



Analysis Of 100-Meter Sprint Acceleration Movement (Study Of Male 100-Meter Sprint Athletes In National Training Center B, From A Biomechanical Perspective)

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Abstract

This study aims to analyze acceleration movement in the 100-meter sprint of male athletes from the National Training Center B from a biomechanical perspective. The main focus of the study is to examine the start phase, acceleration phase, and stride technique that affect optimal speed. The research method uses a qualitative descriptive approach with three-dimensional video analysis. Data were collected through high-speed camera recordings and measurements of stride length, stride frequency, push-off angle, and reaction time. The results of the analysis show that in the initial acceleration phase, the optimal push-off angle is in the range of 42°–45° to the track surface, while the highest stride frequency is achieved at a distance of 30–50 meters. In conclusion, mastery of biomechanical techniques, especially in the start and acceleration phases, greatly influences the achievement of maximum speed in the 100-meter sprint.

Keywords: *100-Meter Sprint Acceleration, Athletic Biomechanics.*

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INTRODUCTION

According to (Putra et al., 2020), the sport of athletics is one of the oldest sports in the world because it has existed since ancient times. (Nopiyanto & Raibowo, 2020:6) in their book stated that athletics is a sport that has a close relationship with everyday life. In daily life, we always perform athletic movements consisting of walking, running, throwing, and jumping (Alfian & Lanos, 2022). Athletics is referred to as the oldest sport in the world and is considered the parent of all existing sports (Efendi et al., 2024). This is because all sports contain elements of athletic movements.

Speed in running is the result of strong and fast contractions of the muscles, which are transformed into smooth, fluid, and efficient movements, and it is essential for runners

to achieve high speed. In sprinting, to attain high speed, a runner must run consistently to increase leg muscle strength and running speed. Additionally, a teacher or coach also needs to perform biomechanical movement analysis to achieve optimal results.

The 100-meter sprint is one of the most prestigious short-distance running events in the sport of athletics. This event is often used as a benchmark of an athlete's achievements because it demands speed, strength, and perfect technique in a short period of time. A sprinter's performance is greatly influenced by the quality of acceleration, especially in the first 30–50 meters after the start, which determines the achievement of peak speed.

Based on the statement, athletics is one of the elements in physical education and health that must be provided to students at various levels, from elementary school, junior high, to senior high school, in order to produce students or athletes who excel in athletic sports, particularly in the 100-meter race. It is not only about the process of delivering material and practice, but also requires an analysis of movements from a biomechanical perspective so that teachers and students thoroughly understand whether the movements performed are correct or incorrect.

According to Abdillah (2016:22), biomechanics is explained as one of the main sciences in sports science. One of the problems in the slow development of sports achievements in Indonesia is the lack of application of science and technology in sports training. One very important scientific study in the development of sports performance is the approach of movement mechanics principles in refining general movement techniques (Biomechanics) (Abdillah, 2016:16). According to Kusumawati & Muhamad (2020), biomechanics is "the science that studies the internal and external forces acting on the human body along with their effects, to achieve maximum performance in sports."

According to Kurniawan (2015), biomechanics is "the science used to improve the efficiency of an athlete's movement when performing a sport. For example, through techniques such as analysis of technique, identification of sports injuries, and evaluation of training programs." The application of movement science in training and knowledge about the principles of movement science and their practical application, biomechanics deals with the influence of forces and the laws of nature on the human body during physical activities. Biomechanics plays a very important role in sports movements, especially in movement techniques; with the application of biomechanics in sports, the ability to maximize movements can be achieved optimally.

In the study of biomechanics, acceleration in sprinting is influenced by several factors, including the body's push-off angle, stride length, stride frequency, coordination of arm and

leg movements, and explosive muscle strength. For National Training Center B athletes, who are part of the national development program, mastery of biomechanical aspects is very important in supporting performance improvement. The analysis of acceleration movements through a biomechanical approach not only provides an overview of the quality of the techniques performed but also serves as a basis for coaches to design more targeted training programs. Based on this background, this study aims to analyze the sprint acceleration movements of 100 meters in male athletes of National Training Center B using a biomechanical approach. The main focus of this research is to examine the start phase, acceleration phase, and maximum speed phase, as well as to describe the biomechanical factors that contribute to achieving optimal speed.

METHOD

The research used a quantitative research type, with the method applied being descriptive quantitative analysis. This is because the study analyzes video of the 100-meter sprint acceleration motion taken from 0-30 meters. The research subjects were 5 male sprint athletes from Pelatnas B participating in the 100-meter race. High-speed camera (120-240 fps) were used to record running movements. Biomechanical analysis software (Kinovea and Dartfish) was used to analyze angles, stride length, and step frequency. Digital stopwatches were used to measure the time taken for each phase. The research procedure for the 100-meter sprint was conducted 3 times on a standard track. Video recordings were analyzed to identify the start phase, acceleration (0-50 m), and maximum speed phase. The biomechanical parameters analyzed included body angles at the start, stride length, step frequency, reaction time at the start, and average speed in each phase. Data analysis was conducted descriptively by calculating the average value (mean), comparison between phases, and describing the findings based on sprint biomechanics aspects.

Inclusion criteria are the characteristics or requirements that subjects must have in order to be included in a study. In the context of biomechanics research or 100-meter sprint performance, the inclusion criteria used are: Athletes who are active members of the National Training Camp (Pelatnas) B in the athletics sprint (100 meters) category. Male athletes aged 18–28 years to maintain homogeneity in physiological conditions and physical performance. Minimum of 5 years of sprint training experience. The population in this study consists of all male sprint athletes of Pelatnas B athletics in Indonesia who are participating in the national training program at the time the research was conducted. The population size in this group is

known to consist of five active athletes. In this study, these five athletes also served as the research sample, because the entire population meeting the inclusion criteria was used as observation subjects. It was determined that these 5 athletes represent the entire population as well as the sample.

RESULTS AND DISCUSSION

Results

Based on the results of video analysis and biomechanical measurements of 5 male sprint athletes from Pelantas B, the following descriptive data were obtained:

Tabel 1. Average Biomechanical Parameters of 100-Meter Sprint for Male Athletes of National Training Center B.

Sprint phase	React on Time (second)	Body Angle (°)	Step Length (m)	Step Frequency (steps/second)	Average Speed (m/s)
Start (0–10 m)	0,16	44°	1,75	3,8	7,5
Acceleration (10–50 m)	-	42°–45°	2,10–2,30	4,5	9,8
Step Length (m)					
Sprint phase	React on Time (second)	Body Angle (°)		Step Frequency (steps/second)	Average Speed (m/s)
Maximum Speed (50–80 m)	-	46°–48°	2,40	4,3	10,3
Decrease (80–100 m)	-	48°–50°	2,35	4,0	9,7

Discussion

An average reaction time of 0.16 seconds indicates that the athlete's response to the signal is already good. A forward-leaning body position at an angle of about 42°–45° has been shown to provide optimal horizontal thrust. According to Hay (1993), a body angle that is too upright during the start phase can reduce the effectiveness of initial acceleration. Therefore, controlling body posture from the starting blocks is key to achieving maximum acceleration. Acceleration Phase (0-50 m)

During the acceleration phase, there is an increase in stride length from 1.75 m to 2.30 m. Step frequency also rises, reaching 4.5 steps per second. This condition indicates that the athlete is able to effectively utilize the explosive power of the legs. These findings support the

research of Mero & Komi (1985), which emphasizes the importance of muscle power in enhancing acceleration. The coordination of arm swing with leg steps is also proven to help maintain balance and the stability of movement rhythm.

Maximum Speed Phase (50–80 m)

The average peak speed reached was 10.3 m/s, marked by a stride length of about 2.40 m and a frequency of 4.3 strides per second. In this phase, the athlete's body has already begun to straighten more with an angle of 46° – 48° , which functions to maintain speed momentum. Bartlett (2007) states that the balance between stride length and frequency determines the achievement of maximum speed. Thus, consistency in technique during this phase plays a significant role in the athlete's optimal performance.

Declining Phase (80-100 m)

The athlete's speed decreased to 9.7 m/s due to muscle fatigue and a reduction in anaerobic energy system capacity. This aligns with the opinion of Brüggemann & Glad (1990), who stated that in the last 20 meters, metabolic factors and speed endurance ability are highly determining. Athletes who are less able to maintain their technique and movement rhythm will experience a more significant performance decline.

General Interpretation

The findings of this study confirm that the acceleration phase is a crucial component in achieving performance in the 100-meter sprint. Efficient starting technique, optimal push-off angles, and gradual step length transition contribute to reaching maximum speed. Therefore, the training program for National Team B athletes should emphasize strengthening explosive muscles, starting technique, and biomechanics training to maintain speed consistency until the finish line.

CONCLUSION

Based on the results of biomechanical analysis of the 100-meter sprint by male athletes of Pelatnas B, it can be concluded that: The acceleration phase is the most crucial stage in determining 100-meter sprint performance, as it directly affects the achievement of maximum speed. An average reaction time of 0.16 seconds and an optimal body angle of around 42° – 45° during the start phase have been proven to produce effective horizontal propulsion. Stride length gradually increases from 1.75 m in the initial phase to 2.40 m at maximum speed, while stride frequency remains stable at around 4.3–4.5 steps/second. The average peak speed of 10.3 m/s is achieved between 50–80 meters, but begins to decline in the last 20 meters due to fatigue.

Biomechanical analysis can serve as a basis for designing more specific training programs, especially concerning the start, acceleration, and speed endurance.

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