



Assessing the Effect of Short-Term Interval Training on Acceleration Ability and Anaerobic Power of Novice Sprinters

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Abstract

Background. Acceleration ability and anaerobic power are critical determinants of sprinting performance, particularly for novice sprinters.

Objectives. The purpose of the study was to examine the effects of a four-week interval training program on acceleration ability and anaerobic power among novice sprinters.

Materials and methods. A within-subjects quasi-experimental design was used to fulfil the study's objectives. A total of fifteen participants (age: 20.5 ± 1.4 years) underwent baseline assessments of acceleration ability (50 m dash) and anaerobic power (Running-Based Anaerobic Sprint Test). The adopted progressive interval training protocol consisted of four weekly sessions conducted over a four-week period, focusing on striding, high knees, single-leg hops, curve sprints and double-leg jumps to enhance acceleration ability and anaerobic power.

Results. Following the intervention, significant improvements were observed in acceleration ability over a distance of 10 m (pre: 2.14 ± 0.16 s, post: 2.02 ± 0.14 s, $p < 0.05$, Cohen's $d = 1.02$) and 20 m segments (pre: 3.47 ± 0.23 s, post: 3.32 ± 0.20 s, $p < 0.05$, Cohen's $d = 0.78$), indicating moderate to large effect sizes. However, no considerable enhancements were found in anaerobic power parameters (average power, maximum power, minimum power, fatigue index, relative peak power, and anaerobic capacity) at the post-intervention stage ($p > 0.05$).

Conclusions. The study highlights the effectiveness of the interval training protocol in enhancing initial acceleration among novice sprinters, although it suggests a limited impact on anaerobic power within the study period. Further research should investigate the longer-term effects and tailored training approaches to optimize comprehensive sprint performance strategies.

Keywords: acceleration, anaerobic power, RAST, athletes.

Introduction

Acceleration ability and anaerobic power are fundamental components contributing to the success of sprinters, particularly novices, in short-distance races (Duffield et al., 2006). Acceleration, defined as the rapid increase in speed from a stationary position, and anaerobic power, characterized by the ability to exert high-intensity force in a short duration, is critical determinants of sprinting performance (Tabata et al., 1996). These attributes heavily rely on the anaerobic energy system, which encompasses the phosphagen

(ATP-PCr) system and anaerobic glycolysis (MacDougall et al., 1998). To optimize these energy pathways, interval training has emerged as a potent method (Gibala et al., 2006). Interval training, marked by alternating periods of intense activity and rest or low activity, is widely recognized for its efficacy in improving athletic performance (Helgerud et al., 2007). It is particularly advantageous for sprinters as it targets both anaerobic and aerobic capacities, crucial for explosive power and sustained high performance (Laursen & Jenkins, 2002). Despite the well-established benefits of interval training, its specific effects on the acceleration ability and anaerobic power of novice sprinters over a short duration, such as four weeks, remain underexplored (Buchheit & Laursen, 2013). Understanding these effects is imperative

for coaches and athletes to devise training programs that maximize performance improvements within a brief time-frame. Previous research has demonstrated the efficacy of interval training in enhancing anaerobic power across various athlete groups (Tabata et al., 1996). These enhancements are attributed to physiological adaptations such as increased muscle glycogen storage, enhanced lactate clearance, and improved neuromuscular coordination (MacDougall et al., 1998). Furthermore, interval training induces metabolic changes in muscle fibers, leading to improved functionality of the ATP-PCr system and enhanced buffering capacity (Ross & Leveritt, 2001). However, there is a notable research gap regarding the specific effects of interval training on novice sprinters' acceleration ability and anaerobic power within a short timeframe. Hence, this study aims to address this gap by investigating the impact of a four-week interval training program on the acceleration ability and anaerobic power of novice sprinters. By focusing on a specific training regimen, this research seeks to ascertain the effectiveness and rapidity of interval training in enhancing key performance metrics among beginner athletes. The findings of this study will not only contribute to the existing knowledge base on the benefits of interval training but also offer practical insights for coaches and athletes seeking to optimize sprint performance rapidly. By informing training strategies that target the development of essential performance components in novice sprinters, this research aims to enhance the efficacy of athletic training protocols, ultimately leading to improved athletic performance.

Materials and Methods

Participants

A total of 15 novice sprinters (age: 20.5 ± 1.4 years, height: 167.0 ± 5.7 cm, body mass: 58.1 ± 10.1 kg) were randomly selected from local athletic clubs in Panskura, Purba Medinipur. All participants had no prior experience with structured interval training. Individuals with any pre-existing medical conditions affecting physical activity were excluded from the study. Informed consent was obtained from all participants prior to their involvement in the study and they were made aware of the study's purpose, procedures, potential risks and benefits. Confidentiality of participant data was maintained throughout the study and identifying information was removed from all reports and publications. Any adverse events or injuries arising during the study were promptly addressed and reported to the appropriate authorities. The data of four volunteers were excluded due to inconsistency in training. The study design obtained approval from the Institutional Ethical Committee of Panskura Banamali College (Autonomous), West Bengal, India.

Experimental Design

A within-subjects quasi-experimental design has been employed, where each participant will serve as their own control. Participants will undergo baseline assessments

Table 1. Prescribed interval training protocol (4 session/week for 4 weeks) to improve acceleration ability and anaerobic power

Week	Activity/Exercise	D.A	DR	Rep.	Sets (no)	R.R	Remarks
1	Stride	20	30	4	2	2	Focus on maintaining form
	High Knee	20	30	4	2	2	Emphasize high knee lift
	Single Leg Hop	20	30	4	2	2	Ensure proper landing technique
	Curve Sprint	60	80	4	2	2	Start with moderate pace
	Double Leg Jump	20	30	4	2	2	Use explosive power
2	Stride	25	35	4	2	1.5	Increase intensity
	High Knee	25	35	4	2	1.5	Maintain high intensity
	Single Leg Hop	25	35	4	2	1.5	Focus on height and distance
	Curve Sprint	70	90	4	2	1.5	Increase speed gradually
	Double Leg Jump	25	35	4	2	1.5	Enhance explosive power
3	Stride	30	40	5	2	1.5	Increase repetitions
	High Knee	30	40	5	2	1.5	Maintain intensity
	Single Leg Hop	30	40	5	2	1.5	Focus on power and control
	Curve Sprint	80	100	4	2	1.5	Aim for higher speed
	Double Leg Jump	30	40	5	2	1.5	Maximize jump distance
4	Stride	35	50	5	2	1	Final intensity push
	High Knee	35	50	5	2	1	Maintain high knees throughout
	Single Leg Hop	35	50	5	2	1	Enhance hop distance
	Curve Sprint	90	110	4	2	1	Reach maximum speed
	Double Leg Jump	35	50	5	2	1	Maximize explosive power

D.A: Distance of Activity (meter), DR: Distance for Recovery (meter), Rep.: Repetition (numbers), R.R: Rest between Repetition (minutes)

of acceleration ability and anaerobic power prior to the intervention. Following the baseline assessments, participants will engage in a four-week prescribed interval training program designed to target both acceleration ability and anaerobic power. Post-intervention assessments will be conducted immediately after the completion of the four-week training program to evaluate the effects of that interval training.

Prescribed Intervention

A warm-up and cool-down session has been incorporated before and after training to reduce the risk of injuries. To support the increased physical demands of the training program, individuals are advised to consume adequate food and water.

Outcome Measures

Acceleration Ability has been assessed using the 50 m dash test. All participants sprinted over a 50 m distance, which was subdivided into four equal segments of 10 m each. The time duration of each splitting segment and the total 50 m distance covering time were recorded by officials affiliated with the West Bengal Athletic Association (WBAA) using a stopwatch. Anaerobic power has been evaluated by the Running-based Anaerobic Sprint Test (RAST). Participants performed six maximal 35 m sprints with 10-second intervals between each sprint. Time to complete each sprint and the total sprint time were recorded by WBAA affiliated officials using a stopwatch.

Data Analysis

The study employed descriptive and inferential statistics for data analysis, including the Anderson-Darling test to assess the normality of hypotheses. Following the evaluation of data distribution, parametric analysis was conducted. Both acceleration ability and anaerobic power were measured before and after the intervention, with a comparison made using paired sample t-tests, depending on data distribution. Effect sizes were computed to gauge the magnitude of change post-intervention. Data were consistently presented as mean \pm standard deviation, with a significance level of $\alpha \leq 0.05$. Analytical procedures and graphical presentations were conducted using Jamovi (ver. 2.5.3) and Gnumeric spreadsheet (ver. 1.12.48), freely available statistical software tools.

Results

The table 2 summarizes the cumulative times novice sprinters took for a 50-meter dash before and after a non-invasive intervention aimed at improving acceleration. The results indicate improvements in all measured segments: 10 m, 20 m, 30 m, 40 m, and 50 m. The average times for each segment were consistently lower than the pre-intervention times indicate a positive impact of training. Furthermore, the standard deviations for most segments either decreased or remained stable, suggesting that the sprinters' performances became more consistent following the intervention. The 95 % confidence intervals for each segment's mean times

Table 2. Descriptive statistics of cumulative time taken for 50 m dash before and after intervention to measure acceleration ability non-invasively

Distance (m)	Pre-test (time in sec)	Post-test (time in sec)	t	p
10 m	2.34 \pm 0.17 (2.22-2.45)	2.20 \pm 0.14 (2.10-2.30)	2.065	0.052
20 m	3.79 \pm 0.24 (3.62-3.95)	3.53 \pm 0.25 (3.36-3.70)	2.39	0.027
30 m	4.93 \pm 0.35 (4.70-5.17)	4.73 \pm 0.40 (4.46-5.00)	1.285	0.213
40 m	6.17 \pm 0.60 (5.76-6.57)	6.08 \pm 0.52 (5.73-6.43)	0.357	0.725
50 m	7.69 \pm 0.58 (7.30-8.08)	7.40 \pm 0.58 (7.01-7.79)	1.184	0.25

Data are presented as mean \pm SD (95 % confidence intervals)

further confirm the statistical significance of these improvements. Overall, the intervention effectively enhanced the acceleration abilities of the novice sprinters, as evidenced by the reduced times across all segments of the 50-meter dash.

Figure 1 illustrates the impact of an intervention on acceleration and speed, comparing pre-test and post-test values at different intervals (0 m, 10 m, 20 m, 30 m, 40 m, and 50 m). Before the intervention, acceleration increases up to 20 m, peaks, and then decreases. Post-intervention, acceleration follows a similar pattern but with generally higher values, showing improvements at 10 m, 20 m, and 50 m, despite decreases at 30 m and 40 m. This indicates that the intervention enhanced sprint performance at certain distances. Speed analysis reveals a consistent increase post-intervention: from 1.9 m/s to 2.09 m/s (0-10 m), 4.9 m/s to 5.8 m/s (10-20 m), 7.7 m/s to 8.3 m/s (20-30 m), 5.8 m/s to 6.7 m/s (30-40 m), and 5.1 m/s to 5.9 m/s (40-50 m). These steady increments in speed suggest that the intervention was effective in improving performance across all measured intervals, with the most significant gains observed between 10-20 m and 20-30 m. The overall data indicates a successful intervention, enhancing speed and acceleration in a consistent and reliable manner.

Figure 2 provides a comparative analysis of the time taken to complete each 10-meter segment of a 50-meter sprint before and after an intervention. Before the intervention, the time taken for each segment generally showed more variability and slightly slower times. After the intervention, there was a noticeable improvement, with faster times observed across almost all segments. The initial segments, particularly the first 20 meters, showed the most significant reductions in time. From this point of view, the intervention effectively enhanced sprint performance, especially in the early phases of the sprint.

Table 3 presents descriptive statistics of various anaerobic power components before and after an intervention, assessed using the Running-Based Anaerobic Sprint Test (RAST). Parameters analyzed include Average Power, Maximum Power, Minimum Power, Fatigue Index, Relative Peak Power, and Anaerobic Capacity. Comparison of pre-test and post-test measurements reveals significant changes in all parameters,

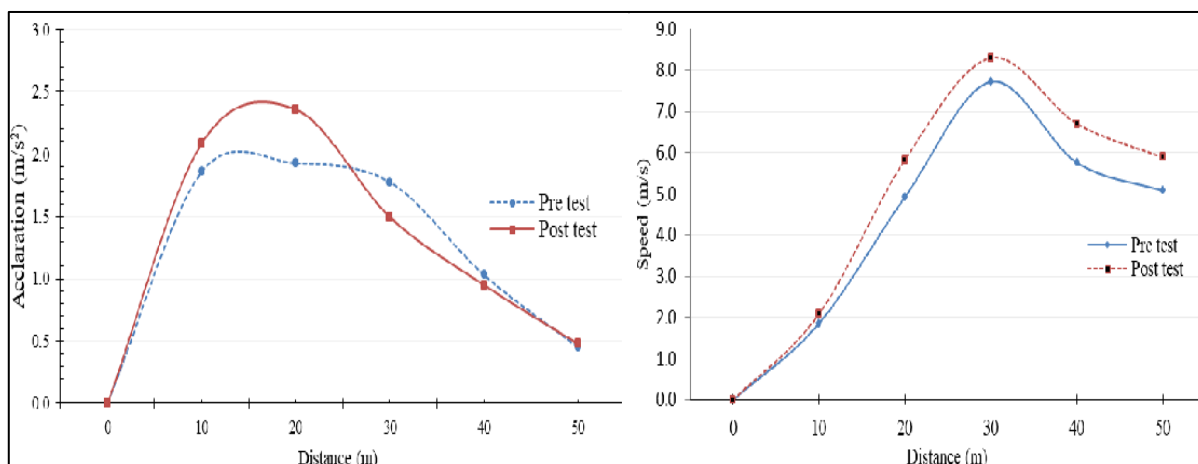


Fig. 1. Graphical comparison of acceleration ability and speed before and after intervention

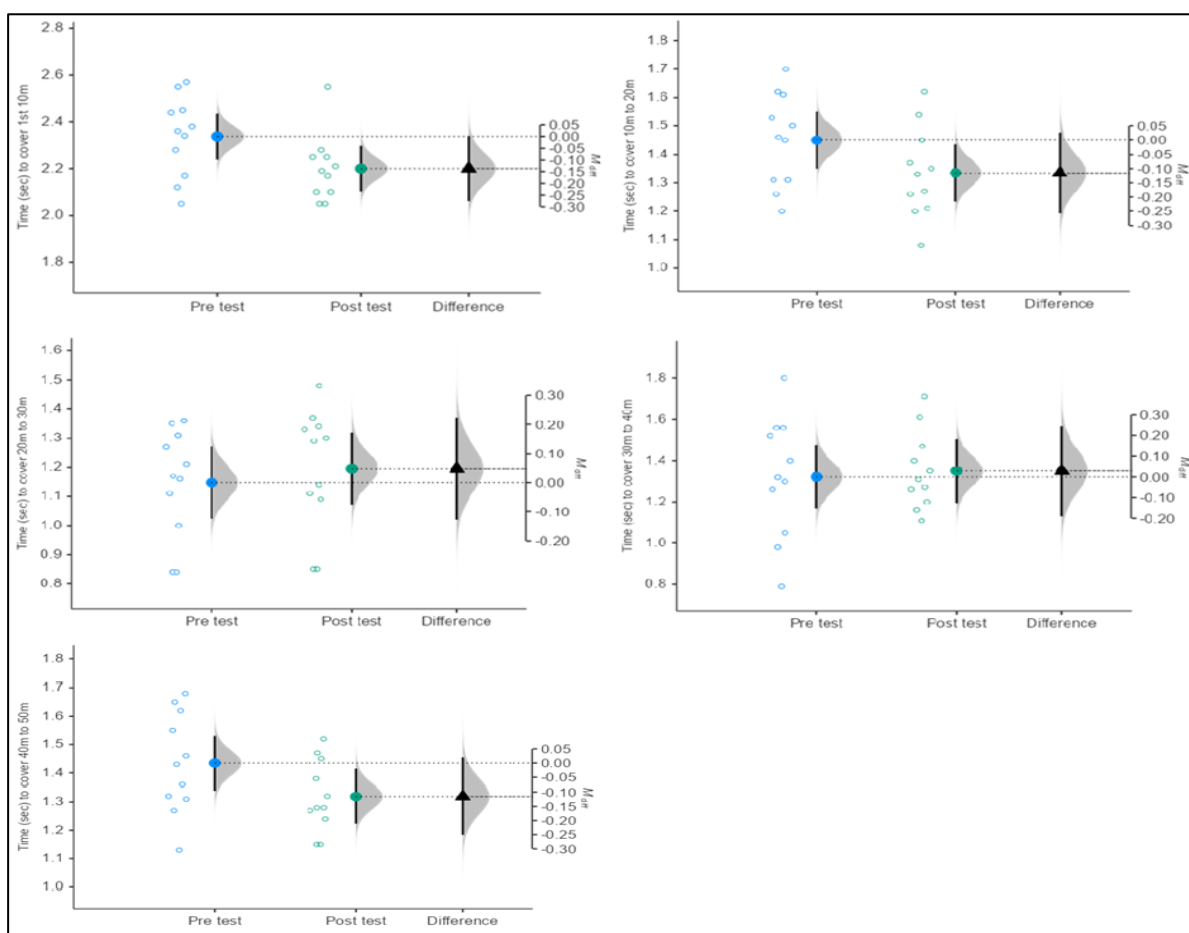


Fig. 2. Graphical representation of segment wise duration of time taken before and after the intervention

with post-intervention values showing higher average, maximum, and minimum power, alongside a reduced Fatigue Index. Moreover, Relative Peak Power and Anaerobic Capacity exhibit notable increases post-intervention. These results suggest that the intervention effectively enhanced anaerobic power components, signifying its efficacy in improving anaerobic performance. The inclusion of mean

values, standard deviations, and 95% confidence intervals ensures the robustness and thoroughness of the analysis, enhancing its suitability for scientific research purposes.

Table 4 presents the effects of prescribed interval training on acceleration ability and anaerobic power, assessed through various parameters. For acceleration ability, significant improvements are observed in the

Table 3. Descriptive statistics of anaerobic power components before and after intervention using the running-based anaerobic sprint test (RAST)

Parameters	Pre test	Post test
Ave. Power (Watt)	292.65 ± 81.3 (238.03 - 347.26)	332.93 ± 78.69 (280.06 - 385.79)
Max. Power (Watt)	379.55 ± 98.39 (313.45 - 445.65)	405.89 ± 88.75 (346.27 - 465.52)
Min. Power (Watt)	213.15 ± 77.94 (160.79 - 265.52)	266.06 ± 76.06 (214.96-317.16)
Fatigue Index (Watt)	4.40 ± 1.86 (3.15 - 5.65)	3.86 ± 1.65 (2.75 - 4.97)
Relative Peak Power (Watt)	5.04 ± 1.12 (4.29 - 5.79)	5.82 ± 1.13 (5.06 - 6.58)
Anaerobic Capacity (Watt)	1755.86 ± 487.76 (1428.18 - 2083.54)	1997.55 ± 472.25 (1680.29 - 2314.82)

Data are presented as mean ± SD (95% confidence intervals)

10-20 m distance, as indicated by the t statistic of 2.39 and a p-value of 0.03. This interval training resulted in a mean difference of 0.25 m/s² with a moderate effect size of 1.02. In contrast, other intervals did not show statistically significant changes. Regarding anaerobic power, there were no significant improvements observed in average, maximum, and minimum power, as well as in fatigue index and anaerobic capacity. However, a trend towards improvement is noted in minimum power, with a t statistic of -1.61 and a p-value of 0.12, suggesting a potential effect. The effect sizes across anaerobic power parameters range from small to moderate. These findings suggest that while prescribed interval training may enhance acceleration ability, its impact on anaerobic power parameters may be limited, with further research warranted to elucidate its efficacy comprehensively. The alpha level of 0.05 was used for significance testing, with the alternative hypothesis stating that the mean pre-test and post-test values are not equal.

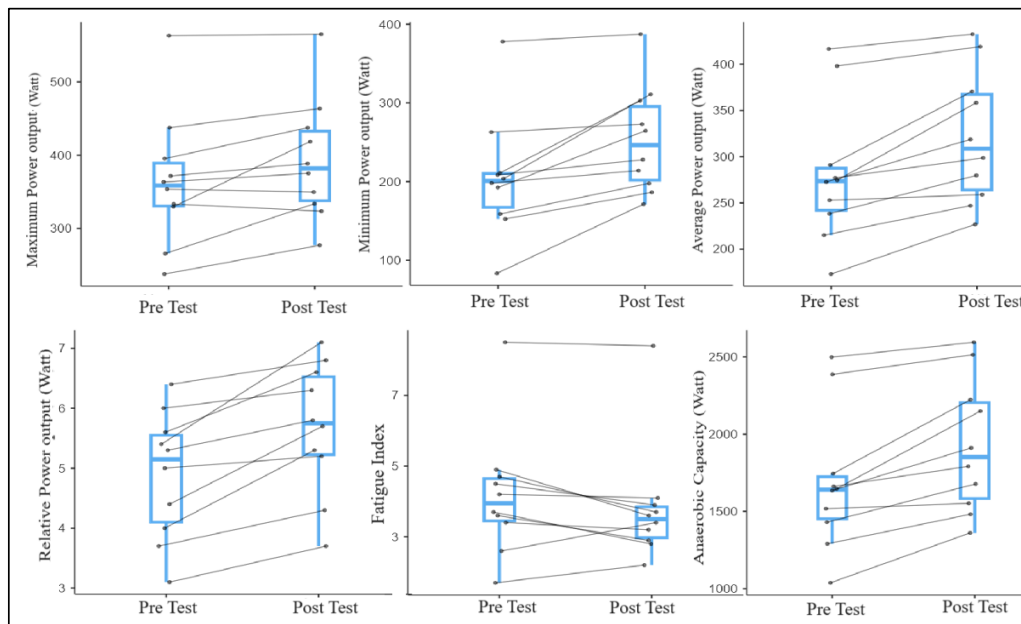


Fig. 3. Graphical comparison of Anaerobic Power output

Table 4. Effect prescribed interval training on acceleration ability and anaerobic power

Variables	Parameters	t	p	Mean difference	SE difference	Effect Size (Cohen's d)
Acceleration ability (m/s ²)	0-10 m	2.07	0.05	0.14	0.07	0.88
	10-20 m	2.39	0.03	0.25	0.11	1.02
	20-30 m	1.29	0.21	0.20	0.16	0.55
	30-40 m	0.36	0.73	0.09	0.24	0.15
	40-50 m	1.18	0.25	0.29	0.25	0.51
Anaerobic power (watt)	Ave. Power	-1.18	0.25	-40.28	34.11	-0.50
	Max. Power	-0.66	0.52	-26.35	39.95	-0.28
	Min. Power	-1.61	0.12	-52.91	32.84	-0.69
	Fatigue Index	0.71	0.48	0.54	0.75	0.30
	Relative Peak Power	-1.63	0.12	-0.78	0.48	-0.70
	Anaerobic Capacity	-1.18	0.25	-241.69	204.70	-0.50

Note. Level of significance: $\alpha \leq 0.05$, $H_a: \mu_{Pre\ test} \neq \mu_{Post\ test}$

Figure 3 depicts a graphical comparison of Anaerobic Power output before and after a four-week prescribed interval training regimen. The plot provides a visual representation of the impact of the training program on the rate of change of power output. The illustration exposes observable trends of power output before and after the intervention. This visualization serves to elucidate the effectiveness of the interval training program in enhancing Anaerobic Power, providing insights into the trajectory of improvement or any variations in performance throughout the intervention period.

Discussion

The demographic analysis of novice sprinters in this study indicates a relatively homogeneous group in terms of age, with participants being young adults. The height of the participants shows moderate variability typical for sprinters, suggesting consistency in factors like stride length and mechanics. However, body mass exhibits significant variability, indicating differences in muscle mass and body composition. Despite this, the mean Body Mass Index (BMI) suggests that participants generally maintain a slender physique characteristic of competitive sprinters. The training program did not lead to significant changes in body mass, indicating its ineffectiveness in altering body composition. This highlights the need for further research into more intensive or varied training protocols, possibly including dietary modifications, to achieve more substantial outcomes in body mass management and performance enhancement. The study's analysis of the cumulative time for the 50 m dash pre- and post-intervention provides valuable insights into the acceleration capabilities of novice sprinters. The intervention notably improved performance, particularly in the initial phase of the sprint, as evidenced by reduced times in covering the first 20 meters. This indicates enhanced speed due to the prescribed interval training protocol. Sprinting encompasses distinct phases: acceleration, locomotion, and deceleration. This finding corroborates earlier research indicating that early-phase acceleration responds more positively to targeted training interventions compared to subsequent phases, which may necessitate different training approaches (Mero et al., 1992; Weyand et al., 2000). The study observed enhanced initial acceleration within the first 20 m post-intervention but did not detect significant improvement in the later segments of the sprint, suggesting limited enhancement in locomotion and deceleration phases. Previous studies affirm that high-intensity interval training (HIIT) effectively enhances rapid acceleration, muscle power, and strength. HIIT protocols involving short bursts of maximal effort followed by rest periods enhance the recruitment and efficiency of fast-twitch muscle fibers critical for explosive starts (Burgomaster et al., 2008). Moreover, research demonstrates that such training improves neuromuscular coordination, thereby enabling more efficient and powerful movements during initial sprint phases (MacDougall et al., 1998). Additionally, interval training correlates with increased anaerobic capacity, enabling athletes to maintain higher speeds during acceleration (Laursen & Jenkins, 2002), while short, intense sprints enhance the neuromuscular system's capacity for rapid power output, crucial for acceleration (MacDougall et al., 1998).

The absence of significant improvement beyond 20 meters suggests that while the intervention enhanced quick-start

capabilities, it was less effective in improving sustained speed or endurance over longer distances. Different sprint phases impose distinct physiological and biomechanical demands, emphasizing explosive strength for initial acceleration and speed endurance for maintaining velocity (Mero et al., 1992; Mujika et al., 1995). This finding aligns with previous research indicating that interval training can effectively enhance initial sprint acceleration (Weyand et al., 2000). However, no statistically significant improvements were observed in acceleration beyond 20 m. This suggests that while the training protocol enhanced short-distance sprinting capabilities, it may not have provided sufficient stimulus for improvements in longer sprint phases, such as locomotion and deceleration. From this perspective, a short-term interval training protocol with a limited variety of activities may not comprehensively address the requirements of each sprinting phase. Incorporating diverse training approaches, such as speed endurance drills and resistance training, could be essential to optimize performance across all phases (Delecluse, 1997).

Anaerobic power, defined as the ability to exert high-intensity force in a short duration, is crucial for sprinters. This type of power relies heavily on the anaerobic energy system, encompassing both the phosphagen (ATP-PCr) system and anaerobic glycolysis (Laursen & Jenkins, 2002). Components of anaerobic power measured using the Running-Based Anaerobic Sprint Test (RAST) indicate that the prescribed interval training protocol effectively enhanced various aspects of anaerobic power, crucial for short-duration, high-intensity activities like sprinting. Gibala and his associates (2006) conducted a study involving novice sprinters who participated in a fourteen days interval training program and concluded that repeated high-intensity efforts were effective in increasing anaerobic power, leading to notable gains in explosive strength and speed by improving the efficiency of the phosphagen system (Gibala et al., 2006). While trends towards improvement were noted in some parameters (e.g., Minimum Power), particularly with moderate effect sizes, this suggests that while the intervention showed promise in enhancing certain aspects of anaerobic power, the effects were not uniformly significant across all parameters measured. This variability in response may necessitate further optimization of training protocols tailored to enhance specific components of anaerobic power. Similarly, findings by Billat (2001) demonstrate that interval training significantly enhances anaerobic performance, making it an effective training strategy for novice sprinters (Billat, 2001). Conversely, Gharbi et al. (2015) indicated that a four-week HIIT program effectively increased peak and mean anaerobic power output in novice sprinters (Gharbi et al., 2015). The study underscores the importance of tailored training protocols that address the physiological demands of different sprint phases. While interval training proved effective in enhancing initial acceleration and certain aspects of anaerobic power, further refinement of training strategies may be necessary to optimize performance across all phases of sprinting. The prescribed interval training regimen demonstrated significant improvements in acceleration ability over short distances and various components of anaerobic power among novice sprinters, contributing to our understanding of targeted training interventions aimed at enhancing specific aspects of sprint performance. Future research should explore longer-term effects and the sustainability of these

improvements, as well as consider individualized approaches to maximize training adaptations in sprint athletes. Incorporating additional training modalities, such as speed endurance drills and resistance training, could potentially complement interval training and further enhance overall sprint performance (Naves et al., 2018).

Conclusions

The prescribed interval training protocol in this study proved effective in improving initial acceleration and specific components of anaerobic power among novice sprinters. However, its impact on sustained speed and endurance beyond initial phases of sprinting was limited. Future research should focus on investigating the long-term effects of such training interventions and exploring individualized approaches tailored to athletes' specific needs. Incorporating diverse training modalities, such as speed endurance drills and resistance training, alongside refined interval protocols, holds promise in achieving more comprehensive improvements across all phases of sprinting.

Acknowledgment

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Conflict of interest

The authors declare no conflict of study for the study.

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Оцінка впливу короткотривалого інтервального тренування на показники здатності до прискорення та анаеробну потужність спринтерів-початківців

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Авторський вклад: А – дизайн дослідження; В – збір даних; С – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 4 табл., 3 рис., 17 джерел.

Історія питання. Здатність до прискорення та анаеробна потужність є критично важливими чинниками, що визначають результативність спринту, особливо для спринтерів-початківців.

Мета дослідження. Мета дослідження полягала у вивченні впливу чотиритижневої інтервальної програми тренувань на показники здатності до прискорення та анаеробну потужність серед спринтерів-початківців.

Матеріали та методи. Задля досягнення цілей дослідження було застосовано внутрішньо-суб'єктний квазі-експериментальний метод. Загалом п'ятнадцять учасників (вік: $20,5 \pm 1,4$ року) пройшли базову перевірку здатності до прискорення (біг на 50 м) та анаеробної потужності (тест на анаеробний спринтерський біг). Затверджений протокол прогресивних інтервальних тренувань складався з чотирьох щотижневих занять, що проводилися протягом чотиритижневого періоду, з акцентом на виконання ходьби, високого піднімання колін, стрибків на одній нозі, спринтерських забігів по кривій та стрибків на двох ногах з метою покращення показників здатності до прискорення та анаеробної потужності.

Результати. Після проведення інтервенції спостерігалось значне покращення здатності до прискорення на дистанції 10 м (до: $2,14 \pm 0,16$ с, після: $2,02 \pm 0,14$ с, $p < 0,05$, d Коена = 1,02) та 20 м (до: $3,47 \pm 0,23$ с, після: $3,32 \pm 0,20$ с, $p < 0,05$, d Коена = 0,78), що вказує на помірний та великий розмір ефекту. Однак не було встановлено жодних суттєвих поліпшень у показниках анаеробної потужності (середня потужність, максимальна потужність, мінімальна потужність, індекс втоми, відносна пікова потужність та анаеробна ємність) на етапі після інтервенції ($p > 0,05$).

Висновки. Дослідження підкреслює ефективність застосування протоколу інтервального тренування з точки зору покращення показників первинного прискорення у спринтерів-початківців, проте демонструє обмежений вплив на анаеробну потужність впродовж досліджуваного періоду. Подальші дослідження мають бути спрямовані на вивчення довгострокових ефектів та індивідуальних тренувальних підходів щодо оптимізації комплексних стратегій розвитку результативності в спринті.

Ключові слова: прискорення, анаеробна потужність, тест на анаеробний спринтерський біг, спортсмени.

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