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Prediction of 20 Meter Sprint Speed via Muscle Fibers and Leg Power at Cibubur National Training Center

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Keywords

Sprint speed 20 meters; muscle fibers; Limb power; Athletes of the National Sports Training Center Cibubur

Abstract

Objective: This study aims to predict the speed of a 20-meter sprint based on the characteristics of muscle fibers and leg power in athletes who participate in a coaching program at the Cibubur National Sports Training Center (CNSTC). This study is expected to provide an understanding of the contribution of physiological factors and explosive abilities of the legs to short-distance sprint performance. Methods: The study used a quantitative approach with a predictive correlational design. The subjects of the study are athletes who undergo a training program at CNSTC Cibubur. The characteristics of the muscle fibers were identified through neuromuscular measurements, while the strength of the limbs was measured using the vertical jump test. Sprint speed is measured through a 20-meter sprint test with an electronic timekeeping device. Data were analyzed using descriptive statistics, correlation tests, and regression analysis to determine the contribution of predictive variables to sprint performance. Results: The results of the analysis showed that the dominance of fast muscle fibers and high leg power were positively and significantly related to the 20-meter sprint speed. Athletes with these characteristics tend to record faster sprint times. Regression analysis also showed that both variables simultaneously made a significant contribution to predicting short-distance sprint performance. Conclusion: Muscle fibers and leg power are important predictors in determining the speed of a 20-meter sprint in athletes, so the development of explosive and neuromuscular exercises has the potential to improve sprint performance more effectively.

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INTRODUCTION

Sprint speed is one of the important components in various sports that demand the ability to accelerate and maximum speed in short distances. Sprint performance is greatly influenced by the neuromuscular ability, muscle strength, and physiological characteristics of the athlete. Physiologically, the composition of muscle fibers plays a big role in producing the rapid contractions and explosive force required when sprinting. Fast-twitch muscle fibers have the ability to generate force and contraction velocity higher than slow-twitch muscle fibers, so they are often associated with sprint performance and other explosive activities. Research Wackwitz et al It shows that the characteristics of muscle fibers are related to sprint performance ability in elite athletes, since the dominance of fast muscle fibers is related to the high power-producing capacity in high-speed activities (Wackwitz et al., 2025).

In addition to the composition of muscle fibers, leg power is also an important factor in determining sprint speed. Leg power describes the ability of muscles to generate force quickly through a mechanism Stretch-shortening cycle (Jariono et al., 2022, 2026; Nurhidayat et al., 2023). This ability can be measured through various tests such as Vertical jump, which is often used as an indicator of the explosive capacity of the leg muscles (Fristrup et al., 2024). Several studies have shown a significant relationship between vertical jumping ability and short-distance sprint performance, as both involve high force production in short ground contact times (Gheller et al., 2023). In addition, other studies have shown that leg muscle function ability and biomechanical parameters contribute to sprint performance in athletes, especially in the acceleration and maximum speed phases (Pietraszewski et al., 2025).

The results of initial observations in athletes who participated in the coaching program at the Cibubur National Sports Training Center (CNSTC) showed that there was a variation in the ability of the 20-meter sprint between athletes even though they followed a relatively uniform training program. These differences are thought to be related to individual physiological factors, specifically the composition of muscle fibers and the power ability of the limbs. Previous research has also shown that the physical characteristics and explosive capacity of muscles have a significant relationship with sprint ability in athletes of various sports (Oliveira et al., 2024). However, studies that specifically analyze the contribution of these two factors in predicting sprint speed in athletes in national coaching programs are still relatively limited.

Recent studies have shown that sprint performance is influenced by the interaction of physiological, neuromuscular, and biomechanical factors. The study by Thomas Wackwitz confirms that the typology of muscle fibers, specifically the dominance of fast-type muscle fibers, is closely related to the ability to produce explosive contractions that support high sprint speeds (Wackwitz et al., 2025). Another study by Rafael G. Gheller shows that exercises that combine sprints and Vertical jump able to increase capacity Speed-power athletes significantly (Gheller et al., 2023). In addition, biomechanical analysis was carried out by Paweł Pietraszewski emphasized that leg muscle activity and movement mechanics during the acceleration phase play an important role in determining the efficiency of the sprint (Pietraszewski et al., 2025). The results of Nuno M. Oliveira's research also show that there is a strong relationship between jumping ability and sprint performance in athletes (Oliveira et al., 2024). The findings are reinforced by Yifan Niu's research which emphasizes that physical fitness components, including muscle strength and explosiveness, contribute to repetitive sprint ability (Niu et al., 2024). Furthermore, Dong Sun stated that the strength training program is able to improve sprint performance through increased muscle force production (Sun et al., 2025). Syarif Y. Dahri's research also shows that leg muscle strength is positively correlated with running speed (Prawibowo et al., 2025). Overall, a study in the European Journal of Applied Physiology confirms that the main determinants of sprint acceleration come from a combination of kinetic and neuromuscular factors that affect the production of force and the efficiency of an athlete's movement (Fristrup et al., 2024).

Based on this description, the formulation of this research problem is: (1) whether the characteristics of muscle fibers affect the athlete's 20-meter sprint speed, (2) whether leg power affects the athlete's 20-meter sprint speed, and (3) whether these two variables together can predict athletes' sprint performance. This study aims to analyze and predict the speed of a 20-meter sprint through the characteristics of muscle fibers and leg power in athletes who participate in the coaching program at CNSTC Cibubur.

The hypotheses of this study are:

1. There is a significant relationship between muscle fibers and 20-meter sprint speed.
2. There is a significant relationship between leg power and 20-meter sprint speed.
3. Muscle fibers and leg power simultaneously are significant predictors of athletes 20-meter sprint performance.

METHODS

Research Methods

This study uses a quantitative approach with a correlational design(Jariono et al., 2025) to analyze the ability of muscle fibers and limb power in predicting the speed of a 20-meter sprint in athletes. This approach is used to determine the relationship and contribution of predictor variables to the performance of short-distance sprints. The prediction model was developed through regression analysis to identify the influence of physiological variables and the explosive ability of the legs on the athlete's sprint performance.

Research Tools/Design/Instruments

The research instruments include:

1. Vertical Jump test to measure leg power.
2. The 20 Meter Sprint test uses an electronic timing system or photocell to accurately measure the sprint time.
3. Measurement of neuromuscular characteristics as an indicator of the dominance of muscle fiber types (fast-twitch and slow-twitch).

The use of vertical jump tests has been shown to have a strong association with sprint acceleration performance in elite athletes(He et al., 2025).

Subject/Object of Research

The subjects of the study were athletes who participated in a coaching program at the Cibubur National Sports Training Center (CNSTC). The research objects include the characteristics of muscle fibers, leg power, and 20-meter sprint performance.

Data Type

The data used is in the form of quantitative data, including:

1. limb power score (jump height),
2. characteristics of muscle fibers,
3. Sprint time of 20 meters.

Data Capture

Data collection was carried out through direct physical tests in the field. Athletes do a standard warm-up, then undergo a vertical jump test to obtain a leg power score, followed by a 20-meter sprint test with an electronic timer.

Data Analysis

Data analysis used descriptive statistics, Pearson correlation test, and multiple linear regression analysis to determine the contribution of muscle fiber and limb power variables in predicting sprint speed.

Formula (Prediction Model)

Regression models used:

Y = a + b1X1 + b2X2

Description:

Y	= 20 meter sprint speed
X1	= Muscle fiber
X2	= Leg power
a	= constant
b1.b2	= regression coefficient

The entire data analysis was done using the SPSS program version 26

RESULTS AND DISCUSSION

This study involved as many as 20 athletes who were members of the coaching program at the Cibubur National Sports Training Center as research subjects. The variables studied in this study include muscle fiber composition (X1), leg power ability (X2), and 20 meter sprint speed performance (Y) as bound variables. The data analysis process is carried out through descriptive statistical stages, normality assumption testing, and hypothesis testing using correlation and regression analysis techniques.

Descriptive analysis

Descriptive analysis is used to describe the characteristics of research data which include mean values, standard deviations, minimum values, and maximums.

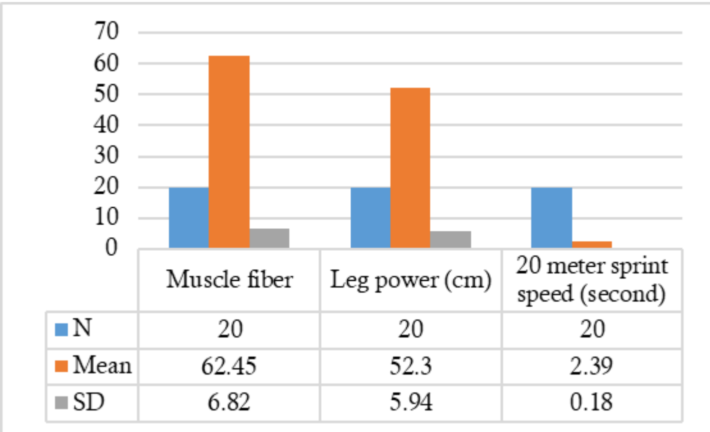

Figure 1. histogram of muscle fiber characteristics, leg power and 20 meter sprint

The average 20-meter sprint time in athletes was recorded at 2.39 seconds, reflecting the level of consistency of performance with relatively low variation in results between individuals. Meanwhile, the results of measuring the power of the limbs through the vertical jump test showed a relatively good explosive capacity, with an average value of 52.30 cm. These findings indicate that athletes have the explosive power of leg muscles that support short-distance sprint performance.

Data Normality Test

The normality testing of the data in this study was carried out using the Shapiro–Wilk method to verify that the data distribution met the assumption of normality as a prerequisite before the implementation of further analysis related to the prediction of 20-meter sprint speed based on muscle fibers and leg power in athletes at the Cibubur National Sports Training Center.

Table 1. Data normality

Variabel	Statistik Shapiro-Wilk	Sig. (p)	Remarks
Muscle Fibers (x1)	0.962	0.574	Normal
Power Limb (X2)	0.955	0.432	Normal
Sprint 20 Meters (Y)	0.948	0.318	Normal

All research variables showed a significance value (p-value) greater than 0.05, so it can be interpreted that the data has a normal distribution. Thus, the assumption of normality has been fulfilled and the data is declared worthy of further analysis using correlation and regression techniques in assessing the prediction of 20-meter sprint speed based on muscle fibers and leg power in athletes at the Cibubur National Sports Training Center.

Hypothesis Test

Table 2. Hypothesis test results

Variabel	r	Sig. (p)
$X_1 \rightarrow Y$	0.65	0.002
$X_2 \rightarrow Y$	0.76	0.001
X_1 and $X_2 \rightarrow Y$	0.87	0.000

Partially, the muscle fiber variable (X1) had a correlation coefficient of 0.65 with a significance value (p) of 0.002. This value indicates a strong and significant positive relationship between muscle fiber composition and a sprint speed of 20 meters. This means that the more dominant the muscle fibers that support rapid contraction, the sprint performance of athletes tends to increase.

Furthermore, the limb power variable (X2) showed a higher correlation coefficient, which was 0.76 with a significance value (p) of 0.001. This confirms that leg power has a strong and significant positive relationship to the speed of a 20-meter sprint. Thus, the increase in the explosive ability of the limbs contributes significantly to improving the performance of short-distance sprints.

Simultaneously, the combination of muscle fibers (X1) and leg power (X2) to a sprint speed of 20 meters resulted in a correlation coefficient of 0.87 with a significance value (p) of 0.000. These findings suggest that the two variables together have a very strong and significant relationship in predicting 20-meter sprint speed. Thus, the integration of muscle physiological characteristics and leg power ability becomes a major determining factor in the performance of sprint athletes.

Table 3. Multiple Regression Analysis Results

Variabel	r	R^2	F	Sig.
X_1 and $X_2 \rightarrow Y$	0.87	0.75	14.29	0.000

Simultaneously, the results of multiple regression analysis obtained a correlation coefficient value (r) of 0.87 which shows a very strong relationship between the variable muscle fibers (X1) and leg power (X2) simultaneously to the sprint speed of 20 meters (Y) in athletes at the Cibubur National Sports Training Center.

A determination coefficient value (R^2) of 0.75 indicates that 75% of the variation in the 20-meter sprint speed can be explained by a combination of muscle fibers and leg power, while the remaining 25% is influenced by other factors outside the study model.

Furthermore, the calculated F value of 14.29 with a significance level (Sig.) of 0.000 (< 0.05) indicates that the regression model used has a high feasibility level and is statistically significant. Thus, it can be concluded that muscle fibers and leg power together have a significant effect in predicting the speed of a 20-meter sprint in athletes.

The discussion of the results of the hypothesis test in this study shows that the variables of muscle fibers and leg power have a very significant contribution in predicting the speed of the 20-meter sprint in athletes of the Cibubur National Sports Training Center. This is evidenced by the correlation coefficient value (r) of 0.87 which indicates a very strong relationship, and the value of the determination coefficient (R^2) of 0.75 which means that 75% of the variation in sprint speed can be explained by the two variables. In addition, an F value of 14.29 with a significance of 0.000 (<0.05) confirms that the regression model used simultaneously is significant in explaining the relationship between variables. Thus, these results empirically answer the formulation of the problem that muscle fibers and leg power are the main predictors in short-distance sprint performance.

Physiologically, these results are in line with the theory of muscle contraction which states that fast-twitch muscle fibers have the ability to produce higher force and contraction speed than slow-twitch muscle fibers. This makes fast-type muscle fibers very dominant in explosive activities such as sprints. Modern biomechanical studies also explain that the kinetic characteristics of muscles, particularly in the actin-myosin system, determine the force production ability and speed of muscle motion in rapid activity (Buonfiglio et al., 2024). In addition, the coordination of muscle synergy in the lower extremities plays an important role in the efficiency of the running movement, especially in the acceleration phase of the sprint (Ye et al., 2025). Therefore, the combination of muscle fiber quality and power generation is a key factor in increasing sprint speed.

The findings of this study are also supported by various previous studies, both national and international. Research by Sanga Dwi et al. shows that leg power has a significant effect on increasing sprint acceleration speed (Dwi et al., 2018). Another study found that the explosiveness of leg muscles has a significant contribution to sprint performance, including in the 100-meter sprint number (Harahap & Sulastio, 2021). Rafli's research also revealed a relationship between leg muscle strength and 20-meter running speed (Rafli et al., 2025). In addition, research by Dermawan and Makorohim shows that leg muscle power correlates with running speed performance and explosive motion ability (Dermawan & Makorohim, 2025).

Furthermore, other studies have shown that the explosiveness of the leg muscles contributes significantly to the performance of fast movements over short distances, which characteristically requires speed and strength similar to sprints (Amanda et al., 2025). Iswandi's study also found that the combination of sprint and leg muscle power contributed simultaneously to explosive motion performance by more than 50%.

Research Smash Bros. (2024) Emphasizing that the combination of leg muscle power and running speed has a significant influence on athletic performance, especially in activities that demand high acceleration and explosiveness. These findings are reinforced by various international studies that show that leg muscle power is a major determinant in short-distance sprint performance. A meta-analysis study by Pietraszewski et al. (2025) reveals that the activity and coordination of the muscles of the lower extremities, such as the gluteus and hamstrings, play a direct role in increasing the frequency of steps and thrust during sprinting. In addition, the research Singh (2025) It shows that increased explosive power through strength training and plyometrics significantly improves short-distance sprint performance as well as the efficiency of running mechanics. In line with that, experimental studies by Xu et al. (2025) It proved that an eight-week plyometric training program was able to increase leg muscle power while significantly improving sprint performance.

Based on these theoretical and empirical studies, it can be concluded that the results of this study are consistent with the theory of sports physiology and are supported by various previous studies that state that muscle fibers (especially the fast type) and leg power are the main determinants in sprint speed. Practically, the implication of these findings is that sprint athletes' training programs need to be focused on developing fast-type muscle fibers through explosive exercises as well as increasing leg power such as plyometric and resistance training. Thus, the final results of this study confirm that the combination of muscle fiber quality and leg power simultaneously is a very strong predictor in determining the performance of the 20-meter sprint in national-level athletes.

CONCLUSION

The results of this study show that muscle fibers and leg power have a very strong and significant contribution in predicting the speed of a 20-meter sprint in athletes at the Cibubur National Sports Training Center. This is evidenced by a correlation coefficient value of 0.87 which reflects a very close relationship, as well as a determination coefficient of 0.75 which indicates that 75% of the variation in sprint performance can be explained by these two variables. In addition, significant results of the F test (Sig. 0.000 < 0.05) confirm that the regression model used is feasible and has high predictive power. Thus, the combination of the physiological characteristics of muscle fibers and the power ability of the legs is a major factor that determines the performance of short-distance sprint speed in athletes.

REFERENCES

Amanda, B., Pratama, N. Z., & Antoni, P. (2025). Hubungan daya ledak otot tungkai dengan kecepatan lari jarak pendek kelas X Merdeka 1 di Sekolah SMAN 2 Tembilahan. *Jurnal Olahraga Indragiri, 9*(1), 10–19. https://doi.org/10.61672/joi.v9i1.2903

Buonfiglio, V., Pertici, I., Marcello, M., Morotti, I., Caremani, M., Reconditi, M., Linari, M., Fanelli, D., Lombardi, V., & Bianco, P. (2024). Force and kinetics of fast and slow muscle myosin determined with a synthetic sarcomere-like nanomachine. *Communications Biology, 7*(1), 1–12. https://doi.org/10.1038/s42003-024-06033-8

Dermawan, J. S., & Makorohim, M. F. (2025). Kontribusi power otot tungkai dan kecepatan terhadap hasil lompat jauh pada siswa putra kelas VIII SMP Negeri 1 Pasir Penyu Kabupaten Indragiri Hulu. *Innovative: Journal of Social Science Research, 5*(4), 12301239. https://jinnovative.org/index.php/Innovative

Dwi, D., Asmawi, M., Wasan, A., & Widiastuti, W. (2018). Pengaruh metode latihan dan power tungkai terhadap peningkatan kecepatan akselerasi sprint. *JUARA: Jurnal Olahraga, 3*, 62. https://doi.org/10.33222/juara.v3i2.236

Fristrup, B., Krustrup, P., Kristensen, K. H., Rasmussen, S., & Aagaard, P. (2024). Test-retest reliability of lower limb muscle strength, jump and sprint performance tests in elite female team handball players. *European Journal of Applied Physiology, 124*(9), 2577–2589. https://doi.org/10.1007/s00421-024-05470-x

Gheller, R. G., Kons, R. L., Pupo, J. D., & Detanico, D. (2023). Effect of vertical jump and sprint training on power and speed performance transfer. *Motor Control, 27*(2), 373–401. https://doi.org/10.1123/mc.2022-0103

Harahap, L. H., & Sulastio, A. (2021). Kontribusi daya ledak otot tungkai terhadap kemampuan lari sprint 100 meter. *Journal Athletic and Sport Nutrition, 1*(1), 30–37. https://journal.uir.ac.id/index.php/jasti/index

He, J., Li, M., Zhang, Q., & Zhang, Z. (2025). Associations between the performance of vertical jump and accelerative sprint in elite sprinters. *Frontiers in Bioengineering and Biotechnology, 13*, 1539197. https://doi.org/10.3389/fbioe.2025.1539197

Jariono, G., Rofiq, T. A., & Maharani, R. A. (2026). Preventive benefits of physical activity for psychosocial health and well-being. *Journal of Holistic Sports and Physical Education Page, 1*(1), 19–30. https://journals2.ums.ac.id/jhspe/article/view/14426

Jariono, G., Subekti, N., Sistiasih, V. S., Fatoni, M., & ... (2022). Pkm pendampingan dan pelatihan olahraga renang untuk anak usia dini. ... *Journal of Community ..., 2*(1), 12–19. http://icjcs.esc-id.org/index.php/home/article/view/50

Jariono, G., Usman, A., Ihsan, A., & Nurhidayat, N. (2025). *Metode peneltian pendidikan jasmani dan olahraga* (1st ed.). RajaGrafindo Persada.

Maifa, S. (2024). Analisis power otot tungkai dan kecepatan lari terhadap kemampuan lompat jauh. *Jurnal Porkes, 7*(1), 595–605. https://doi.org/10.29408/porkes.v7i1.25973

Niu, Y., Zhang, M., Sun, J., Cao, H., & Shen, M. (2024). Study of the relationship between specialised physical fitness and repeated sprinting ability in university football players. *Academic Journal of Science and Technology, 12*(2), 2–6. https://doi.org/10.54097/g4exjn57

Nurhidayat, N., Jariono, G., Sudarmanto, E., Subekti, N., Nugroho, H., & Maslikah, U. (2023). How to improve special needs children's motor skills by modifying circuit exercises. *International Journal of Human Movement and Sports Sciences, 11*(6), 1244–1252. https://doi.org/10.13189/saj.2023.110608

Oliveira, N. M., Lázari, E., Matias, C. N., Guerra-Júnior, G., & Gonçalves, E. M. (2024). Sprint and jump performance are determined by localized BIA - an ecological study in track and field adolescent athletes. *BMC Sports Science, Medicine and Rehabilitation, 16*(1), 235. https://doi.org/10.1186/s13102-024-01023-z

Pietraszewski, P., Maszczyk, A., Zając, A., & Gołaś, A. (2025). Muscle activity and biomechanics of sprinting: A meta-analysis review. In *Applied Sciences, 15*(9), 4959. https://doi.org/10.3390/app15094959

Prawibowo, M., Dahri, S. Y., Mardiansyah, M. A., & Alhafi, M. I. (2025). The relationship between leg muscle strength and 100-meter running speed in high school athletes. *JIPES: Journal of Indonesian Physical Education and Sport, 11*(2), 55–58. https://doi.org/10.21009/JIPES.112.05

Rafli, R., Ati, A., Haetami, M., Yunitaningrum, W., & Pranata, D. (2025). Hubungan kekuatan otot tungkai dan kecepatan lari 20 meter dengan hasil shooting bola ke gawang pada pemain futsal. *Jolma, 5*(1), 23–36. https://doi.org/10.31851/v5i1.17865

Singh, L. (2025). Comparative effects of strength and plyometric training on explosive power and short-sprint performance in competitive sprinters. *International Journal of Physiology, Exercise and Physical Education, 7*(2), 304–309. https://doi.org/10.33545/26647249.2025.v7.i2e.231

Sun, D., Peng, J., Rao, Y., & Zheng, B. (2025). The effect of strength training on core strength and specialised performance in sprint athletes. *Advances in Social Behavior Research, 16*(10). https://doi.org/10.54254/2753-7102/2025.30091

Wackwitz, T., Minahan, C., Lievens, E., Kennedy, B., Derave, W., & Bellinger, P. (2025). Muscle-fiber typology is associated with sprint-cycling characteristics in world-class and elite track cyclists. *International Journal of Sports Physiology and Performance, 20*(1), 142–148. https://doi.org/10.1123/ijspp.2024-0089

Xu, Z., Sun, J., Gu, J., & Yu, L. (2025). Effects of 8 weeks of combined strength and plyometric training on lower limb vertical stiffness and jump performance in elite long jump athletes. *Frontiers in Physiology, 16*(November), 1–10. https://doi.org/10.3389/fphys.2025.1692254

Ye, M. A., Shixin, L., Fu, S., Yuwei, L., Chenyi, G., Dongwei, L., & Meijin, H. (2025). Muscle synergy patterns during running: Coordinative mechanisms from a neuromechanical perspective. *ArXiv Preprint, 7*, 1–18. https://doi.org/10.48550/arXiv.2512.24654