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Original Article Research

Analysis of 1000-meters run in Sportyjoy Club athletes in Cimahi City: *A biomechanical sports perspective*

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Abstract

The importance of understanding biomechanics in sports, particularly in running activities, significantly contributes to improving athletes' techniques and performance. This study aims to analyze the 1000-meter running motion of athletes from the Sportyjoy Club in Cimahi City through a sports biomechanics review. The study employs a descriptive analytical method with a one-shot case study design. Kinematic data were obtained from video recordings analyzed using Kinovea software (version 2023.2.1). The study sample comprised 10 middle-distance athletes aged 11–14 years selected through purposive sampling. The results showed that the athletes' average running speed was 3.88 ± 0.68 m/s, with a maximum speed of 5.00 m/s and a minimum speed of 2.87 m/s. The average stance phase duration was 0.21 ± 0.05 seconds, while the swing phase lasted an average of 0.32 ± 0.09 seconds. Biomechanical parameters such as arm flexion angle (57.25 ± 9.69º) and knee height (0.45 ± 0.06 m) were also analyzed to evaluate running efficiency. Based on physical fitness assessments, 2 athletes were categorized as very good, 4 as good, 1 as fairly good, and 3 as poor. This study demonstrates that running efficiency is influenced by the stance and swing phases, arm flexion angles, and knee height. Therefore, coaches and athletes can use these findings to improve running techniques, enhance performance, and reduce injury risk through a biomechanical approach.

Keywords: Biomechanics, 1000-Meters Run, Kinematics, Motion Analysis

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1. INTRODUCTION

The importance of mechanical knowledge in understanding sports techniques and human movement has become a fundamental need, particularly in the field of athletics. Sports biomechanics is a science that applies mechanical principles to the structure of the human body and the equipment used during sports activities (Bambang et al., 2014). This understanding is crucial for physical education teachers, coaches, and athletes, as without a basic knowledge of mechanics, they may struggle to grasp proper sports techniques. Biomechanical knowledge aids in selecting the best techniques, modifying them to fit individual athlete characteristics, identifying movement errors, and correcting them effectively.

One of the movements in sports is running, which involves basic body motion by accelerating footsteps. Unlike walking, running includes a phase where both feet are airborne simultaneously, whereas in walking, at least one foot is always in contact with the ground (Yapinus & Rukmantara, 2018; Nurhuda & Jannah, 2018). In running biomechanics, there are two main phases: the stance phase and the swing phase. The stance phase starts from initial contact until toe-off (when the foot leaves the ground), while the swing phase occurs when the foot is airborne, preparing for the next step (Kapri et al., 2021; Lohman et al., 2011). Understanding these phases is critical, as the time spent in the stance phase directly affects a runner's speed.

In biomechanics, as explained by Irawan & Long-Ren (2019), understanding proper techniques is essential as it allows for the evaluation and improvement of inefficient movements and the reduction of injury risks. Movement analysis plays a vital role in sports for correcting errors and enhancing running performance.

The biomechanical analysis in this study includes several physical parameters such as age, height, weight, BMI, and leg length, which can affect running performance. Additionally, this research explores other biomechanical factors, such as arm flexion angles and knee height, in relation to running speed and movement efficiency. Using kinematic analysis methods, the time spent in each movement phase is measured and correlated with the speed achieved by each runner.

Observations of the training program at Sportyjoy Club revealed that some athletes' 1000-meters running times were not yet optimal. These times are closely related to running speed and body movement efficiency. This motivated the researchers to analyze the 1000-meters running movement of Sportyjoy Club athletes, focusing on a sports biomechanics perspective. This study is expected to provide an evaluation of proper running techniques and assist athletes in improving their performance.

2. METHOD

2.1 Participants

This study involved ten middle-distance runners from the Sportyjoy Club, selected using the purposive sampling method. Purposive sampling is a technique for determining samples based on specific criteria (Sugiyono, 2013). The participant criteria included:

- Active members of the Sportyjoy Club.

- Aged between 11–14 years.
- No history of serious illnesses such as asthma or heart conditions.
- Willing to participate in the study.
- Parental consent.

The average age of participants was 12.2 years, with uniform physical characteristics to ensure equality in biomechanical analysis.

2.2 Research Design

This study employed a Pre-Experimental Designs (nondesigns) approach using a one-shot case study method. According to Sugiyono (2013), this design is characterized by samples not being randomly selected. In this design, measurements are taken after a single treatment is applied (Arikunto, 2013). The treatment in this study consisted of recording the athletes' running movements during a 1000-meters run. The biomechanical data measured included stance phase duration, arm flexion angle, knee height, swing phase duration, and knee flexion and extension angles. Additionally, physical parameters such as age, height, weight, BMI, leg length, and physical fitness categories were also measured.

2.3 Instruments

The instruments used in this study included:

- Kinovea Software (version 2023.2.1): Used for slow-motion video analysis to measure biomechanical parameters such as phase duration, joint angles, and step dynamics.
- Camera and Accessories: Techno Pova 5 smartphone camera and tripod to ensure stability while recording movements.
- Field Equipment: Stopwatch, measuring tape, and markers (e.g., tape) for consistent measurements and athlete positioning on the track.
- Computer Equipment: A laptop with Kinovea software (version 2023.2.1) for data processing.
- Physical Measurement Tools: Measuring tape for height and leg length, and scales for weight.

2.4 Procedures

The study began with a warm-up session for all participants to minimize injury risk and maximize performance. Each athlete then performed a 1000-meters run, which was recorded using cameras strategically positioned around the track to capture different angles of movement. The video recordings were transferred to a laptop and analyzed using Kinovea software (version 2023.2.1), focusing on:

- Running speed.
- Stance Phase: Duration, arm flexion angle, and knee height.
- Swing Phase: Duration, knee flexion, and extension angles.

The performance of each participant was evaluated based on the measured biomechanical parameters, physical characteristics such as age, height, weight, BMI, and leg length, and physical fitness categories. Participant consent was obtained in advance by securing parental permission, and the study adhered to ethical guidelines for human research.

2.5 Data Analysis

The collected data were analyzed using a quantitative descriptive-analytic method with descriptive statistics (mean, standard deviation, minimum, and maximum values) to identify biomechanical characteristics. Descriptive statistics were used to present data in an easily understandable or readable format (Nasution, 2017).

The main parameters analyzed were the kinematic data of the 1000-meters run, including the stance phase duration, arm flexion angle, knee height, swing phase duration, knee flexion angle, and knee extension angle. The Kinovea software (version 2023.2.1) was used to measure angles and time accurately. Additionally, several other parameters were measured, including:

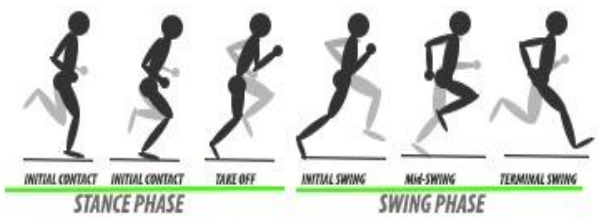
- Data distribution such as age, height, weight, BMI, and leg length, referencing research by Baktiyaningsih & Irawan (2023) on 1000-meter running analysis in elementary school children.
- Physical fitness assessment based on the PAN norms by Nurhasan (2013) for 1000-meter middle-distance running.
- Physical fitness categories classified into several criteria: very good, good, fairly good, poor, and very poor (Nurhasan, 2013).

3. RESULTS

The analysis of running movement in this study is categorized into two phases which are shown in Figure 1.

Figure 1.

Two Phases of Running Performance



Source: Optimal Movement (n.d.) adapted from *"The Importance of Running Technique"* (https://optimal-movement.co.uk/omguide/endurance-training/the-importance-of-running-technique)

3.1 Data Distribution Results

The results of this study are presented in the form of a table to determine the distribution of data from 10 samples of the Sportyjoy Club in Cimahi City in the 1000-meters run. Below is the data distribution in this study.

Table 1.

Data Distribution

Parameter	Mean ±	Min	Max
Age (years)	12,2 ± 1	11	14
Height (m)	1,522 ± 0,105	1,37	1,70
Weight (kg)	42,6 ± 11,46	29	70
BMI (kg/m²)	18,13 ± 2,96	14,17	24,22
Leg Length (m)	0,778 ± 0,079	0,65	0,89

Source: Primary Data

Based on the table above, the average age of the samples is 12.2 ± 1.0 years, with the highest age being 14 years and the lowest 11 years. The average height is 1.52 ± 0.11 meters, with the shortest height being 1.37 meters and the tallest 1.70 meters. The average weight is 42.6 ± 11.5 kg, with the lowest weight being 29 kg and the highest 70 kg. The average Body Mass Index (BMI) is 18.13 ± 2.96 kg/m², indicating a normal category. The average leg length is 0.78 ± 0.08 meters, with the minimum length being 0.65 meters and the maximum 0.89 meters.

3.2 Kinematics of the 1000-Meters Run Results

The results of the video analysis using Kinovea software (version 2023.2.1) can be seen in Table 2 below:

Table 2.

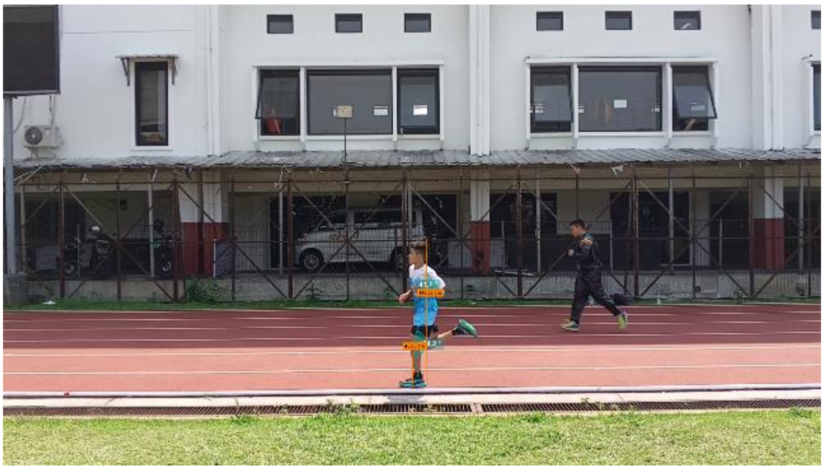
Kinematic Data of the 1000-Meters Run

Parameter	Mean ±	Min	Max
Running Speed (m/s)	3,88 ± 0,68	2,87	5,00
Stance Phase			
Stance Phase Duration (s)	0,21 ± 0,05	0,14	0,32
Arm Flexion Angle (⁰)	57,25 ± 9,69	45,1	77,3
Knee Height (m)	0,45 ± 0,06	0,34	0,53
Swing Phase			
Swing Phase Duration (s)	0,32 ± 0,09	0,15	0,46
Knee Flexion Angle (⁰)	114,71 ± 8,17	102,2	128,7
Knee Extension Angle (⁰)	171,83 ± 1,68	170,6	174.8

The analysis results show that the average running speed is 3.88 ± 0.68 m/s, with a minimum speed of 2.87 m/s and a maximum speed of 5.00 m/s. During the stance phase, the average time recorded is 0.21 ± 0.05 seconds, with a minimum time of 0.14 seconds and a maximum of 0.32 seconds. The average arm flexion angle during the stance phase is 57.25 ± 9.69 degrees, with a minimum of 45.1 degrees and a maximum of 77.3 degrees. The average knee height during this phase reaches 0.45 ± 0.06 meters, with a minimum height of 0.34 meters and a maximum of 0.53 meters. Meanwhile, during the swing phase, the average time recorded is 0.32 ± 0.09 seconds, with a minimum time of 0.15 seconds and a maximum of 0.46 seconds. The average knee flexion angle during the swing phase is 114.71 ± 8.17 degrees, with a minimum angle of 102.2 degrees and a maximum of 128.7 degrees. Additionally, the average knee extension angle is 171.83 ± 1.68 degrees, with a minimum angle of 170.6 degrees and a maximum of 174.8 degrees.

Figure 2.

Running Analysis



Source: Primary Data

3.3 The Average Results of the 1000-Meters Run

The average results of the 1000-meters run by athletes from the Sportyjoy Club in Cimahi City are presented in the table below.

Table 3.

Physical Fitness Assessment Results of the 1000-Meters Run

Parameter	Mean	Min	Max
Time	4:20.58	3:20.06	5:48.67

Based on the data in Table 3, it can be observed that the average running time recorded is 4 minutes 20.58 seconds. The minimum time achieved is 3 minutes 20.06 seconds, while the maximum time is 5 minutes 48.67 seconds.

3.4 Physical Fitness Categories Results

Table 4.

Physical Fitness Categories

n=10	Total
Excellent	2
Good	4
Fair	1
Poor	3
Very Poor	

Based on the data in Table 4, it can be seen that 2 students fall into the "very good" category, 4 students are in the "good" category, and 1 student is in the "fairly good" category. Meanwhile, 3 students are in the "poor" category, and no students fall into the "very poor" category.

4. DISCUSSIONS

The results indicate that shorter ground contact time (stance phase) is associated with higher running speed. This is consistent with the findings of Baktiyaningsih & Irawan (2023), who stated that the shorter the stance phase duration, the faster a person can run. A shorter stance phase also increases the percentage of the swing phase, which can reach 60% or more. As running speed increases, the swing phase lengthens while the stance phase shortens, and the initial stance point also shifts (Kapri et al., 2021). Changes in the duration of the stance and swing phases affect step frequency, which directly impacts running speed. Kapri et al. (2021) also showed that stride length and frequency are related to speed and step duration; increasing stride length and frequency reduces step duration but increases speed.

According to the distribution data in Table 3.1, some children have values below average, which may affect their running ability. Factors such as human physiology, anthropometry, biomechanics, training techniques, age, gender, and environmental conditions are key determinants of running ability. The total running gait cycle is related to all these characteristics, and changes in one characteristic will cause changes in the running gait cycle (Kapri et al., 2021). When focusing on height and leg length, both also influence running speed. This aligns with Pasau (1998:81), who stated that individuals with taller and larger physiques tend to have better physical capabilities—such as strength, speed, endurance, heart and lung capacity, muscle endurance, and others—compared to shorter and smaller individuals. Additionally, individuals with good physical development typically have better health. Athletes with long legs or tall stature, combined with ideal body mass and weight proportions, tend to excel in various sports, particularly in running, due to greater stride reach and strength compared to those with shorter legs and smaller bodies (Hardianto, 2019).

In arm swing mechanics, optimal values have not yet been achieved. According to Darumoyo et al. (2006), swinging the arms while running should involve bending the elbows close to 90°. At high-speed motion ranges, joint angle involvement helps increase speed and balance the body (Kapri et al., 2021). Arm swing movements are crucial as they maintain stride length and upright posture (Hardianto, 2019). During running, most forward propulsion can be generated by the arm and leg swings (Kapri et al., 2021).

Participants with higher knee lifts during the swing phase displayed longer strides, contributing to faster speeds. This observation aligns with Indra & Lumintuarso (2014), who noted that the farther the running distance, the lower the knee height, resulting in smaller strides. Conversely, higher knee lifts impact stride length (Baktiyaningsih & Irawan, 2023). Al Ardha et al. (2022) also revealed that analyzing running motion at each step of the right and left foot, including step length and speed per step, shows that participants with lower knee flexion angles have proportionally slower running speeds. This is consistent with previous research by Kapri et al. (2021), which stated that increasing knee angles or knee flexion during steps and swing phases has been proven to improve running speed. The degree of motion depends on the athlete's level of training and speed.

Variability in fitness levels, as observed in performance categories, indicates differences in training background and potential biomechanics, such as foot type. Foot type impacts running speed (Baktiyaningsih & Irawan, 2023). Foot type functions to enhance speed, agility, stability, and flexibility (Darwis, 2016). Abnormal foot development can affect balance and unstable movements (Irawan et al., 2020). According to Irawan & Long-Ren (2015), normal feet exhibit better agility compared to flat feet.

Overall, these findings highlight the importance of optimizing biomechanics in athletic training. Future research should explore specific interventions targeting swing phase efficiency and ground contact dynamics to improve running efficiency.

5. CONCLUSIONS

Based on the results of this study, it can be concluded that the biomechanical analysis of running movements provides an in-depth understanding of athletes' efficiency and performance. The average running speed for 1000 meters achieved by Sportyjoy Club athletes was 3.88 ± 0.68 m/s, with a maximum speed of 5.00 m/s. During the running phases, the average stance phase time was recorded at 0.21 ± 0.05 seconds, while the swing phase took an average of 0.32 ± 0.09 seconds. This study indicates that the shorter the stance phase time, the faster the running speed of an athlete. Additionally, knee height and arm flexion angles influence movement efficiency and stride length.

The physical fitness assessment results showed that the average time to complete the 1000-meters run was 4 minutes 20.58 seconds. The fastest time achieved was 3 minutes 20.06 seconds, while the slowest time was 5 minutes 48.67 seconds. Based on physical fitness categories, two athletes fell into the "very good" category, four athletes into the "good" category, one athlete into the "fairly good" category, and three athletes into the "poor" category.

The relationship between biomechanics and running performance reveals that movement efficiency is influenced by stance and swing phase times, foot type, and knee height. Athletes with normal foot types tend to have better agility and speed compared to those with flat feet. Optimal knee height also contributes to stride length, thereby increasing running speed.

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