the subjects. They were finalized as participants for the current investigation. Post-test data were gathered one week after the end of the training programs.

While estimating the sample size prior to the intervention in the present research work, the investigators took the help of the concepts of a few previous studies (Faigenbaum et al., 2014; Nobre et al., 2017; Sortwell et al., 2021). A priori power analysis was carried out for ANCOVA by the help of a software: G*Power V3.1.9.4 (Sortwell et al., 2021) to determine the minimum sample size for the groups in a given condition of α = 0.05, Power = 0.80, Effect size = 0.307 (N. Munger et al., 2022), numerator df =2, and Number of groups =3 that determined a total sample size of one hundred and six (n=106) with Denominator df = 101 and the Critical value of F =3.0864. Therefore, thirty five subjects would be needed in each group for the investigation. Considering 10% to 12% attrition rate five subjects were added in each group and the investigation started with a sample size of one hundred and twenty (N=120) i.e. forty subjects in each group (Faul et al., 2007). After exclusion and elimination in different stages, sample size in post test condition finally became One hundred and five with equal group strength of thirty five in each group. Simple blind folded randomization technique was adopted for selecting and dividing the cricketers into different groups.

Treatment Protocol

While constructing the training protocol the researcher went through an exhaustive review on the studies that used weighted vest hypergravity training and sometimes weighted sled training (Biswas & Ghosh, 2022a, 2022b; Ghosh & Biswas, 2020; Macadam, Cronin, et al., 2017) which were used as reference, that guided the researchers to frame the training protocol. From those studies few were shorted out (J. B. Cronin et al., 2016) according to the specificity of weighted vest hypergravity training as would be applicable to the cricketers on the basis of similarity of movement pattern, load mechanics and experts' suggestion while framing the training protocol for this study. Those training protocols were basically targeted to the improvement of lower limb muscle power and sprinting speed of the players of different games and sports. The above standardized training protocols were followed partially during the construction of the training protocol for the present study with slight modification and inclusion of few exercises as indicated in Tables 1-3 below. Intellectual inputs and suggestions from the experts also helped the researcher during framing the present training protocol. The constructed protocol was as follows:

Hypergravity Training

In hypergravity training the cricketers did eight different exercises such as 4 ×20 m shuttle run, short distance sprint 30 m, high knee 40 m (front-left-right-back), lunging 20 m, push up (15 count), squat (15 count), plunk (15 sec), and skipping (50 sec) sequentially by adding weighted jacket which was filled by appropriate weight. In hyergravity training (HT) all the subjects were to wear a specially designed weight jacket (Figure 2) in one hour before starting the training session and become exposed continuously with WV up to one hour after the training session implemented for 3 days in a week. The jacket was so designed that the weight can vary as per the requirement of training in different weeks of progression. The weight vest was progressively increased and it was implemented as a percentage of Mean Body Mass (%MBM) of the cricketers which was pre-calculated for several weeks. The subjects become weighted vest for a total period of $3\frac{1}{2} - 4\frac{1}{4}$ hours including the time before and after the training session. The implemented WV in % of MBM (starting from 4% of MBW to 14% of MBW in the last two weeks) for different training weeks of the entire training session has been mentioned in Table 3 (Bosco, 1985; Sands et al., 1996; Macadam, Cronin, et al., 2017; J. B. Cronin et al., 2016).

Normalgravity Training

In normalgravity training the cricketers did the same exercise as performed by the HGTG, but the only difference was that the NGTG group performed those exercises without taking any weight. The exercises were 4 ×20 m shuttle run, short distance sprint 30 m, high knee 40 m (front-left-right-back), lunging 20 m, push up (15 count), squat (15 count), plunk (15 sec), and skipping (50 sec). The subjects of NGTG

Table 1. Training schedule for the experimental groups for I to XII weeks

Training Weeks	Training Volume	Name of the exercise	Time (s)	Training Repetition	Training set	Training Intensity
I to III	1096 (s) ≈ 18 m	4×20 m Shuttle Run	30-35	2	2	Low
		Short Distance Sprint 30 m	8-12	2	2	Low
		High Knee 40 m (Front-Left-Right-Back)	45-50	2	2	Low
		Lunging 20 m	36-42	2	2	Low
		Push up (15 count)	30-35	2	2	Low
		Squat (15 count)	30-35	2	2	Low
		Plunk (15 Sec)	15-20	2	2	Low
		Skipping (50 Sec)	40-45	2	2	Low
IV to VI	1620 (s) ≈ 27 m	4×20 m Shuttle Run	30-35	3	2	Low
		Short Distance Sprint 30 m	8-12	3	2	Low
		High Knee 40 m (Front-Left-Right-Back)	45-50	3	2	Low
		Lunging 20 m	36-42	3	2	Low
		Push up (15 count)	30-35	3	2	Low
		Squat (15 count)	30-35	3	2	Low
		Plunk (15 Sec)	15-20	3	2	Low
		Skipping (50 Sec)	40-45	3	2	Low
VII to IX	1962 (s) ≈ 33 m	4×20 m Shuttle Run	25-30	3	3	Medium
		Short Distance Sprint 30 m	7-10	3	3	Medium
		High Knee 40 m (Front-Left-Right-Back)	37-42	3	3	Medium
		Lunging 20 m	30-35	3	3	Medium
		Push up (15 count)	25-30	3	3	Medium
		Squat (15 count)	25-30	3	3	Medium
		Plunk (15 Sec)	15-20	3	3	Medium
		Skipping (50 Sec)	35-40	3	3	Medium
X to XII	1974 (s) ≈ 33 m	4×20 m Shuttle Run	15-20	4	3	High
		Short Distance Sprint 30 m	5-8	4	3	High
		High Knee 40 m (Front-Left-Right-Back)	35-40	4	3	High
		Lunging 20 m	20-25	4	3	High
		Push up (15 count)	20-25	4	3	High
		Squat (15 count)	25-30	4	3	High
		Plunk (15 Sec)	15	4	3	High
		Skipping (50 Sec)	30-35	4	3	High

'*s*' indicates the unit of time in seconds & '*m*' indicates the unit of time in minutes

Table 2. Time distribution of the training program

Training Weeks	Worm-Up Periods	Training Volume	Cooling Down Periods	Rest Between Repetitions	Rest Between Exercise	Rest Between Sets	Total Rest Periods	Total Training Periods	Training Intensity
I to III	15m	18m	15m	1m	1m	5m	50m	98m	Low
IV to VI	15m	27m	15m	0.75m	0.75m	5m	60m	117m	Low
VII to IX	15m	33m	15m	0.50m	1m	5m	60m	123m	Medium
X to XII	15m	33m	15m	0.50m	1m	5m	72m	135m	High

'*m*' indicates the unit of time in minutes

performed those exercises sequentially without wearing any WV jacket during the training session for twelve weeks. The intensity and the volume were progressively increased. Two to three-minute passive recovery was given between each set of exercises. The detailed protocol of the normalgravity training is shown in Tables 1, and 2 (Biswas & Ghosh, 2022a, 2022b; Ghosh & Biswas, 2020; Macadam, Cronin, et al., 2017).

The subjects of all the groups did not wear any WV jackets during everyday tasks. Both training groups were provided with appropriate warm-up & cooling down exercises for 15m each just before and after the training session respectively. The daily training session (3 days per week) including warm-up, cooling down and rest periods lasted for (90 -120) min approximately. The training sessions were arranged 3 days in a week and it was continued progressively for 12 weeks. Including data collection and resting weeks, a total 14 weeks were consumed to complete the study. Data (baseline and post-test) were gathered on sprinting speed just one week before and after the training intervention on sprinting speed. During baseline data collection, all demographic and physiological parameters were also measured and presented in Table 4.

Measurement Procedure

Sprinting Speed: Sprinting speed, as the only dependent variable, was assessed through a 30m sprint run test for the

Figure 2. The two different types of training executed on grassy turf a: Normalgravity Training Group (NGTG); b: Hypergravity Training Group (HGTG).

Table 3. Weight implemented on the training groups in different training weeks

Training Weeks	Experimental Groups-I NGTG	Experimental Groups-II HGTG	Training Intensity
I & II	NBW	Added weight 4% of MBM	Low
III & IV	NBW	Added weight 6% of MBM	Low
V & VI	NBW	Added weight 8% of MBM	Low
VII & VIII	NBW	Added weight 10% of MBM	Medium
IX & X	NBW	Added weight 12% of MBM	Medium/High
XI & XII	NBW	Added weight 14% of MBM	High

NGTG=Normalgravity Training Group; HGTG=Hypergravity Training Group; NBW=Normal Body Weight; MBM=Mean Body Mass

Table 4. Demographic and physiological description of the subjects

Name of the Groups	No. of Subjects (N=105)	Age (years)	Height(cm.)	Weight (Kg.)	BMI ($Kg.m^{-2}$)	RSBP (mmHg)	RDBP (mmHg)	RHR ($beats.min^{-1}$)	HRmax ($beats.min^{-1}$)	TA (Years)
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
NGTG	35	19.06±1.19	170.51±6.05	59.89±7.40	20.66±2.89	118.34±4.24	77.56±3.44	67.64±1.65	194.67±0.96	9.64±1.22
HGTG	35	18.71±1.15	169.05±11.29	60.04±8.45	21.23±4.18	120.82±5.62	79.33±3.82	68.54±3.42	194.91±0.88	10.20±1.04
CG	35	18.89±1.37	170.22±8.97	60.17±9.73	20.92±4.05	122.82±3.55	77.94±3.78	70.10±2.64	194.78±0.92	9.76±1.31
Total No. of Subjects=105										

NGTG=Normalgravity Training Group; HGTG=Hypergravity Training Group; CG=Control Group; BMI=Body Mass Index; RSBP=Resting Systolic Blood Pressure; RDBP=Resting Diastolic Blood Pressure; RHR=Resting Heart Rate; HRmax=Maximum Heart Rate, TA=Training Age present study. Data was collected in seconds (s). The time data of 30m sprints of each participant were converted into sprinting speed by the formula: $Speed = \frac{Distance}{Time}$ or $S = \frac{D}{t}$ i.e. $S = \frac{30}{t}$. It was presented in $m.s^{-1}$.

Measurement of sprinting time(s): 30m sprint run test- This test measures sprinting speed ability. All the subjects were provided a proper warm-up for 15 minutes by following a standard protocol consisting of short running, resistance running, stimulating the muscles, and stretching exercises. *Equipment*: measuring tape, marked 30m track, stopwatch, cone markers, flat and clean grassy turf, starting clapper, highly experienced time keeper, scorer (Figure 3). *Pre-test instructions*: Entire test procedures were explained to the subjects with practical demonstration. *Testing procedure*: The test consists of just one maximum sprint running over 30 m. The 'time' in seconds to cross the distance was recorded by a stopwatch as data. A maximum of two practice trials was given. Subjects were motivated to give their best possible effort. Standing start was used. Score: Two trials were allowed. The best time in one hundredth of a second is considered as data. At least 45 min of rest was given between two trials.

Resting Heart Rate (RHR) measurement: After 30 minutes of absolute rest, the measurement of heart rate of the participants was performed. The subjects were instructed to lie down for 3-5m and breathe calmly just prior to the measurement. Resting heart rate of all the participants was measured at the radial artery of the right hand. In this measurement by the help of a wrist-watch heart beats were counted as felt on the right radial artery in the 30s. This value was converted into beats per minute (BPM), simply multiplying by two. Thus the unit of measurement was beats per minute ($beats.min^{-1}$).

Blood Pressure (BP) measurement: Measurement of Systolic and diastolic blood pressures of all the subjects were done by a digital pressure machine (BP-09, Jotech Healthcare). It was operated as per the guidelines written in the manual. The unit of measurement was mmHg (Shakoor et al., 2020).

Maximum Heart Rate (HR_{max}) estimation: For estimating maximum heart rate a regression equation developed through the prediction of age (Tanaka et al., 2001) was used as shown below: R_{max}= 208-0.7×Age. Age was measured in years from birth certificates. The unit of maximum heart rate was same as heart rate i.e. beats per minute ($beats.min^{-1}$)

Instruments Used for the study: A brass-made anthropometric rod (Aarson Scientific Works), was utilized to estimate the height of all the participants. A digital weighing machine, model No: Omron HBF-212 was used to measure the body mass. A digital machine (BP-09, Jotech Healthcare) was used to measure blood pressure (Sys & Dia).

Figure 3. Measurement of sprinting speed, a: starting point; b: finishing point.

Statistical Analysis

In the pre-test (baseline) condition the reliability of the collected data was justified by using a coefficient of correlation. The collected data were analyzed and presented in mean & standard deviation. Data normality was confirmed by the Kolmogorov–Smirnov test. Therefore, parametric inferential statistics analysis of covariance (ANCOVA) was adopted for comparing the means of sprinting speed for different groups in baseline and post-intervention conditions. Inter group comparisons of the mean value were performed by Tukey's LSD post-hoc test. Significance of the mean was tested at p<.05 level. To make the analysis more clear, % of change in sprinting speed from pre to post-test were calculated by using the following equation:

Δ% = [(Adjusted Post Test Mean – Baseline Mean) × 100/Baseline Mean]

Data normality through the Kolmogorov-Smirnov test was performed by *Social Science Statistics Software*. *Vassar Stats*, a software package for statistical calculations, was used for computing the ANCOVA. In the excel spreadsheet, Tukey's LSD test and related other calculations were performed.

RESULTS

In terms of adherence to the training programs, the HGTG participated 34.6 ± 0.14 sessions (96.11%), the NGTG participated 34.3 ± 0.46 sessions (95.28%) out of a total 36 sessions in the training program. All the subjects in the different training groups (NGTG & HGTG) participated minimum 88% of the scheduled classes in the training program. No adverse events occurred during or outside of the training sessions. The detailed descriptive data of the subjects have been presented in Table 1. In this table the Division of Groups, No. of subjects in each group and as a whole, age (years), height (cm.), weight (Kg.), BMI ($Kg.m^{-2}$), RSBP (mmHg), RDBP(mmHg), RHR ($beats.min^{-1}$), HR_{max} ($beats.min^{-1}$) and training age (years) were presented for all the groups.

During the intervention of the training protocol for twelve weeks the subjects were constantly monitored and motivated so that they could participate in the training program with a positive mind set. They strictly followed the guidelines and participated in the training schedule without any negligence and unwilling absence. The participants enjoyed the training sessions and co-operated with the researchers throughout the course of study.

In Table 5 the ANCOVA on Sprinting Speed among NGTG, HGTG & CG have been presented. It was observed from Table 5 that the F value in the adjusted post-test was found significant [F (2,101) = 61.122; p < 0.001]. It confirmed that all the three groups (HGTG, NGTG & CG) differed significantly in sprinting speed. To be confirmed which group differed significantly to whom the intergroup mean

Table 5. Analysis of covariance (ANCOVA) on sprinting speed among NGTG, HGTG & CG

Test	NGTG ($m.s^{-1}$)	HGTG ($m.s^{-1}$)	CG ($m.s^{-1}$)	Source of variance	Sum of squares	df	Mean squares	'F' Ratio	p-value
Baseline Mean±SD	5.93±0.32	5.84±0.29	5.88±0.42	Between	0.17	2	0.08	0.698	0.555
				Within	12	102	0.12		
Post Treatment Mean±SD	6.72±0.73	7.10±0.40	5.84±0.29	Between	29.39	2	14.69	57.184	0.001
				Within	26.21	102	0.26		
Adjusted post test Mean	6.70	7.12	5.84	Between	29.74	2	14.87	61.122	0.001
				Within	24.57	101	0.24		
(Δ %)	12.98%	21.91%	- 0.68%						

NGTG=Normalgravity Training Group; HGTG=Hypergravity Training Group; CG=Control group; SD=Standard deviation; df=Degree of freedom; Δ % = Percentage of Improvement in sprinting speed.

differences were compared by post-hoc Tukey's LSD test which have been presented in Table 6.

From Table 6 it was found that the HGTG and NGTG while compared with the CG the mean differences (1.28 & 0.86) were found higher than the critical difference (CD) value (0.41). So, both the training groups (HGTG & NGTG) had improved significantly compared to the control group (CG). A significant mean difference (0.42) was found (CD value = 0.41) that confirmed the significant difference between the HGTG and NGTG in sprinting speed.

After the completion of the 12 weeks training programs, it was found that the *% of change* (Δ %) *in sprinting speed* between baseline and adjusted post test condition for NGTG, HGTG & CG were 12.98%; 21.91%; & -0.68% respectively. It was also observed that the mean difference between HGTG and NGTG was significant. Therefore, the result confirmed that both experimental groups i.e. hypergravity training group (HGTG), and normalgravity training group (NGTG) were significantly improved with respect to the control group (CG) in sprinting speed. It was also observed that the HGTG improved best (21.91%) in sprinting speed due to twelve-week training intervention compared to NGTG (12.98%) and CG (-0.68%). It confirmed that the HT was more effective than NT for the development of sprinting speed.On the basis of the findings the hypothesis as drawn at the very outset of the research work was completely accepted. The details of the mean values of sprinting speed have been depicted with respect to different groups and training conditions in Figure 4 & 5 respectively for better understanding the research outcomes.

Table 6. Post-hoc tukey's LSD test among different groups in sprinting speed for adjusted mean score

Adjusted Mean Scores for different groups			Mean Difference (MD)	Critical difference (CD)
NGTG	HGTG	CG		
6.70	7.12		0.42*	0.41
6.70		5.84	1.28*	0.41
	7.12	5.84	0.86*	0.41

*Sign indicate that the values are significant at $p<.05$ level

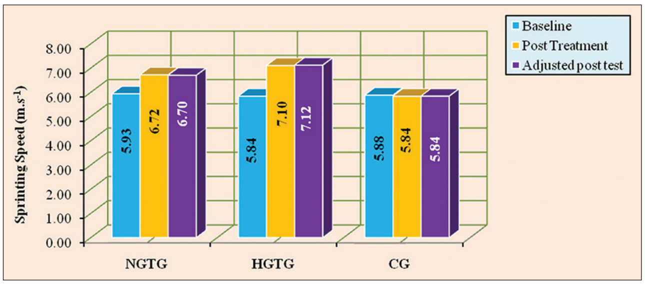

Figure 4. Mean values of sprinting speed in baseline, post treatment and adjusted post test for different groups (NGTG, HGTG & CG)

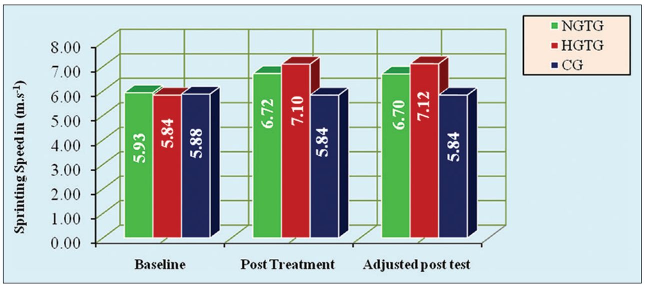

Figure 5. Mean values of sprinting speed for NGTG, HGTG & CG in baseline, post treatment & adjusted post test

DISCUSSION

The present research work was designed to investigate the effect of hypergravity training (HT) on sprinting speed of the cricketers in comparison with the traditional normalgravity training (NT). After the completion of twelve weeks of experimentation, it was seen that both training groups (HGTG & NGTG) led an improvement of 21.91% & 12.98% respectively in sprinting speed in comparison to the control group (CG) which showed -0.68% improvement. Therefore, HT proved more effective than the traditional NT for developing sprinting speed. Thus, the findings of the study confirmed that HT is far better than the conventional NT, usually used by the coaches and trainers most often in normal field settings. The improvement of sprinting speed of the HGTG was surprisingly high enough (21.91%) and proved more successful than the traditional NGTG. Thus HT as an unconventional training method can be a very good alternative to the coaches while targeting to develop the muscle power of the lower limbs and sprinting speed of the cricketers, moreover, the player's related to other games also within a considerably less possible time. As the cricketers have to carry additional weight of the equipment & protective gears (bat, helmet, Chest Guard, elbow guard, gloves, box, thigh pad, pads of both leg, shoes etc.) for hours long which is compulsory to put on their body during batting, wicket keeping and to a lesser extent while fielding this type of HT through WV gives an opportunity to adopt carrying additional weight into habituation that can also be aid to improve not only the sprinting speed but also the power of their antigravity muscle groups sustaining during the batting for long periods of time. This type of weight vest habituation can be helpful to the players during performance also.

Coaches & trainers using traditional training means like NT, towards the improvement of lower-body power and sprinting speed, finally achieve a very little improvement in the comparatively less trainable fitness factors like sprinting speed even after providing enormous effort for years long in the field. The players involved under such type of conventional training means reached to a certain stage of performance saturation after some quick initial improvement usually faced a plateau (Barr et al., 2014) called speed barrier– no further improvement observed after a certain level of achievement in sprinting speed, eliciting no further training adaptation happens (Barr et al., 2015).Very often, an experienced athlete has reached such a speed plateau, in which his or her training no longer yields faster speeds. This stabilization of the athlete's speed qualities is the speed barrier. In order to break this speed barrier, training conditions and means should be replaced with a new one. Sometimes coaches presume that the players were negligent during the training sessions and blame the support staff and even the players for their honesty during the training periods. However, they do not look down to investigate the training methods they adopted, the affectivity and limitations of the training means never judged at all.

In the present study the enhancement of sprinting speed of the HT group was found best that could be happen due to the positive adaptation of the training intervention, at the same time the intervention duration was adequate (twelve weeks) with gradual enhancement of added weight (4% of MBM up to 14% of MBM) and training intensity (low-moderate-high). Adequate recovery periods were also given between the exercise, between the repetitions as well as between each set to the participants both for the HGTG & NGTG. In the training session, HGTG group was given sufficient warm-up and cooling down with a weighted vest that can also help for training adaptation more. Similar result of improvement in speed and power was observed in few studies conducted on athletes and rugby players with weighted vest (10% - 12% MBM) HT (Bosco, 1985; Bosco et al., 1984; J. Cronin et al., 2008; Scudamore et al., 2016). Again few studies reported that HT improves the lower-body power (Barr et al., 2015) that can happen for the subjects of the present study which helped during sprint running. However, in few studies opposite impact of HT was reported, few of them reported that due to the implementation of weight vest the ground contact time (GCT), stride frequency, stride length (SL), relative SL were reduced but the flight time (FT) increased that may negatively affect sprinting speed (Macadam et al., 2022; Scudamore et al., 2016; Simpson et al., 2020). Again due to the adaptation of the HT lead to an increase in the force production rate, which consequently lead to a decrease in ground contact time (GCT) and an increase in flight time (FT) as a result acceleration of the training group significantly decrease whereas the same group showed an improvement in weighted counter movement jump (CMJ) (Barr et al., 2015). One study reported that Wearable Resistance (WR) of 3% or 6% MBM overloaded the subjects that subsequently decreased the propulsive force & muscle power and velocity as a result of reduced jump height and landing force (Macadam, Simperingham, et al., 2017). It is reported that wearing weighted vests (5–10% MBM of 3 days/weeks) in daily-living activities excluding the time of sport and physical activities improved agility-type performance of young men (Rantalainen et al., 2012). On the other hand, while investigating the effects of WV loading in daily-living activities on counter movement jump (CMJ) and sprint performance no significant improvement in jump and sprint performance was observed due to WV training (Simpson et al., 2020) whereas in some previous investigations conducted on the elite athletes (male) a robust significant improvement was observed in high intensity anaerobic performance tasks due to the implementation of greater WV loads (Lowe et al., 2016; Rantalainen et al., 2012). A study conducted on the male soccer players with and without weight vest training showed significant improvements in 10-m & 30-m sprint performances and repeated sprinting ability (RSA) from pretest to posttest for both groups (Rey et al., 2017). Again in a study, conducted on twenty-three (n=23) soccer players (age 20.8 y) the force-velocity-power profile was tested through a variable load weighted vest during sprinting. In this study the players executed ten maximal 30-m sprints with 5 different added loads (0%, 10%, 20%, 30%, and 40% MBM) from which it was seen that when load heavier than 20% MBM the force production reduced considerably, consequently, the study recommended to implement load ≤ 20% MBM for improving sprinting ability through WV training (Carlos-Vivas et al., 2019). In this investigation the researchers followed the guidelines of the above study and restricted themselves while implementing load on the cricketers, therefore, maximum load was limited to 14% of MBM (≤ 20% MBM). In an experiment on military personnel with and without a weight vest, experimental groups were compared with the control group in a shuttle run where no significant difference of improvement was observed between the experimental groups (Swain et al., 2010, 2011).

Like the present research work, in a previous study the researchers (Scudamore et al., 2016) examined the effects of hypergravity training (HT) for the periods of three weeks on anaerobic performance. The study also used HT protocol by means of weighted vests where the participants were worn vest load 8 hours per day, 4+ days per week. The weight was gradually increased from 11.2 ± 0.6% MBM in the first week and enhanced to 13.2 ± 0.7% MBM in the 2nd -week and finally 16.1 ± 0.4% MBM in the last week. A total of nine active men (N = 9) completed three-week HT. Improvement of Performance (Sprint time) was recorded from Baseline

(4.69 ± 0.29 s) to the post treatment i.e. at end of 3rd week (4.58 ± 0.22 s) recorded a total improvement of sprinting time of 2.40%. Therefore, HT for the periods of three weeks significantly enhanced short running performances. In a systematic review study conducted by (Macadam et al., 2022) examined the effects (both acute & longitudinal) WV during sprint-running where initially170 articles retrieved from various sources, among those 11 studies were finalized (6 acute & 5 longitudinal) by satisfying the inclusion criteria. In this study they observe improvements in speed (1.2–1.3%) and times (1.2–9.4%) for the longitudinal studies. The studies used WV of 5.6–18.9% MBM for 3–7 weeks. A study was conducted by (Simpson et al., 2020) where the subjects wear WV during every day task and training as well to examine its effect on sprint performance of trained females (experimental group size, N = 9 & control group (CG) size, N = 10). The experimental group wore weighted vest of ~8% MBM for 4 days per week for 8 hours per day (total 32 hours per week). In this study subjects performed three training sessions in a week for the first three weeks. Subsequently, they performed in regular exercise program without WV for another three weeks to complete the schedule. The CG did not involve any kind of WV physical training program, just normal exercise for six weeks. Sprint running performances were measured through Twenty five-meters sprint runs at baseline, after completion of the 3rd week and 6th week as well. No performance improvements observed in sprinting time for the female athletes with weighted vest training. In the present study the hypergravity training was also implemented through weighted vest (starting from added weight 4% of MBM and gradually increased up to 14% of MBM) worn by weight jacket by the cricketers (3.5 - 4.5) hours/day and 3 days/week for a total periods of twelve weeks shown an improvement of sprinting performance 21.91% from baseline to post treatment. Thus all the studies showed HT as an effective training means for the improvement of sprinting time or sprinting speed.

Thus in most of the studies, HT proved as an effective training means than the traditional NT for the development of sprinting speed. Therefore, the findings of this study confirmed that HT is far better than the traditional NT, usually used by the coaches and trainers most often in normal field settings. At the beginning of this study it was hypothesized that twelve weeks WV hypergravity training would be impactful for the improvement of sprinting speed of the cricketers. The findings of the study support the hypothesis, therefore, it is accepted. The improvement of sprinting speed of the HGTG was surprisingly high enough (21.91%) and proved very successful than the traditional NGTG group. Thus HT as an unconventional training method can be a very good alternative to the coaches while targeting to develop the muscle power of the lower limbs and sprinting speed of the cricketers, moreover, this training can also be extended to the player's of other games also that will surely improve the sprinting speed within a considerably less possible time.

From the above discussion it is clear that sprinting speed depends on various factors like acceleration ability, stride length (SL), stride frequency (SF), ground contact time (GCT) and flight time (FT). Acceleration ability is largely determined by the propulsive force as produced by the anti gravity muscle group specially the extensor muscles of hip, knee, and foot. To get greater acceleration it is necessary to strengthen the above muscle groups that allows greater force production and reduced GCT, consequently leading to an increase in SF as well (Maćkała et al., 2015). Sprinting ability is the summation of numerous stretch shortening cycles (SSC). In SSC maximum force production depends on the utilization of elastic energy in amortization phase (support phase) (Mero & Komi, 1986). This ability increases with the increased SL. HT being a special unconventional training means may lead to an increase in the production of force output of the above muscle groups that can be a leading cause for increasing the SL. As a result, overall sprinting speed may increase due to the intervention of twelve weeks HT. From the above discussion the exact cause of the improvement of sprinting speed is not clear. To justify the actual cause of the improvement of sprinting speed due to the intervention of HT on the cricketers need further study which will measure different factors of sprinting speed like acceleration ability, stride length (SL), stride frequency (SF), ground contact time (GCT) and flight time (FT), moreover, it is also needed to study on the lower-limb muscle power and the measurement of force production simultaneously. Then only the exact effect of HT can be justified for the improvement of sprinting speed. In the present study weight is implemented for approximately three hours per day and three days per week. This time of WV should be extended and if possible WV loading should also be extended not only prior and after one hour during exercise time but at the time of daily living activities also. It is also felt by the researchers that the effects of WV should also be considered during daily life activities. In future if any study on HT be planned it is recommended to incorporate weight vests by means of WR not only on the trunk but can also be loaded in the upper and lower limbs.

Strength and Practical Implications of the Study

Improvement of sprinting speed for the players with an extensive training experience through conventional training methods looks really challenging to the coaches and trainers. At the very outset it becomes effective but after an initial level of improvement in sprinting speed these training means fail to progress further in spite of spending enough time and providing the best possible effort in the field by the coaches and players as well. The trainers feel the limitations of those traditional training means as they become ineffective in this situation in the field. In this phase of training the coaches and trainers' requires a more specific and acute training stress followed by a recovery in a constant cyclic manner according to the demand of the players. *Hypergravity Training* (HT) implemented through weighted vests has been identified and proved to be a new type of training that could be used in these situations for the improvement of speed and power of the experienced players not only in cricket but for the players in almost all games and sports. As it has become crystal clear from the findings of the present study that hypergravity training through weighted vest (externally added load) proved very effective (Δ % = 21.91) for the improvement of sprinting speed, this unconventional training method could be a very good alternative to the coaches while targeting to develop the muscle power of the lower limbs and sprinting speed of the players in a considerably less possible time. Hypergravity weight vest loading can also be implemented on the players during their daily living activities according to their comfortable situation that can save the time and efforts of the players and coaches for further improvement of performance in the field, which is surely the true strength of this study.

CONCLUSION

From the findings of this research work it can be concluded that - 1) the sprinting speed of the cricketers for both experimental groups (HGTG & NGTG) significantly improved with respect to the control group (CG) after the twelve weeks' sprint training intervention with and without implemented weighted vest. 2) But the HGTG improved significantly better than the NGTG in sprinting speed. Thus HT was found to be significantly better than NT for the development of sprinting speed. It confirms that hypergravity training (HT) is a better choice than conventional normalgravity training (NT) while directed towards the improvement of the sprinting speed for the cricketers.

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