Study on the Relationship between 100-Meter Sprint Performance of Male Athletes and Lower Limb Maximum Strength, Explosive Power, and Jumping Ability

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Abstract: Objective: To investigate the relationship between 100-meter sprint performance and lower-limb maximal strength, explosive power, and jumping ability in male sprinters, and to identify key physical fitness indicators affecting sprint performance, providing a basis for specialized physical training and monitoring. Methods: Male 100-meter sprinters were recruited as participants. Indicators of basic body morphology, lower-limb maximal strength, explosive strength, and jumping ability were collected, including peak force (PF) from the isometric mid-thigh pull (IMTP), relative maximal strength, rate of force development (RFD) at 100 ms and 150 ms, countermovement jump height, squat jump height, dynamic strength index (DSI), eccentric utilization ratio (EUR), and high-intensity reactive strength index (RSI). the best 100-meter performance in the past year was used as the criterion for sprint performance. Descriptive statistics, correlation analysis, and multiple linear regression were conducted to explore the relationships between these physical fitness indicators and 100-meter performance, and to screen for key influencing factors. Results: Relative maximal strength (r=-0.582, P<0.01), 100 ms RFD (r=-0.615, P<0.01), 150 ms RFD (r=-0.523, P<0.05), countermovement jump height (r=-0.485, P<0.05), squat jump height (r=-0.450, P<0.05), and high-intensity RSI (r=-0.540, P<0.05) were all significantly correlated with 100-meter performance. Multiple regression analysis showed that 100 ms RFD, relative maximal strength, countermovement jump height, and high-intensity RSI entered the final model, with 100 ms RFD contributing the most (β=-0.410, P=0.012). Conclusion: Male 100-meter sprint performance is closely related to lower-limb maximal strength, explosive power, and jumping ability, with 100 ms RFD being the most critical physical fitness indicator influencing sprint performance. Training should emphasize the coordinated development of relative maximal strength, early rapid force production, and reactive jumping ability to improve 100-meter sprint performance in male athletes.

Keywords: Male 100-Meter Sprint; Sprinting; Relative Maximal Strength; Explosive Power; Rfd; Jumping Ability

1. Introduction

The 100-meter sprint is one of the most representative speed events in track and field, and its performance is influenced by multiple factors, including the start reaction, acceleration ability, maximum speed maintenance, and technical efficiency of the movement [1]. Among these, lower limb strength and the ability to produce rapid force in a short time are crucial physical foundations for determining sprint performance. Athletes need to generate substantial ground reaction force in a very short time during the start, acceleration, and support phases of the sprint, which enables higher speed output [2]. Therefore, scientifically assessing the lower limb strength characteristics of sprinters and uncovering their relationship with sprint performance have long been key focuses in sports training and fitness research.

Previous studies have shown that lower-limb maximal strength, explosive strength, and power levels are closely related to sprint performance [3]. Maximal strength is an essential foundation for athletes to produce high-intensity force outputs. A higher maximal strength level can improve the athlete's push-off ability during the support phase, which is critical for acceleration and maintaining high speed. Moreover, sprinting is characterized by "high force—short time, " meaning athletes not only need to have a significant strength reserve but also must produce effective force output in a very short period of time. As a result, the rate of force development (RFD) is highly significant in sprint performance [4]. Compared to peak force alone, RFD better reflects the neuromuscular recruitment efficiency and rapid force production ability within a limited support time, making it a key focus in current sprint-specific fitness research.

In addition to strength testing, vertical jump tests are widely used in sprint fitness assessments because they are simple to perform, highly repeatable, and well-reflect lower limb explosive power and stretch-shortening cycle ability. Indicators such as countermovement jump (CMJ) [5], squat jump (SJ), reactive strength index (RSI)[6], dynamic strength index (DSI), and eccentric utilization ratio (EUR) [7] can reflect the quick contraction ability, elastic potential energy utilization, and stretch-shortening cycle efficiency of the athlete's lower limb muscles from different perspectives. For sprinters, good jumping ability often indicates strong lower-limb explosive power and favorable neuromuscular function, making it an important reference for monitoring changes in sprint-specific athletic performance.

Although many studies on strength and explosive power in sprinters have been conducted both domestically and internationally, there are still certain limitations in the existing literature. on one hand, some studies only focus on maximal strength or a single jump-related index, which leads to relatively simple analysis of the relationship with sprint performance, making it difficult to fully reveal the relative roles of various physical fitness indicators in performance outcomes [8]. on the other hand, differences in training levels, event structure, and testing systems among different research subjects lead to inconsistent conclusions. Some studies suggest maximal strength is a critical determinant of sprint performance, while others argue that relative strength, rapid force production, or jumping ability are more sensitive indicators for performance [9]. Therefore, integrating multiple indicators, including maximal strength, explosive power, and jumping ability, for a comprehensive analysis in the same group of sprinters has strong theoretical and practical value.

From a practical training perspective, coaches often combine isometric mid-thigh pull (IMTP), countermovement jumps, squat jumps, and related derived indicators to assess and monitor athletes' strength development and competitive status [10]. However, it is still necessary to verify which of these indicators more accurately reflect 100-meter sprint performance and which are more prioritized in training monitoring through actual sample data. In particular, identifying key indicators that are more closely related to sprint performance during routine training monitoring would not only enhance the precision of fitness assessments but also provide a basis for prioritizing strength and explosive power training.

Based on this, this study focuses on male 100-meter sprinters, using their best performance in the past year as the sprint performance indicator. the study combines data from multiple physical fitness tests, including lower-limb maximal strength, explosive power, and jumping ability, to analyze the relationships between these indicators and sprint performance, and further identify the key physical fitness factors influencing male 100-meter sprint performance. the results will provide theoretical reference and practical guidance for sprint-specific fitness assessment, training monitoring, and training plan optimization for male sprinters.

2. Research Subjects and Methods

2.1 Research Subjects

The study focused on male sprint athletes. Based on event information and performance records, the raw test data were screened, and only athletes specializing in the 100-meter sprint, with complete records of their best performance in the past year and major physical fitness test indicators, were included as the final study sample. All participants had undergone relatively systematic sprint training, were in good health, and had no obvious injuries or conditions that could affect test performance prior to testing.

This study primarily collected participants' basic anthropometric data, lower-limb maximal strength indicators, rapid force production indicators, and jumping ability indicators. the best 100-meter performance in the past year was used as the sprint performance evaluation metric. All tests and data compilation were based on the team's routine fitness monitoring and event-specific assessments, with test content aligned with the practical demands of sprint training.

During the study, participants' information was used solely for research purposes, and data processing followed anonymization principles. the participants' basic anthropometric indicators are shown in Table 1.

Table 1. Basic Morphological Characteristics of Participants

Indicator	Mean	Standard Deviation	Minimum	Maximum
Age (years)	21.75	2.45	18	27
Height (cm)	177.70	4.88	172	189
Body mass (kg)	70.64	6.35	57.00	84.77
BMI (kg/m²)	22.36	2.01	18.87	26.31
100 m performance (s)	10.95	0.15	10.67	11.40

2.2 Research Methods

2.2.1 Literature Review

Relevant literature on sprint-specific physical fitness, maximal strength, explosive strength, jumping ability, and event performance was systematically reviewed using databases such as CNKI, Wanfang Data, Web of Science, and PubMed. the aim was to summarize research progress on the relationship between sprint performance and strength or explosive power in male sprinters, clarify the theoretical basis, the rationale for indicator selection, and the research approach of this study, thereby providing references for study design, result analysis, and discussion.

2.2.2 Testing Methods

Considering the characteristics of 100-m sprint-specific physical fitness in males, participants underwent tests for basic anthropometric measures, lower-limb maximal strength, explosive strength, and jumping ability. All tests were conducted under routine training monitoring conditions. Prior to testing, standardized warm-up procedures were performed, including jogging, dynamic stretching, and sprint-specific activation exercises, to minimize measurement error and ensure safety.

(1) Basic Anthropometric Measures

Participants' age, height, and weight were measured, and body mass index (BMI) was calculated. Height was measured using a stadiometer, weight using an electronic scale, and BMI was calculated as weight (kg)/height² (m²). These measures primarily describe the basic characteristics of the sample and serve as reference variables for subsequent analyses.

(2) Lower-Limb Maximal Strength Test

The isometric mid-thigh pull (IMTP) was used to assess participants' maximal lower-limb strength. During testing, participants stood on a fixed testing apparatus in a half-squat position resembling the second pull phase of a high pull, with a naturally upright torso and hands gripping a fixed bar. Participants were instructed to exert maximal voluntary isometric force upward as quickly as possible upon the signal and maintain it for a few seconds. Peak force generated during the test was recorded as the maximal strength indicator, and relative maximal strength was calculated by normalizing to body weight, reflecting force output per unit body mass.

(3) Explosive Strength Indicators

Based on signal acquisition during the IMTP, short-term force output characteristics were extracted. Indicators such as the 100-ms rate of force development (100-ms RFD), 150-ms RFD, and zero-velocity force were calculated to evaluate participants' explosive strength output. RFD reflects the rate of force increase per unit of time and effectively represents the ability of sprinters to rapidly recruit neuromuscular activity and produce effective force during very short ground contact times.

(4) Jumping Ability Tests

Countermovement jump (CMJ) and squat jump (SJ) tests were performed to assess lower-limb explosive power and stretch-shortening cycle capacity. Participants either placed hands on hips or followed standardized instructions to minimize arm-swing interference. CMJ required participants to jump immediately after a rapid countermovement, while SJ required participants to jump from a static half-squat to reduce pre-stretch effects. Jump height, CMJ peak force, and SJ height were recorded.

Derived indicators were further calculated, including the dynamic strength index (DSI), eccentric utilization ratio (EUR), and reactive strength index (RSI). DSI reflects the extent to which dynamic explosive power utilizes maximal strength reserves; EUR evaluates the degree to which the athlete benefits from eccentric pre-stretch during jumping; RSI primarily reflects rapid take-off and reactive elasticity. These indicators provide additional insight into lower-limb neuromuscular function and sprint-specific fitness characteristics.

(5) Event Performance Indicator

The participant's best 100-m performance in the past year was used to evaluate sprint-specific performance. To ensure consistency in event specialization, only male 100-m sprinters were included in the analysis; 200-m or other sprint performances were excluded from the model.

2.2.3 Statistical Analysis

Raw data were first organized and screened. Event records were standardized, and samples with inconsistent specialization or missing key indicators were excluded. Descriptive statistics for all included indicators were calculated and expressed as mean±standard deviation ($\bar{x}$±s). Normality of each variable was tested using the Shapiro-Wilk test. For normally distributed variables, Pearson correlation analysis was used to assess relationships between event performance and physical fitness indicators; for non-normally distributed variables, Spearman rank correlation was used.

Based on correlation analysis, the best 100-m performance in the past year was set as the dependent variable, and fitness indicators closely related to performance were set as independent variables to construct a multiple linear regression model. This further identified key fitness factors affecting male 100-m sprint performance and analyzed the explanatory power of each variable. To avoid multicollinearity, variance inflation factor (VIF) was checked during modeling. Statistical significance was set at $P<0.05$.

3. Results and Analysis

3.1 Descriptive Statistics of Basic Information and Physical Fitness Indicators of Male 100-m Sprinters

Descriptive statistical analysis was conducted on lower-limb maximal strength indicators, explosive strength indicators, and jumping ability indicators of the male 100-m sprinters included in this study. the results are shown in Table 2. Overall, participants were similar in basic indicators such as age, height, weight, and BMI, indicating a certain degree of homogeneity in the sample. However, individual differences were observed in IMTP peak force, relative maximal strength, 100-ms RFD, 150-ms RFD, countermovement jump height, squat jump height, and high-intensity RSI, suggesting notable variation in lower-limb strength and explosive power levels among different athletes.

Regarding event performance, the participants' best 100-m times over the past year were generally at a high level, but individual differences still existed. This provides a basis for further analysis of the relationship between sprint performance and physical fitness indicators. Overall, the physical fitness characteristics of male 100-m sprinters not only reflect a high reserve of lower-limb strength but also demonstrate strong explosive power and efficient utilization of the stretch-shortening cycle. However, the distribution of these fitness indicators is not entirely consistent across individuals.

Table 2. Descriptive Statistics of Physical Fitness Indicators in Male 100 m Sprinters

Indicator	Mean	Standard Deviation	Minimum	Maximum
IMTP peak force (N)	3218.65	650.12	2157	4513
Relative maximal strength (N/kg)	44.96	7.37	32.79	62.65
100 ms RFD (N/s)	9466.15	3385.20	3210	17710
150 ms RFD (N/s)	8735.35	2344.65	3187	13420
Countermovement jump height (cm)	50.70	4.78	43.3	63.3
CMJ peak force (N)	2122.20	221.45	1500	2393
Squat jump height (cm)	46.79	3.65	39.0	56.3
DSI	0.675	0.094	0.493	0.850
EUR	1.084	0.058	0.968	1.212
High-intensity RSI	2.04	0.35	1.36	2.77

3.2 Correlation Analysis Between Men's 100-meter Performance and Physical Fitness Indicators

To explore the relationship between men's 100-meter performance and various physical fitness indicators, a correlation analysis was conducted between the best 100-meter time in the past year and basic physical traits, lower-limb maximal strength, explosive strength, and jumping ability indicators. the results are shown in Table 3.

The results revealed significant correlations between the 100-meter performance and certain strength and explosive power indicators. Specifically, relative maximal strength showed a significant correlation with 100-meter performance, suggesting that force output ability under unit body weight conditions plays a crucial role in sprinting performance. Both 100 ms RFD and 150 ms RFD were significantly correlated with 100-meter performance, indicating that an athlete’s ability to quickly generate force in a short time is closely linked to sprinting success. Jumping ability indicators, such as countermovement jump height, squat jump height, and high-intensity RSI, also showed certain correlations with 100-meter performance, indicating that lower-limb explosive power and the efficient use of the stretch-shortening cycle positively impact men's 100-meter performance.

In contrast, some basic physical traits showed relatively weak correlations with performance, suggesting that, within a group of male 100-meter sprinters with similar training levels, body morphology may not be as critical for explaining performance as lower-limb strength and explosive power indicators. Overall, the relationship between men’s 100-meter performance and relative strength, explosive strength, and jump explosiveness is relatively strong, providing a basis for further selection of key physical fitness indicators.

Table 3. Correlation Analysis between 100 m Performance and physical Fitness Indicators in Male Sprinters

Indicator	r	P
Relative maximal strength	-0.582	<0.01
100 ms RFD	-0.615	<0.01
150 ms RFD	-0.523	<0.05*
Countermovement jump height	-0.485	<0.05*
CMJ peak force	-0.312	0.180
Squat jump height	-0.450	<0.05*
DSI	-0.125	0.600
EUR	0.184	0.437
High-intensity RSI	-0.540	<0.05*

*Note: *P<0.05, *P<0.01

3.3 Analysis of the Relationship Between Different Categories of Physical Fitness Indicators and Men's 100-Meter Performance

3.3.1 Relationship Between Maximal Strength Indicators and Performance

The correlation analysis between maximal strength indicators and performance shows that although absolute IMTP peak force is somewhat related to 100-meter performance, relative maximal strength demonstrates a highly significant negative correlation with 100-meter time (r=-0.582, P<0.01). Since 100-meter performance is measured in time (where lower values indicate better performance), this strong negative correlation clearly indicates that, in men's 100-meter sprinting, strength relative to body weight is more critical than absolute peak force output alone. During the start and acceleration phases, sprinters must overcome their own body weight to achieve effective propulsion; therefore, improving relative maximal strength is a fundamental basis for enhancing movement efficiency and acceleration capability.

3.3.2 Relationship Between Explosive Strength Indicators and Performance

The data indicate that both 100 ms RFD (r=-0.615, P<0.01) and 150 ms RFD (r=-0.523, P<0.05) are significantly negatively correlated with 100-meter performance. Notably, 100 ms RFD shows the highest correlation with performance among all tested variables. In sprinting, ground contact time during the support phase is extremely short (typically around 100 milliseconds), requiring athletes to generate high levels of force within this brief moment. the highly significant correlation of 100 ms RFD strongly confirms the reative role of neuromuscular recruitment efficiency within very short time frames in determining 100-meter performance. These findings strongly suggest that, in daily training, in addition to basic strength development, special emphasis should be placed on the transfer of rapid force production—particularly explosive output within 100 milliseconds—into sprint-specific speed.

3.3.3 Relationship Between Jumping Ability Indicators and Performance

In jumping tests, high-intensity RSI (r=-0.540, P<0.05), countermovement jump height (r=-0.485, P<0.05), and squat jump height (r=-0.450, P<0.05) all show significant correlations with 100-meter performance. Among these, high-intensity RSI (Reactive Strength Index) demonstrates the strongest relationship, further highlighting the importance of an athlete’s ability to rapidly leave the ground and effectively utilize elastic energy during extremely short ground contact times. In contrast, the dynamic strength index (DSI) and eccentric utilization ratio (EUR) do not show statistical significance in this sample, which may suggest that, for 100-meter sprinters with a certain level of training, direct measures such as jump height and reactive strength are more effective predictors of performance than derived ratio-based indicators.

3.4 Regression Analysis of Key Physical Fitness Indicators for Men's 100-meter Performance

Based on the correlation analysis, a multiple linear regression analysis was performed using the best 100-meter performance from the past year as the dependent variable, with the significantly correlated core physical fitness indicators selected as independent variables. the regression analysis results show that relative maximal strength, 100 ms RFD, countermovement jump height, and high-intensity RSI successfully entered the final regression model (see Table 4), and the model as a whole demonstrated a good explanatory effect ($P<0.05$).

From the independent contributions of each variable to the 100-meter performance (standardized coefficients β), the explanatory weight of 100 ms RFD is the largest (β=-0.410, P=0.012), followed by relative maximal strength (β=-0.380, P=0.018), then countermovement jump height (β=-0.320, P=0.024), and high-intensity RSI (β=-0.280, P=0.045). This quantified ranking clearly reveals the decision-making logic of men's 100-meter performance: the rate of force development in an extremely short time (100 ms RFD) is the most core driving force; supporting this rapid force output is a high level of relative maximal strength; meanwhile, lower limb explosive power (CMJ) and the efficiency of the stretch-shortening cycle (RSI) provide indispensable elastic support. These indicators collectively form the "pyramid" of physical fitness for men's 100-meter sprinting.

Table 4. Multiple Regression Analysis Results for Key Physical Fitness Indicators Associated with 100 m Performance in Male Sprinters

Variable	B	Standard Error	β	t	P
Constant	13.250	0.450	—	29.444	<0.001
Relative maximal strength	-0.008	0.003	-0.380	-2.667	0.018
100 ms RFD	-0.00002	0.00001	-0.410	-2.852	0.012
Countermovement jump height	-0.015	0.006	-0.320	-2.500	0.024
High-intensity RSI	-0.120	0.055	-0.280	-2.181	0.045

4. Discussion

4.1 The Relationship Between Relative Maximal Strength and Men’s 100-Meter Performance

The results of this study show that relative maximal strength is highly and negatively correlated with men’s 100-meter performance and was included in the final regression model. This indicates that the ability to generate force relative to body weight is a critical physical fitness factor influencing 100-meter sprint performance. the 100-meter sprint is a typical speed-strength event, where athletes must rapidly overcome their body mass and generate effective propulsion during the start, acceleration, and mid-race phases within extremely short ground contact times. Therefore, compared with absolute strength, which merely reflects overall force capacity, relative maximal strength better represents an athlete’s actual force output capability under sport-specific conditions.

From a mechanistic perspective, sprint speed relies on the athlete’s ability to produce sufficiently large ground reaction forces during consecutive ground contacts and to effectively convert these forces into horizontal propulsion. Previous studies have indicated that lower-limb strength is closely associated with sprint acceleration and sprinting performance, and in high-level sprinting, force quality (force relative to body mass) is often more relevant than total force [13]. In the present study, the relationship between absolute IMTP peak force and sprint performance was less pronounced than that of relative maximal strength, further demonstrating that men’s 100-meter performance depends more on high-quality force output relative to body weight than on the sheer accumulation of strength.

These findings have clear implications for training practice. For male 100-meter sprinters, strength training should not only focus on increasing maximal force but also on the coordination between strength development and body weight management. If gains in absolute strength are accompanied by unnecessary increases in body mass, sprint-specific movement efficiency may be limited, reducing training benefits. Therefore, training programs should prioritize improvements in relative maximal strength through foundational strength training, enhanced neuromuscular recruitment, and optimization of body composition, promoting the effective transfer of strength gains into sport-specific performance

4.2 The Critical Role of Explosive Strength, Especially 100 ms RFD, in Men's 100-Meter Performance

The results of this study show that 100 ms RFD has the strongest correlation with men's 100-meter performance, and its standardized contribution in the regression model is the largest, indicating that early explosive strength output ability is a key factor in differentiating performance levels in men's 100-meter sprints. This result suggests that differences in sprint performance not only depend on the athlete's strength reserves but also on their ability to quickly generate force within a very short time and apply it to the specific movements required.

The technical characteristics of the 100-meter sprint determine that the ground contact time is extremely limited, especially during the acceleration and high-speed phases. Athletes must quickly complete neuromuscular recruitment and force output within a short time window. Research on RFD has shown that early RFD reflects neuromuscular drive efficiency and rapid recruitment ability more effectively, and is more closely aligned with the demands of explosive sports than maximal strength alone [11]. In this study, 100 ms RFD showed a stronger correlation and higher regression weight than 150 ms RFD, suggesting that force indicators that are closer to the actual ground contact duration in sprinting are more explanatory of sprint performance.

This finding implies that training for men's 100-meter sprinters should not focus solely on increasing maximal strength but also emphasize the conversion of strength to explosive power. Specifically, explosive resistance training, rapid intention-to-force training, Olympic lift variations, and sport-specific strength exercises targeting short ground contact times should be incorporated into training to enhance athletes' ability to quickly exert force in the early support phase. Regarding training monitoring, 100 ms RFD could also serve as a sensitive indicator for evaluating the athlete's physical condition and predicting performance changes [14].

4.3 The Reflective Value of Jumping Ability Indicators on Men's 100-Meter Performance

This study found that reverse jump height, squat jump height, and high-intensity RSI were significantly correlated with men's 100-meter performance, with reverse jump height and high-intensity RSI entering the final regression model. This suggests that jumping ability effectively reflects the explosive strength and elastic utilization required for men's 100-meter sprint performance. It indicates that sprint performance depends not only on strength reserves and explosive strength but also on the neuromuscular system's ability to quickly transition and efficiently leave the ground under short contact conditions [15].

From a test content perspective, reverse jump height reflects the lower-limb explosive strength of athletes in the stretch-shortening cycle, while squat jump height more specifically reflects explosive strength in pure concentric contraction conditions. RSI comprehensively reflects contact time control and rapid takeoff ability. Previous research has shown that indicators such as CMJ, SJ, and RSI are stably linked with sprint acceleration and speed performance, making them important tools for monitoring sprint-specific training [16, 17]. the results of this study are consistent with these findings, showing that jumping-related tests have good specificity for the men's 100-meter sprint event.

It is worth noting that CMJ peak force, DSI, and EUR did not reach significant levels in this study. This may be due to factors such as a small sample size, closely matched training levels within the sample, and the sensitivity of ratio-based indicators to testing errors. In contrast, direct performance indicators such as jump height and RSI showed better discriminative validity in this study [5]. This result suggests that in the daily monitoring of men's 100-meter sprinters, more intuitive indicators like jump height and RSI may have greater practical application value than some derived ratio indicators.

4.4 The Multi-Dimensional Physical Fitness Determinants of Men's 100-Meter Performance

Combining the results of correlation and regression analyses, it is evident that men's 100-meter performance is not determined by a single physical fitness indicator but is the result of the combined effects of relative maximal strength, early explosive power, and stretch-shortening cycle efficiency. In this study, 100 ms RFD, relative maximal strength, reverse jump height, and high-intensity RSI all entered the final regression model, indicating that men's 100-meter performance is characterized by multi-dimensional physical fitness determinants.

From a structural perspective, relative maximal strength provides the foundational platform for performance, enabling high-quality force application; 100 ms RFD determines the release efficiency of force within the critical time window, making it the core link for converting force into speed [18]; reverse jump height and high-intensity RSI further reflect the neuromuscular system's integration ability from the perspectives of explosive strength and elastic utilization. Previous research has suggested that sprint performance is influenced by multiple factors, including force output level, force output timing characteristics, technical movements, and neuromuscular coordination. Therefore, sprint performance evaluation should not be limited to a single indicator [19].

Therefore, improvements in men's 100-meter performance are essentially a process of multi-dimensional physical fitness factor optimization, rather than a linear accumulation of a single ability. This conclusion also explains why in training practice, focusing on just one physical fitness component often fails to bring stable and sustained performance breakthroughs. If an athlete has high maximal strength but lacks rapid recruitment ability, the force cannot be applied in time; if an athlete has good jumping ability but lacks sufficient strength foundation, it is difficult to maintain high ground reaction force during high-speed running [5].

5. Conclusion and Recommendations

5.1 Conclusion

(1) the performance of men's 100-meter sprinters is closely related to lower limb strength, explosive strength, and jumping ability. Among these, relative maximal strength, 100 ms RFD, 150 ms RFD, reverse jump height, squat jump height, and high-intensity RSI all show significant correlations with 100-meter performance.

(2) the correlation between 100 ms RFD and 100-meter performance is the highest, and it contributes the most in the regression model, indicating that the ability to generate explosive force within a very short time is a key physical factor influencing men's 100-meter performance. Relative maximal strength, reverse jump height, and high-intensity RSI also have good explanatory power.

(3) the formation of men's 100-meter performance results from the combined effects of relative maximal strength, early explosive power, and stretch-shortening cycle efficiency, with 100 ms RFD being the most critical indicator.

5.2 Recommendations

(1) Training should focus on improving relative maximal strength as a foundation, balancing strength development and body weight control, and enhancing the ability to generate force per unit body weight.

(2) 100 ms RFD should be prioritized in explosive strength training, aiming to improve the ability to exert rapid force during short ground contact times through explosive resistance training and specialized acceleration strength exercises.

(3) It is recommended to strengthen enhanced training and reactive jumping training to improve reverse jump ability and high-intensity RSI levels, promoting the conversion of explosive strength and elastic utilization ability into improved performance in the 100-meter sprint.

(4) in daily monitoring, it is advisable to prioritize indicators such as 100 ms RFD, relative maximal strength, reverse jump height, and high-intensity RSI to assess the specialized physical condition of men's 100-meter sprinters.

References

[1] Wang Y. Research on the balanced regulation of endurance and speed in track and field training [J]. Track and Field, 2025, (12):58-60.

[2] Zheng X, Chen H, Su B, et al. Progress and trends in scientific training for 100 m sprint: Based on sport biology and methodology [J]. China Sport Science, 2022, 42(2):3-11.

[3] Chen W, Zhang B, Zhang J. Correlation between specific physical fitness and 100 m performance in Chinese male sprint reserve

talents [J]. Journal of Chengdu Sport University, 2019, 45(4):85-90.

[4] MAFFIULETTI N A, AAGAARD P, BLAZEVICH A J, et al. Rate of force development: physiological and methodological considerations [J]. Eur J Appl Physiol, 2016, 116(6):1091-1116.

[5] OLEKSY Ł, MIKA A, KUCHCIAK M, et al. Relationship between Countermovement Jump and Sprint Performance in Professional Football Players [J]. 2024, 13(15):4581.

[6] PLESA J, KOZINC Z, SMAJLA D, et al. the association between reactive strength index and reactive strength index modified with approach jump performance [J]. PLoS One, 2022, 17(2): e0264144.

[7] HE Z, DUAN T, LI D, et al. Effects of resisted sprint training on agility and change-of-direction performance in soccer players: a systematic review with meta-analysis [J]. 2025, 13: e20084.

[8] Zhou T, Xu W. Relationship between stretch-shortening cycle in jumping and short-distance sprint acceleration ability in young sprinters [J]. China Sport Science and Technology, 2025, 61(3):13-22.

[9] Jiang Z, Li Q. Rethinking strength training for sprinting [J]. Journal of Shandong Sport University, 2017, 33(5):86-93.

[10] Lu H, Xu Y, Wang R. Application of isometric mid-thigh pull test in the assessment of lower limb muscle strength [J]. Journal of Chengdu Sport University, 2022, 48(1):129-142. [11] STAVRIDIS I, ZISI M, ARSONIADIS G G, et al. Relationship Between Isometric Mid-Thigh Pull Force, Sprint Acceleration Mechanics and Performance in National-Level Track and Field Athletes [J]. 2025, 15(3):1089.

[12] Cao H. Reliability and correlation analysis of dynamic strength index and force-velocity imbalance index [D]. Shanghai University of Sport, 2023. [13] MCMAHON J J, MURPHY S, REJ S J, et al. Countermovement-jump-phase characteristics of senior and academy rugby league players [J]. 2017, 12(6):803-811.

[14] MAFFIULETTI N A, AAGAARD P, BLAZEVICH A J, et al. Rate of force development: physiological and methodological considerations [J]. 2016, 116(6):1091-1116.

[15] Dai X, Zhan J. Construction and empirical study of specific strength in sprint events based on structural functional theory [J]. Journal of Xi'an Sport University, 2018, 35(4):506-512.

[16] BEATTIE K, TAWIAH-DODOO J, GRAHAM-SMITH P. Countermovement jump characteristics of world-class elite and sub-elite male sprinters [J]. 2020.

[17] HE J, LI M, ZHANG Q, et al. Associations between the performance of vertical jump and accelerative sprint in elite sprinters [J]. 2025, 13:1539197.

[18] HARTMANN H, WIRTH K, KEINER M, et al. Short-term Periodization Models: Effects on Strength and Speed-strength Performance [J]. Sports Med, 2015, 45(10):1373-1386.

[19] HICKS D S, DRUMMOND C, WILLIAMS K J, et al. Exploratory Analysis of Sprint Force-Velocity Characteristics, Kinematics and Performance across a Periodized Training Year: A Case Study of Two National Level Sprint Athletes [J]. 2022, 19(22):15404.

