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Short report

Analysis of Ball Kicking Speed in High School Soccer Players: A Validation Study

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Abstract

[Introduction] Prior research has shown that measurement of kicking speed in soccer players can offer valuable insights into their competitive levels and potential; however, most studies on this topic have focused on professional and youth players. The purpose of this study was to investigate the relationships between ball-kicking speed, lower limb muscle strength, and lower limb function in high school soccer players involved in intramural club activities. [Methods] The participants were 18 male soccer players on a high school team. The ball kicking speed, knee flexion torque, knee extension torque, and vertical jump height of all participants were measured. The ball-kicking speed was measured as the initial velocity using the dominant leg. Muscle strength assessment involved measurement of the isokinetic knee extension and flexion torque at 60°/s of the dominant leg. Vertical jump height was measured with both arms crossed at a knee flexion angle of 90°, without using upper or lower extremity recoil. [Results] The average kicking speed, knee flexion torque, knee extension torque, and vertical jump height were 83.8 ± 9.6 m/s, 83.0 ± 18.0 Nm, 176.7 ± 34.3 Nm, and 38.8 ± 4.6 cm, respectively. Significant positive correlations were found between ball-kicking speed and knee flexion torque ($r = 0.49$), knee extension torque ($r = 0.47$), and vertical jump height ($r = 0.57$). [Conclusion] The present results suggest that kicking velocity could be used as an effective performance assessment tool for high school soccer players involved in intramural club activities. Understanding the relationship between ball-kicking velocity and lower limb strength and function can provide valuable insights for the optimization of player performance during this critical stage of growth and development.

Introduction

The evaluation of soccer players' performance has evolved beyond simply muscle strength and running velocity; current analyses also include factors such as kicking accuracy and speed, which are directly related to passing and shooting abilities[1)]. In recent years, there has been growing interest in the analysis of kicking speed among soccer players[2-5)]. For example, Vieira et al.[4)] compared the ball-kicking speeds between starting players and substitutes, finding that the ball-kicking speeds of starting players were significantly higher than those of substitutes, which suggests that ball-kicking speed might be a differentiating factor in player selection. Likewise, Rađa et al.[5)] also explored ball kicking speeds in soccer players, and observed that starting players exhibited higher ball kicking speeds. Additionally, they noted that

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individual differences in ball kicking speed were more pronounced in the U-15 and U-17 age groups, indicating that kicking speed may be a crucial factor during the growth and development phases of players. Considering these findings, measuring the ball kicking speed of young soccer players might provide valuable information indicating their performance level.

Although numerous studies have measured the ball-kicking speed of soccer players, most focused on professional and young players. In Japan, soccer is a popular sport, and a significant proportion of the competitive-aged population participates in intramural clubs or circular activities. To effectively assess these players performance, it is essential to establish the validity of kicking speed assessment for intramural club-level players. Furthermore, the measurement method must be inexpensive and simple, considering its intended use within intramural clubs. As such, this study aimed to investigate the relationship among ball-kicking speed, lower limb muscle strength, and lower limb function in high school soccer players involved in intramural club activities. Additionally, we examined the validity of using kicking speed as a reliable measure for performance assessment.

Materials and Methods

The participants were 18 male soccer players (age: 15.9 ± 0.8 years, height: 167.0 ± 4.6 cm, weight: 56.5 ± 6.1 kg) of a high school team. The playing experience in the participants was 6.7 ± 3.3 years. All participants were informed of the purpose, methods, and expected disadvantages of the experiment and their consent was obtained in accordance with the Declaration of Helsinki. This study was conducted after obtaining approval from the institutional ethics committee (approval number: 22-40).

The measurement outcomes included ball-kicking speed, knee flexion torque, knee extension torque, and vertical jump height, which represent lower-body performance. All factors were assessed by the same examiner. A speed meter (MIZUNO, 16JYM10000) was used to measure the ball-kicking speed, recording the initial speed of the kick. Based on the measurement method of Rađa et al.[5], the subjects were instructed to kick the ball as fast as possible using their dominant leg toward the soccer goal, which was 11 meters away, corresponding to the penalty kick distance. To aid in the kick, all subjects had a 3-meter runway (Figure 1). A speed-meter was placed 1 m behind the ball. Measurements were performed twice, and the average value was used.

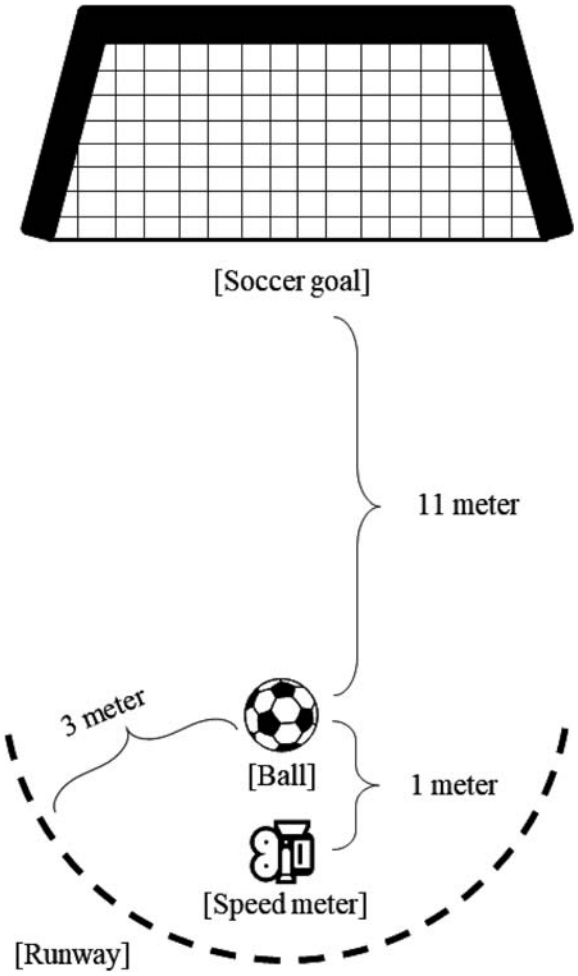

Figure 1. Measurement of the ball kicking speed
A speed-meter was placed 1 m behind each ball, and the subjects were allowed a 3-meter runway.

Torque machines (Biodex Medical Systems, Biodex Systems 3) were used to measure the knee flexion and extension torques. In accordance with previous studies[6] involving soccer players, the maximum constant-velocity knee flexion and extension torques were measured at 60°/s in a sitting posture with the trunk fixed by a belt. Measurements of the dominant leg were performed twice, and the maximum value was used for analysis.

The vertical jump height was measured using a digital vertical jump measuring machine (Takei Kiki Kogyo, T.K.K. 5406). All subjects were instructed to perform a squat jump and execute a maximum vertical jump without using upper or lower extremity recoil starting from a posture with both upper limbs crossed and the knees flexed at 90°. It has been reported that squat jump was a perform-

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ance evaluation that reflects knee extension strength[7]. Measurements were taken twice, and the maximum value was used.

Pearson's correlation coefficient was used to analyze the relationship between ball-kicking speed, knee flexion torque, knee extension torque, and vertical jump height. All analyses were performed using SPSS version 28. The significance level was set at 5%.

Results

There were no participants who were unable to perform ball-kicking speed measurements or performance evaluations due to pain or other conditions, and no participants were excluded from this study. Amongst all the participants, the average kicking speed, knee flexion torque, knee extension torque, and vertical jump height were 83.8 ± 9.6 m/s, 83.0 ± 18.0 Nm, 176.7 ± 34.3 Nm, and 38.8 ± 4.6 cm, respectively. Significant positive correlations were found between the kicking speed and knee flexion torque (r = 0.49), knee extension torque (r = 0.47), and vertical jump (r = 0.57) (Figure 2).

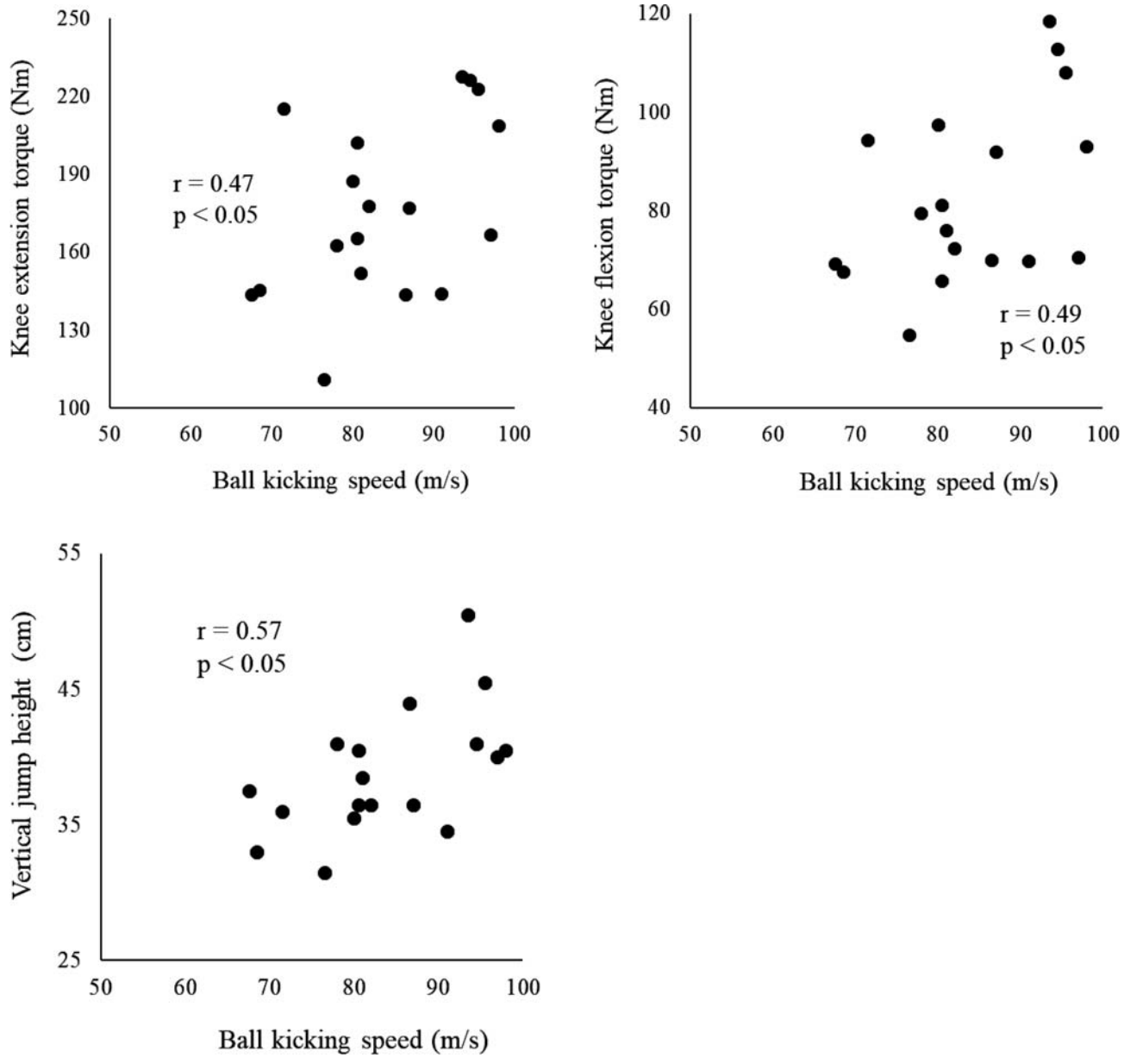

Figure 2. Relationship between ball kicking speed and each measured outcome (n=18)
The kicking speed showed a significant positive correlation with knee flexion torque, knee extension torque, and vertical jump.

Discussion

In the present study, we analyzed the relationship between ball kicking speed and lower muscle strength and function in high school soccer players, to examine whether ball kicking speed evaluation could be used as an effective performance assessment for growing players in intramural club activities. A significant correlation was found between ball-kicking speed and knee extension torque, knee flexion torque, and vertical jump height.

Various factors are involved in the kicking motion, from running towards the ball to flight of the ball, all of which influence the kicking motion. Many investigations on this topic have focused on muscle strength and activity of the knee and other lower limbs[8, 9]. For example, Kellis et al.[9] analyzed the kinematics of the soccer kicking motion, and reported that the contribution of knee extension torque was particularly significant. Although the kicking velocity in the present study was lower than that in previous studies on young subjects, significant correlations were found between knee extension and flexion torques, indicating that the kicking velocity of intramural club-level players reflects lower limb muscle strength.

A significant positive correlation was found between kicking speed and vertical jumps. The squat jump employed in this study has been reported to be a functional assessment that strongly reflects knee extension muscle strength without upper or lower limb recoil[7]. Vieira et al.[4] also reported that kicking speed is an index that reflects hip and knee function rather than simply involving physique factors. Therefore, kicking velocity can be utilized to evaluate the performance of soccer players in intramural club activities.

This study suggests that kicking velocity can be an effective performance assessment tool for high-school soccer players participating in school extracurricular activities. Gaining an improved understanding of the relationship between kicking velocity and lower limb strength and function can provide valuable insights into optimizing player performance during this critical stage of growth and development.

In summary, the present study showed the utility of measuring kicking speed to assess soccer players' performance capabilities. The speed meter used to measure ball-kicking speed is available on the market at a relatively low price and is expected to be widely used in school club activities and circles. However, this study focused only on one school team, which limits the applicability of the results; we plan to expand the scope of the study and further verify its effectiveness by focusing on the positional characteristics of each player in future studies.

Conflict of Interest

The authors declare no conflict of interest.

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