



Developing a Specific Training Program to Improve 200-meter Sprint Ability for Middle School Students in Chaozhou City

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Received 06/09/2025

Revised 30/09/2025

Accepted 31/10/2025

Abstract

Background and Aims: Sprinting plays a central role in youth physical education in China, with the 200-meter sprint serving as a key component of entrance assessments at both middle and high school levels. Despite its importance, training programs in many schools remain repetitive and lack a scientific foundation, often failing to incorporate event-specific principles. Current approaches are largely generic and do not adequately address the unique physiological and technical demands of the 200-meter sprint. Consequently, students struggle to achieve substantial improvements in their sprinting performance. Therefore, this study aimed to develop and evaluate a structured training program designed to improve the 200-meter sprint ability of middle school students in Chaozhou City.

Methodology: This research was mixed-method research. The population of this research was 1,860 students and 24 physical education teachers from four middle schools in Chaozhou. Through the purposive sampling method, a total of 40 students from Zhengrong Middle School were selected as a sample group and participated in a 200-meter sprint test; their performance times were recorded. After that, 40 students were divided into two groups using the systematic sampling method. The training was conducted in 8 weeks, three times per week, and 60 minutes per session. To evaluate 200-meter sprint ability, this research used the sprint start reaction test, the 30-meter running test, the 100-meter curve running test, and the 200-meter sprint test. In this research, mean, standard deviation, independent t-tests, one-way repeated measures ANOVA, and Bonferroni post hoc were used to analyze the data.

Result: The results showed that all ability indicators in the experimental group improved significantly at the 0.05 level compared with the control group. Sprint start reaction time decreased from 0.26 seconds to 0.24 seconds. The 30-meter running time was reduced from 5.08 seconds to 4.64 seconds. In the 100-meter curve running, times improved from 14.25 seconds to 13.75 seconds, and for the 200-meter sprint, times decreased from 27.99 seconds to 27.26 seconds. In addition, within the experimental group, all ability indicators demonstrated significant improvements across each stage (pre-test, mid-test, and post-test) at the 0.05 level.





Conclusion: The findings confirm that the developed training program effectively enhanced the overall 200-meter sprint performance of middle school students in Chaozhou City.

Keywords: Specific Training Program; 200 Meter Sprint Ability; Middle School Students

Introduction

Sprinting is a high-intensity, intermittent discipline that requires athletes to combine exceptional speed, explosive power, and endurance (Li, C., 2024). Among the physical determinants of sprint performance, speed and strength are considered the most critical, making it essential to train both simultaneously. In China, sprint training commonly relies on repetition and interval methods. Repetition training entails repeatedly performing the same exercise with adequate recovery between sets, emphasizing high-intensity efforts to develop absolute speed (Cui, Guo, & Wu, 2015). By contrast, interval training regulates rest intervals so that athletes begin the next set before full recovery, thereby enhancing speed endurance (Zhang, 2005). Each approach offers distinct benefits but also presents limitations.

In recent years, sprint training has become a core element of middle school physical education. As a physically dominant competitive sport, sprinting requires athletic fitness as the foundation for performance (Tian, 2021). The 200-meter sprint, in particular, has been introduced into high school entrance examinations in some regions of China and remains a key assessment item in the National College Entrance Examination for Physical Education Majors. With its rising importance, the central challenge is how to effectively enhance sprint performance. Research highlights that adopting scientifically sound training methodologies is crucial for improvement (Chen, 2020). Yet, in practice, specialized and scientifically structured sprint programs at the middle school level remain inadequate, limiting both student development and training effectiveness. As Li, Z. (2023) notes, despite its seemingly straightforward nature, sprint training is often constrained by real-world challenges, including students' academic pressures, competition from emerging sports, and insufficient training conditions, all of which hinder the overall effectiveness of sprint training. Preliminary classroom observations conducted in several middle schools in Chaozhou have identified persistent challenges in current 200-meter sprint training practices. These include outdated and monotonous training content, limited effectiveness of training outcomes, and a marked lack of student motivation. Furthermore, existing programs are often generic and fail to address the specific physiological and technical demands of the 200-meter sprint. Consequently, students struggle to achieve meaningful performance improvements. Given that the 200-meter sprint has been formally incorporated into physical fitness assessments for both middle and high school entrance examinations in the region, the shortcomings of current practices underscore the urgent need for a scientifically designed and context-specific training





program. Such a program should not only remedy the deficiencies of existing methods but also align with the performance requirements of the entrance examination system, thereby ensuring both effectiveness and educational relevance.

In this context, well-structured sprint training at the middle school level is essential for fostering the athletic development of young sprinters. There is an immediate need to design and implement a targeted training program that reflects the actual needs of middle school students in Chaozhou city while adhering to scientific principles of adolescent physical development. The ultimate goal is to enhance both motivation and training effectiveness. Accordingly, this research aims to develop a structured and scientifically validated training program for middle school students in Chaozhou City, with the dual purpose of optimizing sprint performance and addressing the limitations of current training approaches.

Objectives

This study aims to develop a specific training program to improve 200-meter sprint ability for middle school students in Chaozhou City.

Literature Review

1. 200-Meter Sprint

The 200-meter sprint is a core track and field event that combines the demands of speed, power, and technical efficiency. Unlike the 100-meter sprint, which emphasizes maximal acceleration and top speed, the 200-meter sprint requires athletes to maintain high velocity while negotiating the curve of the track, demanding greater technical proficiency in stride mechanics and force application during curve running (Slawinski et al., 2010). The event is classified as an anaerobic-dominant activity, where performance largely depends on the phosphagen and glycolytic energy systems, supported by high levels of neuromuscular coordination and lower-limb explosive strength (Hanon, Leveque, & Thomas, 2008). Effective 200-meter sprint performance is therefore influenced not only by acceleration and maximal velocity but also by speed endurance, which allows athletes to sustain performance throughout the second half of the race.

The 200-meter sprint is a hybrid event that integrates acceleration, curve running, and speed endurance. In contrast to the 100-meter sprint, it demands greater rhythm control and precise biomechanical efficiency, particularly during the curve phase. Studies emphasize that optimal technical execution, stride frequency, and effective coordination of the energy systems are critical determinants of performance in this event. (Ma, 2013; Liu, 2019).

Improving 200-meter sprint performance requires a multifaceted approach that integrates





physiological, technical, and psychological training. Key determinants include explosive strength, maximal velocity, and speed endurance, all of which must be addressed through structured training methods (Hanon, Leveque, & Thomas, 2008). Strength and power development through resistance training have been shown to enhance acceleration and top-end speed, while plyometric exercises improve neuromuscular coordination and stride efficiency (Lockie, Murphy, & Spinks, 2003). Sprint-specific drills such as resisted sprints, overspeed training, and curve running practice are particularly important for the 200-meter event, as athletes must maintain high velocity on the bend before transitioning into the straightaway (Slawinski et al., 2010). Moreover, repeated high-intensity sprint efforts with controlled recovery through repetition and interval training are effective for developing speed endurance, which is critical for sustaining performance over the latter stages of the race (Zhang, 2005).

2. Sprint Training for Middle School Students

Sprint training at the middle school level plays a critical role in fostering fundamental athletic skills, physical fitness, and long-term interest in sport. Middle school students are in a sensitive stage of physical development, where improvements in coordination, motor control, and muscular strength can be achieved effectively through well-structured training (Malina, Rogol, & Cumming, 2015). Sprint training not only enhances speed, explosive power, and cardiovascular endurance but also develops discipline, resilience, and teamwork when implemented in a school context. In China, the integration of sprinting into physical education curricula and entrance assessments for higher levels of schooling highlights its educational value and the need for systematic approaches (Li, 2024).

Adolescence represents a critical period for the development of speed, strength, and coordination. Research indicates that sprint training during this stage not only enhances physical fitness but also fosters long-term athletic habits. Among the most effective approaches are repetition training, interval training, and high-intensity interval training (HIIT), all of which have been shown to improve sprint performance and increase student motivation when applied in a progressive and structured manner. (Chen, 2020; Tian, 2020). The effective sprint development cannot rely on overly simplified models such as the spring-mass approach alone. Instead, they stressed that sprinting involves a complex interaction of mechanical, neuromuscular, and coordinative factors. Practical implications included prioritizing drills and strength training that enhance horizontal force production, optimizing foot placement relative to the center of mass, and improving force effectiveness (the ratio of horizontal to total ground reaction force). By bridging biomechanics with applied training (Haugen, McGhie, and Ettema, 2019).

3. Specific Training Program

A specific training program refers to a systematically designed plan that targets the unique





physiological, technical, and psychological demands of a particular sport or event. Unlike general conditioning programs, specific training emphasizes the principle of specificity, ensuring that training activities closely replicate the movement patterns, energy systems, and performance contexts required in competition (Zatsiorsky & Kraemer, 2006). In sprinting, for example, this means incorporating drills that develop acceleration, stride frequency, stride length, and speed endurance. Research indicates that when training programs are tailored to the distinct characteristics of an event, athletes achieve more meaningful performance improvements compared to those engaged in generic conditioning (Bompa & Buzzichelli, 2019). Specific training also supports motor learning by reinforcing neural adaptations directly related to competitive movements, thus enhancing transfer of training into real performance settings.

Moreover, Recent biomechanical analyses of elite 200-meter sprinters have highlighted that performance limitations often occur during the curve phase of the race (Haugen et al., 2019; Slawinski et al., 2010). While athletes typically maintain strong stride length, decreases in stride frequency and trunk stability have been identified as critical factors that reduce velocity maintenance and disrupt rhythm control mid-race (Mero et al., 2020). These inefficiencies affect overall running efficiency and rhythm synchronization between upper and lower limbs, leading to decreased sprint velocity on the curve. Consequently, researchers emphasize the importance of incorporating curve-specific training drills that enhance stride rhythm, trunk stability, and arm-leg coordination to improve sprint performance and efficiency (Hanon et al., 2008; Haugen et al., 2019). Liu (2025) investigated the effects of combining functional training with traditional sprint methods and found that integrated approaches produced significantly better results than single-method programs. The study showed that blending sprint drills, resistance training, and interval work enhanced both neuromuscular adaptation and metabolic conditioning, enabling athletes to develop explosive power, speed endurance, and overall sprint efficiency. Compared with groups that relied solely on either functional or traditional training, the experimental group demonstrated superior improvements in performance indicators, confirming that a multi-dimensional training model is more effective for sprint development.

For middle school students, the design of a specific training program is particularly important because it must align with both developmental principles and event-specific requirements. Studies have shown that progressive sprint training programs incorporating repetition runs, interval training, and high-intensity interval training (HIIT) effectively improve both sprint performance and motivation in adolescent learners (Cui, Guo, & Wu, 2015; Li, 2024). Moreover, integrating biomechanical drills such as curve running practice in the 200-meter sprint or resisted sprints for power development ensures that young athletes acquire technical precision alongside physiological gains (Slawinski et al., 2010). A scientifically grounded, age-



appropriate, specific training program, therefore, not only enhances athletic outcomes but also fosters long-term physical literacy and sustainable engagement in sport.

4. Principle of Training

Establishing sound training principles is a prerequisite for designing effective 200-meter sprint programs for middle school students, as these principles provide both the theoretical framework and practical guidelines necessary for structuring, progressing, and monitoring training (Tian, 2010; Liu, 2023). One of the core principles is progressive overload, which must be implemented with caution in adolescents to prevent overuse injuries and safeguard long-term development (Li, 2025; Baechle & Earle, 2008). In line with this, Zhai's (2014) progression model moving from easy to difficult, simple to complex, and slow to fast offers a pedagogically sound approach for youth, consistent with established theories of motor learning and physical growth (Gallahue, Ozmun, & Goodway, 2012). Another crucial principle is individualization, as middle school students vary significantly in biological age, training experience, physical fitness, and psychological readiness. To accommodate these differences, effective programs must incorporate diagnostic assessments, workload monitoring, and continuous feedback to optimize training outcomes while minimizing risks (Wang, 2009; Bompá & Buzzichelli, 2019; Lloyd & Oliver, 2012).

In addition, comprehensive sprint training should integrate both general physical development and event-specific skill acquisition. General conditioning builds the foundation of strength, flexibility, and coordination, while sprint-specific elements such as start mechanics, stride frequency, curve running, and speed endurance directly enhance event performance (Feng, 2016; Slawinski et al., 2010). Equally important is prioritizing health and safety, including medical screening, recovery strategies, and injury-prevention protocols to protect young athletes during high-intensity training (Chen, 2015; Faigenbaum et al., 2009). Maintaining student motivation is another key factor; studies highlight that varied, engaging, and collaborative training environments improve not only adherence but also psychological well-being and long-term athletic commitment (Han, 2011; Deci & Ryan, 2000; Weiss, 2000). Overall, applying these principles ensures that sprint training for middle school students is safe, scientifically grounded, and developmentally appropriate, thereby enhancing both athletic performance and long-term growth in alignment with educational and health objectives.

5. Developing Training Program

The development of a 200-meter sprint training program for middle school students must integrate scientific training principles with practical feasibility, while adapting to the physical, psychological, and educational characteristics of adolescents. Periodization is widely regarded as fundamental, typically progressing from general foundation phases to reinforcement and sprint-



specific phases, thereby maximizing speed development during sensitive growth periods (Zhang, 2023; Chen, 2020). Effective training content should encompass acceleration drills, sprint mechanics, explosive strength development, and core stability exercises. Studies have demonstrated that structured drills, plyometric training, and stride jump methods produce significant improvements in sprint performance and coordination in adolescent athletes (Wang, 2016; Wu, 2020).

Equally important, program design must include clear objectives, measurable indicators, and continuous feedback mechanisms to ensure training efficiency and progression (Chen, 2020). Training load should be carefully monitored and adjusted in line with individual readiness to prevent overtraining and reduce injury risks (Li, 2023; Zhai, 2019). Empirical evidence further highlights the benefits of individualized, engaging, and student-centered approaches, such as integrating agility-based exercises and embedding sprint training within the broader school physical education curriculum, which significantly enhances both sprint ability and general fitness (Qiao, 2020; Zhang, 2022). In summary, the literature confirms that structured, periodized, and age-appropriate sprint programs, balancing sprint-specific drills with the developmental needs of middle school students, not only improve performance and motivation but also promote long-term physical literacy and overall health in school contexts.

Summaries

The 200-meter sprint is a technically and physically demanding event that integrates acceleration, curve-running efficiency, and speed endurance, requiring athletes to demonstrate both biomechanical precision and physiological control. Comparative studies reveal that international sprinters maintain more consistent stride patterns and velocity, whereas Chinese athletes often experience speed plateaus in the latter phases of the race. Middle school is widely recognized as a critical stage for cultivating coordination, muscular strength, and lifelong exercise habits, making it an optimal period for sprint development. Evidence shows that repetition training, interval training, and high-intensity interval training (HIIT) are effective methods for enhancing sprint performance while simultaneously fostering student motivation. Designing effective 200-meter sprint programs for adolescents requires a comprehensive, multidimensional approach. Successful interventions integrate sprint-specific drills with strength and core conditioning, endurance training, and psychological preparation to build resilience and confidence. At the same time, training should prioritize health and safety through appropriate load management, injury-prevention strategies, and ongoing feedback mechanisms. Programs must also be adaptable to school contexts, ensuring they are feasible, engaging, and developmentally appropriate. Overall, the literature supports structured, student-centered, and scientifically grounded training frameworks as the most practical and effective pathway for



improving 200-meter sprint ability among middle school students in Chaozhou, while also promoting long-term physical development and motivation.

Conceptual Framework

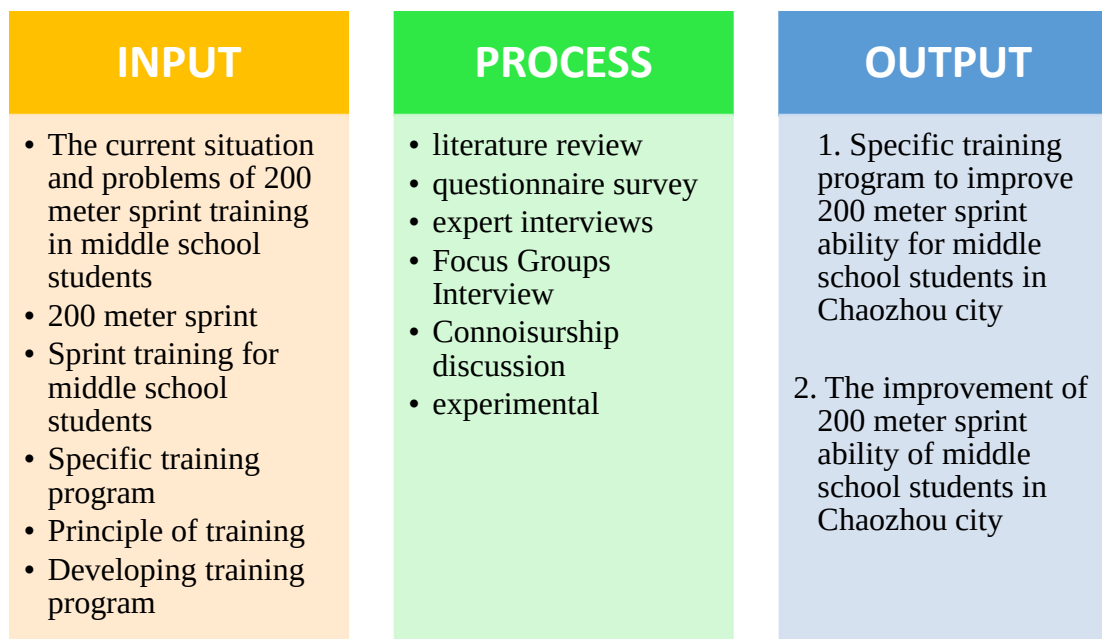


Figure 1 Conceptual Framework

Methodology

1. Population and Sample

The population included 1,860 students and 24 physical education teachers from four middle schools in Chaozhou City, namely Zhengrong Middle School, Jinshan Middle School, Gaoji Middle School, and Chengnan Middle School. A total of 329 students and all 24 physical education teachers completed questionnaires.

In this study, purposive sampling was adopted to select one of the four participating schools in Chaozhou City, namely Zhengrong Middle School, as the experimental school. 40 students who voluntarily agreed to participate in this study were selected to undergo a 200-meter sprint test, and their performance times were recorded. Based on the test results, students were ranked from slowest to fastest. The bottom 40 students with the poorest sprint performance were then selected as the experimental group. Finally, the 40 students were divided into two groups using the systematic sampling method: 20 students in the experimental group and 20 students in the control group.



2. Research Instruments

Research instruments were as follows: (1) a questionnaire for students and a questionnaire for physical education teachers. The evaluation was conducted using the item-objective consistency index (IOC) method. The IOC value of the questionnaire for students was 0.91, and the IOC value of the questionnaire for physical education teachers was 0.82; (2) expert interview outline, and the IOC value of the expert interview outline was 0.87; (3) focus group outline; (4) connoisseurship outline; (5) specific training program; (6) 200-meter sprint ability tests, it was assessed with four tests: sprint start reaction, 30-meter running, 100-meter curve running, and 200-meter sprint.

3. Data Collection

3.1 The questionnaire was distributed online to 329 students aged 14–16 and 24 physical education teachers at middle schools in Chaozhou City. The survey collected detailed data on the current status and problems of 200-meter sprint performance.

3.2 Seven experts were invited to conduct face-to-face expert interviews. The purpose was to analyze the components of a specific training program to improve the 200-meter athletic ability of middle school students.

3.3 Ten experts were invited to participate in the focus group discussion. The purpose of the discussion was to develop a specific training program suitable for middle school students in Chaozhou City, and capable of improving 200-meter ability.

3.4 Seven experts conducted a connoisseurship discussion to evaluate the applicability, feasibility, and effectiveness of the specific training program.

3.5 The specific training program lasted for 8 weeks, and a total of 40 middle school students participated. There were 20 students in the experimental group and 20 students in the control group. They trained three days per week, and each training session lasted for 1 hour.

3.6 The control group conducted the test before and after the training. The experimental group was conducted 3 times test as pre-test, mid-test, and post-test. The test results of the same group and different groups before and after the intervention were compared and analyzed to evaluate the effectiveness of the specific training program.

4. Data Analysis

Descriptive statistics (mean ($\bar{x}$) and standard deviation (S.D.), independent t-tests, One-way repeated measures ANOVA, and Bonferroni post hoc tests were used to analyze the data.

Results

The results of the research are presented in three key parts as follows:

Part 1: Study the current situation and problems of 200-meter sprint training of middle



school students in Chaozhou city.

Part 2: Develop a specific training program to improve 200-meter sprint ability for middle school students in Chaozhou City.

Part 3: Experiment with the specific training program to improve the 200-meter sprint ability of middle school students in Chaozhou City.

Part 1: Study the current situation and problems of 200-meter sprint training of middle school students in Chaozhou city

Questionnaire responses from 329 students and 24 physical education teachers indicated that the current 200-meter sprint training was repetitive, lacked variety, and had limited effectiveness.

Table 1 Summary of Questionnaire Findings

Aspect	Student Responses (n = 329)	Teacher Responses (N = 24)
Content	68% reported repetition/monotony	75% noted a lack of structured programming
Effectiveness	72% reported little improvement	70% observed weak gains in endurance/technique
Motivation	64% reported low interest in sprint training	67% observed low student motivation
Technical	Focus on straight sprints only	Lacked curve running, start reaction, and core training

An initial survey involving 329 students and 24 physical education teachers identified several critical shortcomings in current 200-meter sprint training practices (see Table 1). Among students, 68% reported that training was monotonous and overly repetitive, while 72% felt it resulted in little improvement in sprinting ability. In addition, 64% expressed low motivation to participate in sprint sessions. Teacher responses corroborated these perceptions: 75% noted the absence of structured training programs, 70% observed limited progress in technical skills and endurance development, and 67% highlighted low student motivation. From a technical standpoint, teachers emphasized that existing practices lacked sufficient focus on curve running, start reaction, and core strength conditioning. Collectively, these results point to the urgent need for a systematic, well-structured, and targeted sprint training program.

Insights from interviews and focus group discussions reinforced these findings. Experts observed that traditional approaches tend to overemphasize straight-line sprinting and lower-limb strength development, while neglecting equally important aspects such as technical



execution, curve-running mechanics, and strategies to sustain student motivation. This imbalance has limited the effectiveness of current training methods, further underscoring the necessity of designing comprehensive and scientifically grounded programs tailored to the developmental needs of middle school students.

Part 2: Develop a specific training program to improve 200-meter sprint ability for middle school students in Chaozhou City.

1. Expert interview results

Seven experts agreed that 200-meter sprint training for middle school students in Chaozhou lacks systematic structure, individualization, and recovery planning. They emphasized progressive overload, phase-based training, and tailoring programs to age, gender, and academic demands, while focusing on explosive power, acceleration, curve running, and speed endurance. Recommended programs included three weekly sessions of 45–60 minutes with varied drills, psychological readiness, and injury prevention measures.

For evaluation, experts suggested combining sprint timings and interval tests with qualitative feedback, while recovery should include rest, stretching, hydration, and nutritional support. Despite limited school resources, they affirmed that modular, scientifically grounded programs are feasible and can significantly improve speed, coordination, and confidence in relatively short training cycles.

2. Focus group discussion results

Focus group discussions with 10 experts revealed a strong consensus on the core components of an effective 200-meter sprint training program for middle school students in Chaozhou. Experts emphasized the early prioritization of foundational sprint techniques, including starting posture, stride rhythm, and arm-leg coordination, alongside critical technical elements such as curve-running mechanics, core stability, and acceleration drills. A phased training structure progressing from basic preparation to technical development and performance enhancement was widely endorsed, with three weekly sessions identified as optimal. Individualization was considered essential, with recommendations for station-based training and flexible lesson plans tailored to students' age, gender, and fitness levels.

Injury prevention and recovery were also highlighted, with experts recommending structured cooldowns, stretching routines, and designated low-load days. Practical feasibility was addressed by stressing the need for adaptable training content that fits within school timetables and facility constraints. Finally, sustaining student motivation was seen as critical, with strategies such as gamified drills, peer performance tracking, and recognition systems proposed. Collectively, these insights informed the design of a scientifically grounded and context-sensitive





training program that balances technical rigor, developmental needs, and school-based practicality.

After the current situation investigation and discussion, a framework for a specific training program was finally developed. The specific training program was summarized as follows

The final training program lasted 8 weeks, with three days per week, and 60-minute sessions per time. The program was summarized as follows:

Table 2 Framework of a specific training program to improve 200-meter sprint ability for middle school students in Chaozhou city

Phase	Week	Training Goal
Phase 1: Foundation Building	Week 1-2	Develop basic sprint mechanics, physical literacy, coordination, and flexibility.
Phase 2: Technical Development	Week 3-4	Improve sprint stride rhythm, acceleration, and curve running technique
Phase 3: Performance Enhancement	Week 5-7	Enhance sprint speed, endurance, form consistency, and simulate race conditions.
Phase 4: Peak and Taper	Week 8	Maximize performance readiness through tapering, recovery, and race-phase rehearsal.

3. Connoisseurship discussion results

The 7 experts unanimously affirmed that the 8-week training program is well-structured, scientifically designed, and suitable for middle school students. They agreed that the program effectively addresses key components of 200-meter sprint performance, such as acceleration, speed endurance, curve running, and technical form. The weekly schedule was considered practical for school implementation, and the training content was seen as both age-appropriate and developmentally beneficial. While overall feedback was positive, some experts suggested enhancing the program by adding periodic assessments, self-evaluation tools, and technical feedback mechanisms to further improve engagement and effectiveness.

Part 3: Experiment with the specific training program to improve the 200-meter sprint ability of middle school students in Chaozhou city

To assess the effectiveness of the proposed training program, experimental validation was conducted with both descriptive and inferential statistical analyses. The design compared pre-, mid-, and post-test results between an experimental group, which undertook the newly



developed program, and a control group that continued their traditional training program. Four indicators were measured to evaluate 200-meter sprint ability: sprint start reaction, 30-meter running, 100-meter curve running, and the 200-meter sprint test.

1. Descriptive Statistics of Tests

Table 3 Descriptive Statistics of Performance Tests

Variable	Group	Pre-test ($\bar{x} \pm SD$)	Mid-test ($\bar{x} \pm SD$)	Post-test ($\bar{x} \pm SD$)
Sprint start reaction (s)	Experimental	0.26 $\pm$ 0.01	0.25 $\pm$ 0.01	0.24 $\pm$ 0.01
	Control	0.26 $\pm$ 0.01	—	0.25 $\pm$ 0.01
30-meter running (s)	Experimental	5.08 $\pm$ 0.16	4.78 $\pm$ 0.17	4.64 $\pm$ 0.18
	Control	5.08 $\pm$ 0.09	—	5.08 $\pm$ 0.11
100-meter curve running (s)	Experimental	14.25 $\pm$ 0.34	14.05 $\pm$ 0.41	13.75 $\pm$ 0.36
	Control	14.29 $\pm$ 0.44	—	14.09 $\pm$ 0.53
200 meter sprint (s)	Experimental	27.99 $\pm$ 0.48	27.57 $\pm$ 0.53	27.26 $\pm$ 0.51
	Control	28.07 $\pm$ 0.54	—	27.89 $\pm$ 0.59

As shown in Table 3, both groups exhibited comparable baseline levels across all variables, indicating balanced participant allocation and minimal initial differences. During the eight-week intervention, however, the experimental group demonstrated steady and consistent improvements in all four tests. Sprint start reaction decreased from 0.26 s to 0.24 s, reflecting enhanced neuromuscular responsiveness. The 30-meter sprint improved from 5.08 s to 4.64 s, indicating greater acceleration capacity. Similarly, the 100-meter curve running time declined from 14.25 s to 13.75 s, suggesting improved stride control and technical efficiency when negotiating bends. The 200-meter sprint time decreased from 27.99 s to 27.26 s, a gain of more than 0.70 seconds. Although modest in absolute terms, these changes represent meaningful performance improvements in sprint research, particularly given the short intervention period and adolescent sample. By contrast, the control group showed only minor fluctuations around baseline, highlighting the limited impact of traditional training approaches.

2. Between-group comparisons using an independent sample t-test

Table 4 Independent Sample T-test Results (Between groups)

Variable	Pre-test t (p)	Post-test t (p)
Sprint start reaction	-0.32 (0.75)	-5.02 (0.00*)
30 m running	0.08 (0.93)	-9.68 (0.00*)
100 m curve running	-0.34 (0.74)	-2.38 (0.02*)
200 m sprint	-0.49 (0.63)	-3.64 (0.00*)

Note. Pre-test showed no significant differences between groups. Post-test showed significant improvements in the experimental group across all variables.

As shown in Table 4, independent sample t-tests confirmed no significant differences between the experimental and control groups at the pre-test stage ($p > 0.05$ for all variables), indicating comparability at baseline. In contrast, post-test results revealed statistically significant improvements for the experimental group across all performance indicators. Sprint start reaction improved substantially ($t = -5.02$, $p < 0.001$), while acceleration capacity, assessed through the 30-meter sprint, showed the largest gain ($t = -9.68$, $p < 0.001$). Significant improvements were also observed in curve running ($t = -2.38$, $p = 0.02$) and the 200-meter sprint ($t = -3.64$, $p < 0.001$). Collectively, these findings demonstrate that the specific training program produced measurable and meaningful enhancements in both short- and long-distance sprint performance, surpassing the outcomes of the control group in speed and technical execution.

3. Within-group comparisons of the experimental groups using one-way repeated measures ANOVA

Table 5 Summary of ANOVA results (Experimental Group)

Variable	F(df)	p-value	Interpretation
Sprint start reaction	F(2,38) = 311.28	0.00*	Significant improvement over time
30-meter running	F(2,38) = 555.40	0.00*	Significant improvement over time
100-meter curve running	F(2,38) = 54.33	0.00*	Significant improvement over time
200-meter sprint	F(2,38) = 160.43	0.00*	Significant improvement over time

Note. All results indicate highly significant performance gains from pre- to mid- to post-test. Greenhouse–Geisser corrections were applied where assumptions of sphericity were violated.

As shown in Table 5, within-group analyses using one-way repeated measures ANOVA provided clear evidence of progressive improvement in the experimental group across the three testing points. All four performance variables demonstrated highly significant gains over time:

sprint start reaction ($F(2, 38) = 311.28, p < 0.001$), 30-meter sprint ($F(2, 38) = 555.40, p < 0.001$), 100-meter curve sprint ($F(2, 38) = 54.33, p < 0.001$), and 200-meter sprint ($F(2, 38) = 160.43, p < 0.001$). Post hoc analyses confirmed that improvements occurred progressively from pre-test to mid-test and from mid-test to post-test, indicating that the training effects were cumulative rather than abrupt. This steady trajectory of enhancement highlights the effectiveness of the program's periodized design, in which foundational preparation enabled technical refinement and ultimately led to measurable performance gains.

4. Post hoc tests analysis results

Post hoc analyses revealed that the experimental group achieved significant and progressive improvements across all testing phases. Sprint start reaction times decreased from 0.26 ± 0.01 s (pre-test) to 0.25 ± 0.01 s (mid-test) and 0.24 ± 0.01 s (post-test), with each stage-to-stage improvement statistically significant ($p < 0.05$). In the 30-meter sprint, performance improved from 5.08 ± 0.16 s to 4.78 ± 0.17 s and further to 4.64 ± 0.18 s, with all reductions significant ($p < 0.05$). The 100-meter curve sprint showed steady gains, from 14.25 ± 0.34 s to 14.05 ± 0.41 s and 13.75 ± 0.36 s, with both pre- to mid-test and mid- to post-test improvements significant ($p < 0.05$). Similarly, 200-meter sprint times declined from 27.99 ± 0.48 s to 27.57 ± 0.53 s and 27.26 ± 0.51 s, with significant differences at each stage ($p < 0.05$).

These results confirm that the training program generated cumulative and reliable benefits, producing consistent improvements in reaction time, acceleration, curve-running efficiency, and overall sprint endurance.

Summary

Overall, the descriptive, between-group, and within-group analyses provide strong evidence for the effectiveness of the training program. The experimental group not only improved in raw performance outcomes but also demonstrated consistent progress across all testing phases, while the control group showed minimal change. Independent t-tests confirmed statistically significant post-test differences in sprint start reaction ($p < 0.05$), 30-meter sprint ($p < 0.05$), 100-meter curve sprint ($p < 0.05$), and 200-meter sprint ($p < 0.05$). Repeated measures ANOVA further indicated that improvements within the experimental group across pre-, mid-, and post-tests were highly significant for all variables (all $p < 0.05$). Post hoc analyses showed progressive gains, with significant improvements from pre- to mid-test and from mid- to post-test in every performance indicator, confirming steady and cumulative benefits rather than isolated effects.

Importantly, improvements were observed in both physiological aspects, such as acceleration and speed endurance, and technical aspects, including curve-running mechanics and start efficiency. These findings strongly support the study's hypothesis that a structured,



scientifically grounded program can substantially enhance the sprint capacity of middle school students in Chaozhou. Moreover, the magnitude and consistency of these gains suggest that even within a relatively short intervention period, systematically designed training can produce meaningful and statistically reliable performance improvements.

Discussion

The findings demonstrated that the experimental group achieved significant improvements in start reaction, 30-meter sprint, 100-meter curve sprint, and 200-meter sprint, while the control group showed only minor changes. This indicates that the newly designed training program effectively enhanced neuromuscular response, acceleration, curve-running technique, and speed endurance among middle school students.

These results are consistent with previous studies (Wan et al., 2025; Chen et al., 2025), which emphasize that sprint performance depends not only on strength and speed but also on systematic and targeted training methods. By incorporating progressive overload, curve-running drills, and core-strength components, the program addressed the limitations of traditional, monotonous training and produced measurable improvements.

Furthermore, the 30-meter running test results showed a decrease from 5.08s to 4.64s in the experimental group, while the control group displayed only minor improvement. This aligns with recent findings that speed development among adolescent athletes is strongly influenced by structured high-intensity sprint drills and targeted strength training (Haugen, McGhie, & Ettema, 2019). Haugen, McGhie, and Ettema (2019), in their comprehensive review, emphasized that efficient sprint acceleration depends on maximizing horizontal force and optimizing spatiotemporal mechanics, bridging fundamental biomechanics with practical sprint training applications.

The experimental group also demonstrated significant improvement in the 100-meter curve-running test, reducing their average time from 14.25 s to 13.75 s. These findings indicate that incorporating curve-running drills into the training program effectively enhanced the students' biomechanical efficiency and movement coordination. Recent biomechanical studies emphasize that rhythm control, stride regulation, and curve-specific adaptations are critical determinants of sprint performance (Haugen et al., 2019; Slawinski et al., 2010). Slawinski et al. (2010) reported that during the mid-race curve phase, reductions in stride frequency and trunk stability limit velocity maintenance and disrupt overall running rhythm. Similarly, Haugen et al. (2019) highlighted that sprint efficiency depends heavily on the synchronization of stride rhythm, posture control, and neuromuscular coordination throughout the curved section of the track.

Finally, the experimental group's 200-meter sprint performance improved from 27.99s to





27.26s, compared to the control group's negligible progress. This finding is consistent with research showing that tailored high-intensity interval training (HIIT) and periodized sprint programs are effective in improving both speed endurance and overall sprint times in youth populations (Liu, 2025). Liu (2025) showed that combining functional and traditional sprint training yields superior outcomes compared to single-method approaches. The combination of sprint drills, resistance training, and interval work ensured both neuromuscular adaptation and metabolic conditioning, leading to superior outcomes in the experimental group.

Recommendation

Recommendation for this research

1. Schools in Chaozhou should consider formally adopting the specific training program developed in this study.
2. Teachers are encouraged to utilize a periodized training approach tailored to students' developmental stages. Alternating intensity and content, including plyometrics, sprint mechanics, and neuromuscular work, helps optimize adaptation while sustaining motivation.

Recommendation for further research

1. Future research should assess the long-term impact of the training program over one academic year or longer.
2. Additional studies should explore the effectiveness of the program among younger or older students and compare responses between male and female participants.

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