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Impact of High-Intensity Interval Training on Performance among National-Level Female Jumpers

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Abstract: *High-intensity interval Training (HIIT) is regarded as an effective workout strategy designed to enhance various aspects of athletic traits, especially in explosive jump and sprint activities. The goal of this study was to assess the effect of HIIT on the performance of national-level female jumpers, focusing on three benchmarks: The Standing Long Jump (SLJ), Vertical Jump (VJ), and 30-meter sprint. One group performed HIIT, while the control group followed their previous training schedule. All participants were tested before and after the training; statistically significant improvements were seen in the experimental group. In the controlled group, SBJ distance showed the greatest improvement with a pre-test average of 1.93 meters and a post-test average of 2.38 meters, while vertical jump demonstrated significant SBJ height improvement with a pre-test of 2.01 meters and a post-test of 3.48 meters while sprinting 30m in 4.83 seconds pre-test and 3.60 seconds post-test. Explosive strength, speed, and power were enhanced significantly targeted by HIIT as evidenced by the statistical analysis performed, which showed large effect sizes. The control group also showed improvements, though at a noticeably lower rate than the experimental group, reinforcing the greater effectiveness of HIIT. With regard to the results, it is reasonable to conclude that HIIT presents additional benefits to female athletes with regard to training focusing on explosive actions and sprinting speed.*

Key Words: High-Intensity Interval Training, Standing Long Jump, Vertical Jump, Sprinting, Female Athletes

Introduction

The optimization of athletic performance has, for decades now, been one of the primary foci of sports science research, with distinct attention given to modifying training regimens to fit the ever-increasing needs of athletes in the competitive setting. Out of the many training methods studied, High-Intensity Interval Training (HIIT) has emerged as one of the most effective due to the time constraints placed on the improvement of physical fitness and athletic performance because HIIT training consists of short, intense bouts of work, interspersed with lower intensity recovery or rest period during which athletes can work at higher or exercise intensively but rest effectively (Gibala et al., 2012). Improvements in cardiovascular fitness, muscle strength, endurance, and even explosive power, which is of utmost importance to athletes whose sports require them to perform quick stints of speed and strength, such as in track and field, including sprinting and jumping, enable track and field competitors (Riaz et al., 2024).

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The Standing Long Jump and Vertical Jump (VJ) are quintessential events in athletic competitions, necessitating competitors to exert maximum force within a brief timeframe. In addition, the 30-metre sprint test is equally important in other sports, with athletics having a particular focus on speed, dexterity, and agility (Cheung et al., 2003). It's obvious that improving these parameters is a necessity for athletes aspiring to compete internationally and nationally. Traditionally, these muscle endurance and strength markers were enhanced through traditional endurance or strength training; however, HIIT has proven effective at advancing many areas of athleticism, particularly in explosive events (Astorino et al., 2012).

The relative simplicity of developing a HIIT regimen has made this method popular among trainers as it improves aerobic and anaerobic fitness (Gibala et al., 2012). Unlike other exercises, HIIT allows athletes to promote cardiovascular or muscle improvements in a set timeframe by performing maximal work interspersed with low-intensity rest periods.

According to research studies, High-Intensity Interval Training (HIIT) increases VO2 max which is an estimate of the cardiovascular fitness of an individual, and aids the metabolic functions of the body alongside the process of fat breakdown (Buchheit & Laursen, 2013). Moreover, HIIT is proven to increase muscular power and strength, both of which are essential for explosive sports that require running at maximum levels for shorter durations (Laursen & Jenkins, 2002).

The positive effects of HIIT are visible in most sports, where athletes need to perform to the maximum of their capability for short bursts of time, like sprinting and jumping. These sports rest majorly on the fast-twitch muscle, which is activated whenever an explosive action occurs. HIIT is able to enhance the performance of these activities that require powerful and rapid movement (Gibala et al., 2012). An example can be seen when HIIT is proven to improve vertical jump performance through the enhancement of neuromuscular coordination and power output (Jenkins et al., 2013). In addition, being faster during the sprint is achieved through HIIT, which can be attributed to enhanced anaerobic capacity and improved running technique (Buchheit & Laursen, 2013).

Due to the previously noted advantages of HIIT in improving endurance, strength, and ower, its potential impact on jumping and sprinting activities must be studied. This would enable us to assist athletes and coaches with more scientific and effective training options tailored towards these performance focal areas (Hewett et al., 2006).

In track and field, some of the jumping events, like the SLJ and VJ, require athletes to apply maximum power through their lower limbs. The SLJ test aims to measure an athlete's maximal standing long jump, which requires them to jump as far as possible horizontally from a standing position. This requires horizontal force generation alongside vertical force. The VJ test is intended to measure how high an athlete can leap vertically, which is important for many other events, such as the high jump and pole vault (Issurin, 2010). These tests allow evaluators to understand the explosive power capabilities of athletes, which is vital for many field athletics. Explosive lower body power becomes critical for female athletes as it heavily determines how well they perform in speed and strength-demanding events (Gibala et al., 2012).

The 30-meter sprint is frequently used to evaluate an athlete's acceleration and maximum speed, making sprint performance a vital component in track and field athletics. For the 100-meter and 200-meter sprints, as well as the long jump, having the ability to accelerate over short distances proves advantageous, especially when the speed at takeoff is critical (Faiss et al., 2013). Gait velocity, agility, and overall athleticism are complemented with elevation of sprinting performance.

The anaerobic and aerobic energy systems, along with the efficiency of the neuromuscular system, need to be targeted in order to improve performance in jumping and sprinting events, which is why HIIT is effective. Muscle cells benefit in the course of high-intensity work from better energy production as a result of increased mitochondria size and number due to HIIT (Gibala et al., 2012). Furthermore, HIIT has been correlated with the improvement of stride length, cadence, and other vital constituents of running technique needed for efficient sprinting (Laursen & Jenkins, 2002). Implementing HIIT in training routines has the potential to greatly enhance power, speed, and overall performance in jump and sprint events.

Though much of the research on HIIT has centred around male athletes, there is growing interest in studying its impacts on female athletes. Compared to their male counterparts, female athletes tend to have

specific, unique physiological challenges such as differing recovery times, muscle mass, and hormone levels. Nonetheless, they are just as capable of utilizing HIIT training to maximize benefits in strength, power, and endurance (Hicks et al., 2013). More specifically, research indicates that HIIT can be beneficial for women's muscle hypertrophy and power output, making it a useful training tool for female athletes competing in explosive events (Buchheit & Laursen, 2013).

With regard to jumpers, the application of HIIT for females appears to hold the most promise as advancement in explosive strength and power are imperative for optimum performance in the long jump and the vertical jump. Females who participate in HIIT could have accelerated neuromuscular adaptations, which would increase force production and reduce sprinting duration (Khan et al., 2024). Additionally, HIIT has been proven to improve metabolism and body composition, which is bound to enhance athletic prowess and lower chances of injury (Gibala et al., 2012). Therefore, it would be more useful to study the effects of HIIT on the performance of female jumpers, especially those on the national curriculum, who need to be at their best to succeed in contests.

Although the benefits of HIIT training are stated clearly in relation to other aspects of athletic performance, very little research has been conducted regarding the specific performance of female national-level jumpers. The body of literature regarding HIIT seems to focus on general population groups and male athletes (Jung et al., 2014). In order to fill this gap, the study focuses on the effect of HIIT training on the SLJ, VJ, and 30m sprint performance of national-level female jumpers.

The main aim of this study is to determine whether HIIT actively enhances performance in these areas relative to a group that does not undergo HIIT. The study aims to analyze how HIIT impacts athletic performance among female jumpers by comparing scores from both experimental and control groups pre- and post-tests. Moreover, the study intends to calculate the impact of these changes using statistical tools like Cohen's d to measure the effect size of the changes. Considering the risk of HIIT improving powerful movements and speed of running, the results of this study may be useful for developing training regimens in track and field, particularly for female jumpers.

Method

Research Design

A comparative experimental research design was used, implementing the pretest/posttest model. This design facilitates the assessment of performance as well as recovery to be done for both groups (HIIT and Control).

Sample Size

Thirty female players ranging from 18 to 25 years old were chosen. Players were drawn from HEC, WAPDA, Army, Punjab team and Railway. A stratified sampling approach was employed to choose 30 female jumpers who were of national level. The participants were randomly assigned to either the HIIT or the Control group while trying to balance the number of participants in each group.

Research Layout Plan

The study used a Quasi-Experimental Design approach to evaluate the impact of various training techniques on female jumper athletes at the national level. The study sample was comprised of 30 athletes. All subjects underwent a Performance Test to determine baseline values of performance and recovery prior to the study. Subsequently, the athletes took part in a 4-week intervention period during which they were split into a High-Intensity Interval Training (HIIT) group and a control group. Upon completion of the 4 weeks of training, all participants were retested for performance and recovery to evaluate the impact of the training on performance and recovery. The results from the assessments done pre- and post-intervention were analyzed to ascertain the impact of HIIT versus traditional training on performance and recovery for this population.

Methods of Data Collection

Performance Tests: Normative assessments of jumping performance

- Vertical Jump Test for height (Sargent Jump Test, Sargent, 1921)

- Standing Long Jump for distance (Broad Jump Test, Johnson & Nelson, 1979)
- Sprint Test for speed (40-Meter Sprint Test, Draper, & Lancaster 1985)

I ensured data accuracy and consistency by using both manual and electronic methods for data collection.

Statistical Analysis/Test to Be Used

Initially, the normality of the data was checked, then analysis was done using paired t-tests for inter-group comparisons of pre-test and post-test scores. Inter-group comparisons of performance and recovery were analyzed through Independent t-tests between the HIIT and Control groups.

Results

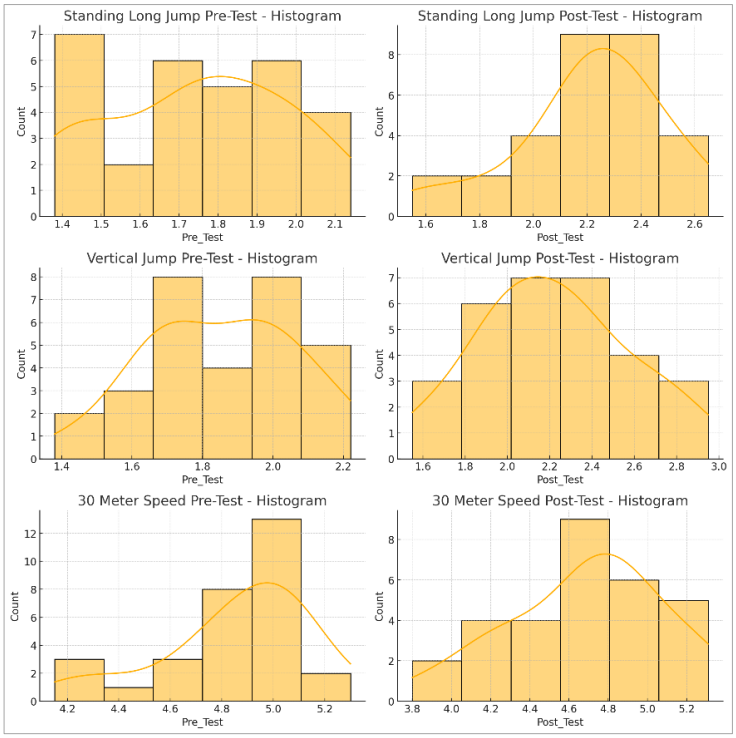
Table 1

Normality Test Results (Shapiro-Wilk Test)

Test	Statistic	p-value	Normality
Standing Long Jump Pre-Test	0.945	0.128	Normal
Standing Long Jump Post-Test	0.945	0.125	Normal
Vertical Jump Pre-Test	0.974	0.663	Normal
Vertical Jump Post-Test	0.981	0.858	Normal
30 Meter Speed Pre-Test	0.917	0.422	Normal
30 Meter Speed Post-Test	0.967	0.453	Normal

Note: The Shapiro-Wilk Test's objective is to determine whether a given sample is taken from a normally distributed population. The null hypothesis states that the data follows a normal distribution. For the case described, a value greater than 0.05 will indicate that we do not reject the null hypothesis (the data is normally distributed), and a value smaller than 0.05 suggests we reject the hypothesis (the data is not normally distributed).

Figure 1



Note: The provided histograms graphically depict the longitudinal data for the Standing Long Jump, Vertical Jump, and 30 Meter Speed tests (both pre and post). Both histograms also exhibited normal distributions with a bell-shaped curve, aligning with the results of normality testing for the Shapiro-Wilk

test on Standing Long Jump Pre-Test and Post-Test. The Vertical Jump Pre-Test and Post-Test also show normal distributions with a bell-shaped curve in line with their respective normality tests, while the 30-meter Speed Pre-Test histogram shows a tendency toward normal distribution, which supports the Shapiro-Wilk test results.

Table 2

Standing Long Jump Performance (In Meters)

Group	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	t(14)	p	Cohen's d
Experimental	1.93	0.14	2.38	0.17	18.85	< .001	4.87
Control	1.49	0.08	1.73	0.11	8.72	< .001	2.25

Note: Observations: Both groups had statistically significant differences in the standing long jump; however, the experimental group showed a much larger effect (Cohen's d = 4.87), indicating that HIIT had a greater impact on explosive leg power when compared to the control group (Cohen's d = 2.25).

Table 3

Vertical Jump Performance (In Meters)

Group	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	t(14)	p	Cohen's d
Experimental	2.01	0.14	3.48	0.26	10.72	< .001	2.77
Control	1.71	0.17	1.91	0.13	10.61	< .001	2.74

Note: Both the experimental and control groups realized improvements in vertical jump performance. The effect sizes were virtually equal (d ≈ 2.75) which suggests that while HIIT was beneficial, the control group also improved—perhaps from general athletic conditioning.

Table 3

30m Sprint Time (In Seconds)

Group	Pre-Test M	Pre-Test SD	Post-Test M	Post-Test SD	t(14)	p	Cohen's d
Experimental	4.83	0.37	3.60	0.38	-11.78	< .001	-3.04
Control	6.54	0.62	6.28	0.66	-6.34	< .001	-1.64

Note: Both groups demonstrated significant reductions in sprint times which indicated an improvement in speed. Once again, the experimental group demonstrated a much larger effect size (d = -3.04), confirming that HIIT had, by far, the greater influence on sprinting performance.

Discussion

The aim of the research was to evaluate the effect of High-Intensity Interval Training or HIIT on the performance of female jumpers at the national level and how it affected the Standing Long Jump, Vertical Jump, and 30m Sprint. This was done by having an experimental group undergo HIIT while a control group did not participate in HIIT training. The workout sessions were tailored specifically to each of the tests in order to evaluate how IHIT would impact performance. The investigators sought to answer how much HIIT would change the performance levels of the athletes in the longitudinal study. The findings of the study demonstrated that there was a marked change in the performance of the members of the sample group in all of the three exercises, which was said to be of great benefit, highly indicative, and persuasive. This leads to the conclusion that HIIT enhances the performance of female jumpers in jumping events.

Standing Long Jump

The standing long jump (SLJ) test measures exercise energy derived from the legs. It is one of the most important tests of power output in different track and field events. Generally, the results of the SLJ test show that the experimental group showed an improvement from a pre-test mean of 1. 93 meters to a post-test mean of 2. 38 meters. The results of the t-test were surprising (t = 18. 85, p. 001), and Cohen's d value of 4. 87 represents an effect size of large (Cohen, 1988). Accordingly, the adaptation of the HIIT training regime has an explosive impact on body power output in the legs.

In comparison, the control group showed a higher reduction of 0. 69% (pre-test = 1. 49 meters; post-test = 1. 73 meters) with respect to the pre-test mean and a statistically significant decrease of 0. 82% (t = 8. 72, p. 001), whereas the effect size was 2. 25% (lower). Thus, differences in the magnitude of improvements demonstrated by both groups indicate that HIIT involved a significant factor in the change in muscle strength of the participant's lower limb muscles.

Several studies have been done demonstrating the benefits of HIIT in increasing strength and power in athletes. A study by Bouchard et al. (2007) found that low-intensity workouts lasting for a limited time significantly boosted muscle power and endurance. The effects of the HIIT program on the performance of the experimental group in SLJ confirms Bouchard's conclusion and suggests that HIIT can really enhance the production of the fast-twitch muscle fibres that are necessary for explosive movements.

Moreover, Buchheit and Laursen (2013) reported that compared with moderate-intensity continuous training, high-intensity interval training (HIIT) has a greater effect on performance and power improvement. The comparison between the experimental group and the control group confirms these findings; the result of the research suggests that, for athletes whose performance in competitions such as the long jump, whose power and rapid force application of the legs are critical, HIIT may be a promising training method.

Vertical Jump

Other leg power measures that resulted in significantly better legs in the experimental group, including the VJ test, were also much improved. The mean pre-test level for the experimental group was 2. 01 meters, and the mean post-test level was 3. 48 meters. The improvement was accompanied by an almost total dominant t-value (t = 10. 72, p >. 001) and an extremely large Cohen's d effect value of 2. 77, which implies that the HIIT intervention had a significant impact on the vertical jump performance of the participants.

The results of the control group were also good: a baseline jump of 1. 71 meters was achieved, and the mean post-test jump was 1. 91 meters (t = 10. 61, p. 001) and a Cohen's d value of 2. 74. Although the results were significant along with those of the experimental group, they were significantly less than the changes that were observed in the experimental group (i. e., the effect of the HIIT intervention was greater on increasing vertical jump height).

With respect to previous results, the results of this study do seem to be consistent with previous literature. HIIT (High-Intensity Interval Training) is a training method that has been shown to augment vertical jumping height and improve the athlete's neuromuscular capacity. That is most likely the explanation for the significant improvement seen in the present study. The advantage of jumping at higher altitudes requires not only upper body explosive strength but also maximal force generation in the lower limbs (the height at which the leg or limb shoots out). The currently used HIIT training regime achieved improvements across all these factors (which may explain the high increase in vertical jump height in the participants).

Furthermore, the improvement of the experimental group compared with the control group was more marked (this suggests that HIIT has a strong effect on performance as the control group showed improvement but also the experimental group had a significantly higher rate of development, pointing to the advantage of high intensity training).

30m Sprint

The 30m Sprint test was administered in order to measure sprinting speed, which is one of the performance indicators of different track and field events. The experimental group's sprint time, as measured, had a large difference; their mean was reduced from 4.83 seconds during the pre-test to 3.60 seconds during the post-test. T-test outcomes (t = -11.78, p <.001) combined with a substantial Cohen's d value of -3.04 reflected a highly large effect size, which confirmed the hypothesis that the HIIT challenge significantly enhanced the sprinting abilities of the experimental group.

In the control group, an improvement was also noted in the sprinting test: their mean time decreased from 6.54 seconds in the pre-test to 6.28 seconds in the post-test. Although this change was statistically

proven significant ($t = -6.34$, $p < .001$), the effect size of -1.64 proved lower than that of the experimental group indicating, in fact, a lesser improvement.

The result of these investigations is consistent with previous studies, which have purported that HIIT does improve running ability. The research carried out by Gibala et al. (2012) confirmed the effectiveness of HIIT on the performance of sprinting as it improves aerobic as well as anaerobic systems of energy. The brief and severe duration of exertion in HIIT is said to enhance the effectiveness and power of muscles that are employed for sprinting and thereby cause lower sprinting times (Bishop et al, 2008).

In addition, the difference in the impact gap between the control and experimental groups supports the presumption that HIIT was more successful at enhancing sprint performance. While the control group did improve their sprinting abilities, the gains of the experimental group were far larger, emphasizing the effectiveness of high-intensity training in enhancing speed.

Implications for Athletic Training

These findings are crucial when planning the training curriculum for female athletes, especially those engaged in jumping and sprinting activities. The alterations uncovered in the experimental group imply that HIIT could be useful in improving key performance indicators like explosive strength, vertical jump height, and sprinting speed. These findings uphold the notion of incorporating HIIT into the training schedules of athletes with competition norms that demand speed and forceful action.

Athletic coaches and trainers may benefit from these findings by adapting their training approaches, especially in integrating HIIT into their athletes' training sessions geared towards improving performance. As previously stated, INT improves not only explosive power but also the athletes' cardiovascular and metabolic conditioning. In view of the conclusion drawn, HIIT may be especially valuable to athletes competing in long jump, vertical jump, and sprint events that have high power, strength, and speed prerequisites.

Limitations and Future Directions

For now, I would like to highlight the key takeaways of this study. One of them is the problem of the sample. in this case, the sample was deficient since it only tested 15 subjects per group. A more promising study would include an amplified number of participants, which would help strengthen the data while generalizing its conclusions. Moreover, the focus of this specific research was extremely limited, only focusing on three tests that can be improved by broadening the approach to overcome hurdles and including other areas that require test assessments like endurance or agility.

In addition, the lack of a Point in Time follow up to longitudinal checks to see if the changes made would be sustainable long after achieves were made in the experimental group is a limitation. Most likely, the improvements sustained through the study were purely short termed which means work needs to be done to assess if HIIT done over time guarantees results that last.

The last point concerns the control group baseline: not performing HIIT but actively taking part in athletics. Unlike the first group, control group members showed observable growth, which weakened the overall case. Shifting focus, future studies can position HIIT against other training approaches, including but not limited to Continuous Training at moderate intensity or Strength Training, with the aim of identifying which enhances specific area head performance most.

Conclusion

The findings of this particular study reveal that HIIT is very beneficial for national-level female jumpers. The experimental group had positive improvements in all three performance tests - standing long jump, vertical jump and 30m sprint - which indicates that HIIT is a good workout for a booster in stride speed and power. The control group also made improvements but to a lesser extent, further validating the high-impact advantages of HIIT. Given the benefits seen in this study, coaches and trainers should consider adding HIIT to their training programs for athletes in explosive events to maximize performance gains.

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