Analysis of Biomechanics of Short Distance Running Movements: A Review of the Literature on the Influence of Running Techniques on Body Performance

Review Article

Jefrio Demitrimus Nubatonis* Yogyakarta State University, INDONESIA

Salmon Runesi Nusa Cendana University, INDONESIA

Muhammad Daffa Haidar Yogyakarta State University, INDONESIA

Abstract. (The word length is not more than 250 words) English Language

Background Short-distance running is a popular sport that involves complex body movements. Proper running technique is essential to improve athletes' performance while minimizing the risk of injury. However, errors in technique such as inefficient stride patterns, poor posture, and incorrect landing can lead to injury and decreased performance.

Objectives This study aims to analyze the biomechanics of short-distance running movements and explore the influence of running techniques on athlete performance and injury based on the latest literature review.

Methods The approach used is a literature study with a qualitative descriptive method that follows the PRISMA guidelines. Data was collected through systematic searches of various databases such as Google Scholar, PubMed, and ScienceDirect using keywords related to running biomechanics, running techniques, athlete performance, and injury. From the initial 1,190 articles, 8 relevant articles were selected for qualitative analysis.

Results Analysis of the literature shows that optimal running techniques, including the right combination of stride length and stride frequency, leg thrust angle, and body movement coordination, can improve athletes' speed, energy efficiency, and endurance. In addition, correct technique can reduce excess pressure on joints and muscles, thereby reducing the risk of injuries such as band IT syndrome and tendinitis. Good musculoskeletal adaptation also plays a role in athlete performance.

Conclusion An in-depth understanding of the biomechanics of short-distance running movement is essential for improving athletes' performance and preventing injury. Coaches and athletes are advised to integrate proper technique training as well as the use of appropriate assistive devices such as shoes for optimal results.

Keywords: biomechanics, short-distance running, running techniques, body performance.

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*Correspondence: jefrynubatonisjefrynubatonis@gmail.com
Jefrio Demitrimus Nubatonis
Yogyakarta State University, Indonesia

INTRODUCTION

Sport is a physical and physical activity that is used to train the human body to be physically and spiritually healthy. By doing sports regularly and regularly, humans can encourage, develop, and nurture the physical and spiritual potentials of a person as an individual or community group in the form of games, competitions or matches [1]. Exercise can also be said to be a part of life that some of the gifts that are commonly used are not human, by exercising physical freshness or have a basis to support[2]. An analysis of a person's physical condition can be improved so that for the biomechanics of one of the sports to carry out daily activities without experiencing a large role to determine the performance of athletes, fatigue means [3].

Running is one of the most basic and popular sports around the world, whether for fitness, recreation, or competition. Although it seems simple, these movements involve complex

interactions between the musculoskeletal system and other body mechanisms. Athletics is a sport that is in demand by the public at this time, especially in the number of running many people who do running sports and have made a lifestyle in life with the aim of maintaining fitness and running a healthy lifestyle [4]. The athletic branch consists of several numbers, namely walking, running, jumping, and throwing. Running consists of short distance running, medium distance running, long distance running and marathon. The short distance run has running numbers including the 50-meter run, the 100-meter run, the 200-meter run and the 400-meter run [5].

The biomechanics of running movement, which studies the principles of physics and mechanics in the human body during running activities, is one of the important aspects that affect athletes' performance as well as the risk of possible injury [6]. Every aspect of running technique, from stride patterns, incline angles, posture, to running style, can affect an athlete's movement efficiency and endurance, which in turn impacts their long-term performance and health. In sports achievement, Biomechanics is a very important discipline and even ranks at the top. So many contributions were made that it was only natural for a developed country like Germany to place it that way [7].

In the context of athletics, good running technique is closely related to improved performance, which includes aspects of speed, endurance, and energy efficiency [8]. Conversely, errors in running technique, such as unbalanced or poorly occurring steps, can lead to disturbances in the body's mechanics [9]. increases the overload on joints, muscles, and ligaments, and increases the likelihood of injury [4]. Running-related injuries such as IT band syndrome, shin splints, tendinitis, and knee ligament injuries are often directly related to improper technique [10].

Biomechanics is an interdisciplinary field that applies the principles of physics to biological systems to understand how organisms move and interact with their environment [11]. The application of motion science in training and knowledge of the principles of motion science and its application in practice [12]. Biomechanics deals with the influence of power and natural laws on the human body during physical activity. Biomechanics plays a major role in sports movement, especially in movement techniques, with the application of biomechanics in sports the ability to maximize movement can be done to the maximum [13]

Research on the biomechanics of running movement has come a long way in recent decades, focusing on how running techniques can be optimized to improve performance and prevent injury. However, there is still a lot of information about the most efficient and safe

running technique, given that individual factors such as body anatomy, muscle strength, desire, and running experience also affect the results achieved.

Therefore, this literature review aims to analyze various current studies on the biomechanics of running movement and understand how proper technique can affect athletes' performance as well as the risk of injury that may arise. Through a deeper understanding of the relationship between running technique, performance, and injury, it is hoped that practical solutions can be found that can be applied by coaches, athletes, and health professionals to optimize training outcomes and prevent injuries in runners.

METHOD

Search Strategy.

This study uses a literature observation approach or literature study which aims to explore and identify various findings related to the analysis of the biomechanics of short-distance running movements by applying the keywords biomechanics of running, running techniques, athlete performance, injuries. [14]. This research is a qualitative descriptive research based on a literature study. This study aims to summarize and analyze information in the literature to gain insights and conclusions that can be used to analyze the biomechanics of running movement and explore the influence of running techniques on athlete performance and injury. The search was conducted by following the guidelines of systematic observation and standard meta-analysis (PRISMA) [15].

Data collection in this study was carried out through the following steps: The research process involved a systematic search of electronic databases, including Google Scholar, PubMed, and ScienceDirect, using specific keywords such as "Biobekanika," "Running Technique," "Athlete Performance," "Injury." Other resources that will also be used are university libraries, conferences, and articles available on the internet, source selection, content analysis. The data analysis in this study was carried out qualitatively.

Exclusion Criteria

With the following steps: Categorization groups research findings based on themes or subtopics, such as biomechanics analysis, running, synthesis compiles conclusions from results found in the literature to identify patterns, similarities, and differences from various sources. Interpretation provides the interpretation of data that has been synthesized.

Procedure.

Initially, 1,190 publications were identified through database searches (Google Scholar, PubMed, and ScienceDirect). After following the exclusion criteria, only 8 articles remained. Most of the items were discarded because the article did not mention lateral epicondyls in

patients with tennis elbow lateral epicondylitis. All articles are extracted from their sources and analyzed through Mendeley software to eliminate duplicate articles. The PRISMA groove can be seen in Figure 1.

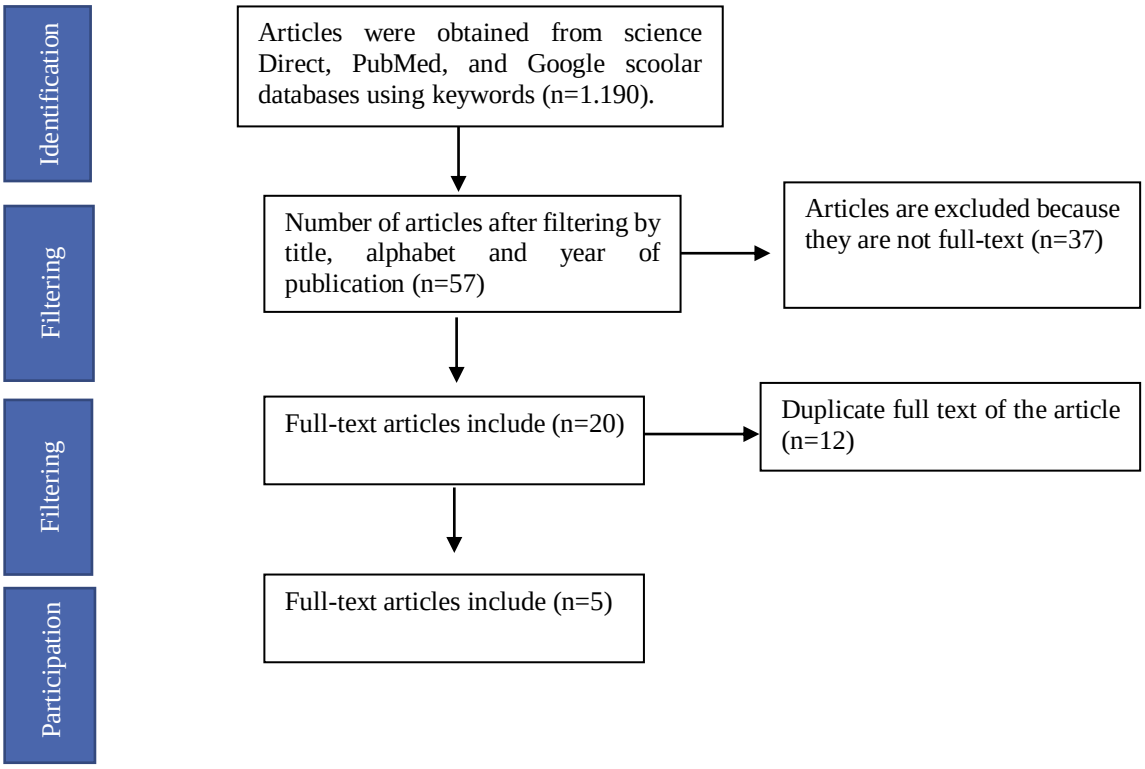

Figure 1. PRISMA research flow diagram.

RESULTS AND DISCUSSION

Results

Based on the category review conducted, the methods and types of research can be said to be as follows: there are four research articles using quantitative descriptive methods, [16], [17], [18], [10], one article using an analytical approach, [19], and one article using the survey method [20].

Author and years	Research methods and types	Title	Research objectives	Research results
[10]	The research method used is quantitative descriptive	Biomechanical Analysis of the 100-Meter Running Movement of Putri Koni	The researcher wanted to analyze the running movement of the Koni women's	The results of the analysis of stride length and stride frequency from HTY athletes amounted to 57 steps and the average stride length was 172.84 cm. There needs to be a good combination of stride length and stride frequency to

		Gresik Regency	100-meter athlete in Gresik Regency.	get the best time record. This ability needs to be combined with consistent pace, allowing him to achieve very high running speed.
[20]	The research method used by the Survey uses observation techniques	Application of Biomechanical Analysis (Kinovea Software) to Develop the Ability to Run Short Distances (100 M) of Pjkr Elemental Students	This study is intended to determine the speed analysis of every 10 meters	The results of the study showed that runners can accelerate at a distance of 0-50 meters with an average acceleration value of 1.23 m/s, and runners again accelerate at a distance of 80-90 meters with an average value of acceleration (acceleration) made by runners which is 1.23 m/s.
[19]	The research method used Descriptive analysis uses the one-shot case study method	Analysis of 1000 Meter Running in Elementary School Children of Bina Amal Semarang City: A Review of Sports Biomechanics	This study aims to find out the analysis of running motion of elementary school children Semarang City charity in the 1000 meter run.	The results of the study showed that the average 1000-meter run at Bina Amal Elementary School in Semarang City was 7.49 minutes. There are no students who have a very good category, no students who have a good category, no students who have a good category, 2 students have a bad category, and 23 students have a very bad category. It can be concluded that the analysis of the running movement of children of Bina Amal Elementary School in Semarang City in the 1000 meter run shows a very bad category. The limitation in this study is that there is no kinetic data that supports kinematic data in this study.
[18]	Research methods	The Relationship	The study was	The results of the study found that the correlation coefficient

	used Quantitative descriptive.	between Leg Muscle Strength and the Ability to Run 100 Meters in 2020 UHO Physical Education Students	conducted with the aim of finding the relationship between leg muscle strength and the ability to run 100 meters in Penjaskes-rek 2020 UHO students.	linking the variables of leg muscle strength and 100-meter running ability was negative, with a correlation value (r) calculated as -0.724 and a significance value of 0.000 < 0.05, along with a determination coefficient of 0.525 or 52.5%, indicating that there was a significant relationship between the relationship between leg muscle strength and 100-meter running ability. The conclusion of this study is that there is a significant relationship between leg muscle strength and the ability to run 100 meters in 2020 UHO Penjaskes-rek students. Leg muscle strength contributes 52.5% to the ability to run 100 meters, while the remaining 47.5% is influenced by a variety of factors, including other physical conditions.
[17]	Quantitative methods with experimental approaches	Musculoskeletal Adaptation of NTT Native Athletes: Biomechanical Perspectives	This study aims to examine the musculoskeletal adaptation of athletes from East Nusa Tenggara (NTT) from a biomechanical perspective.	The results showed that NTT athletes had a higher BMD, especially in the tibia and femur area, which showed structural adaptation to repetitive mechanical loads. In addition, the vertical GRF of NTT athletes was lower during the landing phase, which indicates a more efficient biomechanical strategy in reducing impact forces. This adaptation contributes to improving the performance and physical endurance of athletes.

[16]	Quantitative Descriptive research methods	Analysis of Athletic Skill Movement Number of 100 Meter Sprint Running Numbers of State Junior High School Students 14 Muaro Jambi	This study aims to find out the analysis of athletic skill movement 100 meter sprint running number of SMP Negeri 14 Muaro Jambi students.	The results of the research analysis of the movement of athletic skills in 100 meters sprint running students of SMP Negeri 14 Muaro Jambi, skills are detailed as follows: students who are in the category of less than 5 with a percentage of (25%). Students who are in the category of less than 2 with a percentage of (10%). Students who are in the good category 9 with a percentage of (45%). Students who are in the very good category are 4 with a percentage of (20%). The results of the assessment of the movement analysis of athletic skills in the 100-meter sprint run number of students were in the good category. Mastery of students' 100-meter sprint number movement techniques is essential for running while racing and speed is essential to maintain victory with a very fast time. Based on the results of the research and discussion of the movement analysis of the 100-meter sprint running number of students, SMP Negeri 14 Muaro Jambi students were in the good category.

Discussion

Based on the literature review, the objectives and results of the research were obtained which were developed into three discussions of the biomechanics analysis of short distance running in the first group of articles with the title Biomechanics Analysis of the 100 Meter Running Movement of Putri Koni Gresik Regency, [10]. This researcher aims to analyze the running movements of 100-meter female athletes in Koni Gresik Regency. The results of the

research are as follows. The results of the analysis of stride length and stride frequency from HTY athletes amounted to 57 steps and the average stride length was 172.84 cm. There needs to be a good combination of stride length and stride frequency to get the best time record. This ability needs to be combined with consistent pace, allowing him to achieve very high running speeds.

The discussion of the first two groups of articles with the title The Relationship between Leg Muscle Strength and the Ability to Run 100 Meters in 2020 UHO Physical Therapy Students. [18]. This study aims to find the relationship between leg muscle strength and the ability to run 100 meters in 2020 UHO Penjaskes-rek students. The results of the study found that the correlation coefficient linking the variables of leg muscle strength and 100-meter running ability was negative, with a correlation value (r) calculated as -0.724 and a significance value of 0.000 < 0.05, along with a determination coefficient of 0.525 or 52.5%, indicating that there was a significant relationship between the relationship between leg muscle strength and 100-meter running ability. The conclusion of this study is that there is a significant relationship between leg muscle strength and the ability to run 100 meters in 2020 UHO Penjaskes-rek students. The strength of the leg muscles contributes 52.5% to the ability to run 100 meters, while the remaining 47.5% is influenced by various factors, including other physical conditions.

The discussion of the third group of articles with the title Musculoskeletal Adaptation of NTT Native Athletes: Biomechanical Perspective, [17]. This study aims to examine the musculoskeletal adaptation of athletes from East Nusa Tenggara (NTT) from a biomechanical perspective. The results showed that NTT athletes had a higher BMD, especially in the tibia and femur area, which showed structural adaptation to repetitive mechanical loads. In addition, the vertical GRF of NTT athletes was lower during the landing phase, which indicates a more efficient biomechanical strategy in reducing impact forces. This adaptation contributes to the improvement of athletes' performance and physical endurance.

Discussion of the fourth group of articles with the title. Analysis of Athletic Skill Movement of 100 Meter Sprint Running Number of Students of SMP Negeri 14 Muaro Jambi, [16]. This study aims to find out the analysis of the movement of athletic skills in the 100-meter sprint running number of students of SMP Negeri 14 Muaro Jambi. The results of the research analysis of the movement of athletic skills in 100 meters sprint running students of SMP Negeri 14 Muaro Jambi, skills are detailed as follows: students who are in the category of less than 5 with a percentage of (25%). Students who are in the category of less than 2 with a percentage of (10%). Students who are in the good category 9 with a percentage of (45%). Students who are in the very good category are 4 with a percentage of (20%). The results of the assessment

of the movement analysis of athletic skills in the 100-meter sprint run number of students were in the good category. Mastery of students' 100-meter sprint number movement techniques is essential for running while racing and speed is essential to maintain victory with a very fast time. Based on the results of the research and discussion of the movement analysis of the 100-meter sprint running number, students of SMP Negeri 14 Muaro Jambi are in the good category.

There was one article in the discussion of the second group with the title Biomechanics Analysis Application (Kinovea Software) to Develop Short Distance Running Skills (100 M) of Pjkr Element Students. This study is intended to determine the speed analysis per 10 meters. The results of the study showed that runners can accelerate at a distance of 0-50 meters with an average acceleration value of 1.23 m/s, and runners again accelerate at a distance of 80-90 meters with an average value of acceleration (acceleration) made by runners which is 1.23 m/s.

In the discussion of the third group, there is one article that will be discussed, namely with the title Analysis of 1000 Meters Running in Elementary School Children of Bina Amal Semarang City: A Review of Sports Biomechanics. This study aims to analyze the running movement of Semarang City charity elementary school children in the 1000 meter run. The results of the study showed that the average 1000-meter run at Bina Amal Elementary School in Semarang City was 7.49 minutes. There are no students who have a very good category, no students who have a good category, no students who have a good category, 2 students have a bad category, and 23 students have a very bad category. It can be concluded that the analysis of the running movement of children of Bina Amal Elementary School in Semarang City in the 1000 meter run shows a very bad category. The limitation in this study is that there is no kinetic data that supports kinematic data in this study.

CONCLUSION

Biomechanical analysis of short-distance running movements shows that running techniques have a significant influence on movement efficiency, speed, and injury prevention. A literature review reveals that factors such as body position at start, thrust angle, frequency and length of steps, as well as coordination of upper and lower body movements, directly affect athletes' performance. Proper running techniques can optimize energy use, increase acceleration, and minimize drag and injury risk. Therefore, an in-depth understanding of the principles of biomechanics is essential in coaching short-distance runners to achieve maximum performance.

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AUTHOR CONTRIBUTION STATEMENT

SR is responsible for conceptualizing and designing studies, MDH collects data, and drafts the manuscript. JDN contributes to the analysis, interpretation of results, and critical revision of manuscripts. JDN also acts as a correspondence writer, handling all correspondence and revisions related to publications.

CONFLICT OF INTEREST AND FUNDING

There is no conflict of interest

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