



## El uso de un enfoque de análisis biomecánico para la precisión de la patada en atletas de fútbol sala : Revisión de la literatura

*The Use of a Biomechanical Analysis Approach to Kick Accuracy in Futsal Athletes: Literature Review*

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### Resumen

**Introduction:** This study aims to gain a better understanding of the accuracy patterns of futsal kick-to-goal movements through biomechanical analysis

**Objective:** The biomechanics of futsal kicking is to help understand the kicking movement patterns and develop good kicking accuracy, which is based on frequent practice

**Methodology:** This research uses a qualitative method with a systematic review design. The database in this study comes from the Scopus database. Data collection was done through the Scopus website using the keywords "Biomechanics" and "Accuracy." The determined Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) articles are then extracted, and the quality of the article is assessed based on the PEDro scale.

**Results:** This study's results used the technique of selecting articles with the most citations and the most relevance, which researchers carried out by giving special notations to the articles that had been reviewed. The review obtained the 10 best articles that fit the criteria and objectives of the study.

**Conclusions:** The study's conclusion shows that kicking a goal in futsal requires biomechanical analysis and special accuracy techniques to achieve the desired target. Biomechanical factors also affect the effectiveness of exercises and training programs that must be designed to meet individual and team needs.

### Keywords

Biomechanics; Accuracy; Reviews; Kick; Futsal

### Resumen

**Introducción:** Este estudio pretende conocer mejor los patrones de precisión de los movimientos de pateo a portería en fútbol sala a través del análisis biomecánico

**Objetivo:** La biomecánica del chut de fútbol sala ayuda a comprender los patrones de movimiento del chut y a desarrollar una buena precisión del chut, que se basa en la práctica frecuente.

**Metodología:** Esta investigación utiliza un método cualitativo con un diseño de revisión sistemática. La base de datos de este estudio procede de la base de datos Scopus. La recopilación de datos se realizó a través del sitio web de Scopus utilizando las palabras clave «Biomechanics» y «Accuracy». Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a continuación, se extraen los artículos que se han determinado y se evalúa la calidad del artículo en base a la escala PEDro.

**Resultados:** Los resultados de este estudio utilizaron la técnica de selección de artículos con mayor número de citas y los más relevantes fueron realizados por los investigadores dando anotaciones especiales a los artículos que habían sido revisados. De los resultados de la revisión se obtuvieron los 10 mejores artículos que se ajustaban a los criterios y objetivos del estudio

**Conclusiones:** La conclusión del estudio muestra que chutar a puerta en fútbol sala requiere un análisis biomecánico y técnicas especiales de precisión para conseguir el objetivo deseado. Los factores biomecánicos también afectan a la eficacia de los ejercicios y programas de entrenamiento que deben diseñarse para satisfacer las necesidades individuales y del equipo

### Palabras clave

Biomecánica; Precisión; Revisiones; Patada; Fútbol sala

## Introduction

Futsal is a high-intensity team sport characterized by short and intermittent actions, requiring specific training strategies to improve player performance. In futsal, kicking is a complex skill influenced by various factors, including coordination, ball contact technique, and limb dominance. Futsal kicking accuracy is significantly affected by various training methodologies, which improve player performance through targeted practice. Research shows that dynamic coordination training, target pattern drills, and visual training are effective strategies for improving shot accuracy (Priyambada et al., 2024). Other studies have also shown that different training methods and biomechanical factors can significantly affect the effectiveness and accuracy of futsal kicks (Chung-Fu Huang, Kuei-Hua Lu, 2013). This synthesis explores the key elements that influence futsal kicking performance, drawn from various studies. Based on its main mechanics objective, kicking the ball into the goal is one of the factors that support the game of futsal (Aryananda et al., 2020). Support limb kinematics also play an important role, with adjustments in hip extension helping to maintain performance when kicking a rolling ball despite lower approach running speeds (Çakır, 2024). In addition, kicking biomechanics, such as joint angles and velocities, were similar when kicking stationary and rolling balls, suggesting that elite players can adapt their technique to different ball conditions (Barbieri et al., 2010). Overall, these findings underscore the importance of customized kicking accuracy training that considers individual asymmetries and specific biomechanical parameters to optimize kicking performance in futsal.

Kicking accuracy in futsal is influenced by various training methods and biomechanical factors. Research shows that certain training models, such as target pattern training, significantly improve kicking accuracy (Alfarizi et al., 2024). The results of another study also revealed variations in kick training using the instep have been shown to improve shooting accuracy among female futsal athletes, with an increase in percentage accuracy reported for different groups (Pane & Dewi, 2022). The results of biomechanical research further revealed that kicks towards lower goal targets resulted in higher ball speeds, suggesting that target position can affect kicking performance (Huang et al., 2013). In addition, the strength and balance of the supporting leg are critical, although they are not directly correlated with ball speed or accuracy, suggesting that other factors may also contribute to performance (Idrus & Mohamad, 2015). Accuracy in the biomechanical analysis approach is closely related to the accuracy of the firing point distance and the power of the shot due to one's ability to control free movement toward a target (Karo-Karo et al., 2023). Another study stated that training methods such as squats, heel raises, and cone drills have been identified as effective in improving the accuracy of kicks on goals, highlighting the importance of comprehensive training (Priyambada et al., 2024). Overall, a combination of targeted training, refinement of technique, and understanding of biomechanics is essential to improve kicking accuracy in futsal.

Several problems often arise when analyzing the biomechanics of futsal kick accuracy. Many players have difficulty shooting accurately into the goal, either due to a lack of control or accuracy in determining the direction of the shot. This can be caused by improper technique or rushing when taking a shot, which causes the accuracy of the kick to match the target. The position of the body when kicking the ball is unbalanced or undirected, which can cause the kick to be inaccurate. For example, a body that leans too far back or a head that does not see the ball can affect the accuracy of the kick. Body position when kicking determines the accuracy. A stable posture with a balanced center of gravity helps in controlling the direction of the ball. Problems with analytical methods include difficulties in measuring kick angles and speeds; measuring foot angles, kick angles, and ball speeds requires accurate technology such as motion capture or biomechanical sensors; without sophisticated tools, analysis tends to be subjective and lacks precision. By addressing these issues, biomechanical analysis can provide more accurate insights into improving futsal players' performance in terms of kicking accuracy. Meanwhile, futsal kicking accuracy is essential for scoring goals, making precise passes, and controlling the game. To improve kicking accuracy, a needs analysis is required, which includes the physical, technical, tactical, and psychological aspects of players; by fulfilling these needs, futsal players can improve their kicking accuracy and overall performance on the field.

Hypotheses that can be put forward in research or analysis regarding futsal kicking accuracy, hypotheses can be formulated to test various biomechanical factors, techniques, and player conditions on kick results. Biomechanical factors play an important role in determining the accuracy of futsal kicks.



The hypotheses in this analysis aim to test the relationship between biomechanical variables such as body posture, fulcrum position, kick angle, and movement speed on kick accuracy. This hypothesis is used to test the biomechanical factors that contribute to futsal kick accuracy. With proper analysis, the results of the study can help players and coaches identify biomechanical aspects that need to be improved to increase kicking accuracy

There have been many studies conducted in the past that have resulted in several developments in improving futsal kicking accuracy, including research on the effect of fatigue with futsal matches affecting running performance and neuromuscular parameters but not affecting speed or final kick accuracy (Milioni et al., 2016), The relationship of some fixed foot and body kinematic variables with penalty kick accuracy by futsal players (Qadr, 2019) and the results of a study of kicking performance and muscle strength parameters with dominant and nondominant lower limbs in professional futsal players (Vieira et al., 2016). Overall, the results of this study underscore the multifaceted nature of kicking accuracy in futsal, where training, biomechanics, and physical conditioning collectively contribute to performance outcomes.

The main purpose of analyzing the biomechanics of futsal kicks is to improve the understanding of kicking movement patterns and, most importantly, to create good kicking accuracy. Therefore, using the method of collecting previous research results based on a literature review, the results of this study will prove the use of a biomechanical analysis approach to kick accuracy on futsal goal-kicking performance.

## Method

### *Study Selection Criteria*

The selection criteria for the current systematic revision were investigations: (a) published in English (the language most widely used at the research site), (b) reviewed before being considered for publication, (c) of quantitative or qualitative type, (d) studies that examined the use of biomechanical analysis or biomechanical analysis approaches.

In the same way, the exclusion criteria are: (a) investigations for which it was not possible to access the full text (and it was not possible to contact the authors), (b) systematic revisions or meta-analyses, (c) articles on athlete characteristics that did not include empirical evidence in a real context (opinion or recommendation articles) or (d) investigations of high quality in the evaluation of their relevance to the field of study.

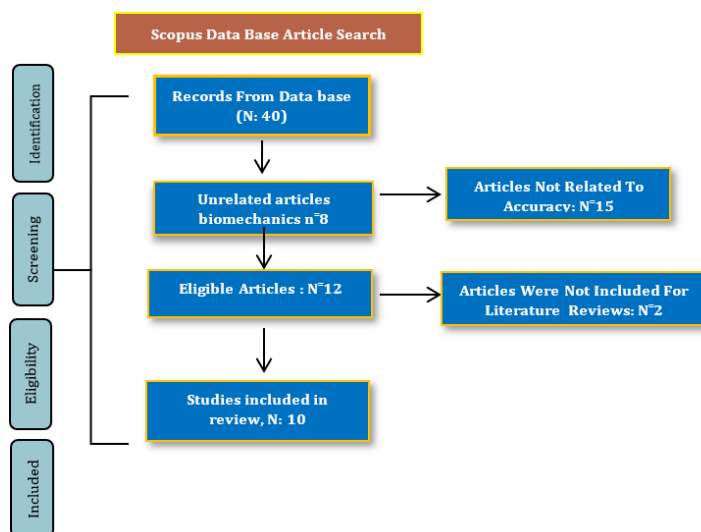
### *Search Strategy*

This systematic review followed the requirements of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. A systematic literature search was conducted using Scopus to identify articles published from 2010 to 2023 on Biomechanics Analysis of Kick Accuracy. The following terms were included in the research formula: analysis OR Biomechanics Analysis AND Kick Accuracy OR Futsal kicks. To ensure that all relevant studies were included in the analysis, a manual search was conducted using the reference lists of the identified relevant articles.

Once the study research was conducted in the database and all results were collected, duplicate studies were removed. After that, screening was done based on the title, and then, on the abstract. In this step, reviews and articles that did not fit the topic were discarded. Once we had a list of potentially interesting studies, they were read in full to assess their eligibility. At this stage, studies that met the exclusion criteria were rejected. Finally, the remaining articles were considered for inclusion in the systematic review, for qualitative assessment

### Statistical analysis

Figure 1. PRISMA flowchart for article selection process



### Data Extraction

Data extraction was organized in the form of a table indicating author, year of publication, and country, which are the main characteristics of the sample. After that, all instruments found to be used in two or more articles were analyzed by indicating the author, what they were assessed for, several, whether they were validated, what value on reliability and validity was given, and identification based on the tools used.

### Quality assessment of studies

The quality of the included studies was evaluated by using the Pedro Scale to assess the methodological quality of randomized controlled trials (Cashin & McAuley, 2020). The scale uses a rating from 0 (lowest quality) to 11. The total score obtained from the PEDro scale can be treated as an interval-level measurement and subjected to parametric statistical analysis. This standard is set to guarantee consistent and objective evaluations, to identify studies with more rigorous methodologies, and minimize the possibility of errors in the analysis.

## Result

Sports science has changed the sport of futsal, especially by analyzing kick accuracy with biomechanics. Sports science relates to various fields and produces kick accuracy exercises, especially sports biomechanics analysis, which can help athletes maximize their performance and reduce the risk of injury (Wallace et al., 2022). Identification results in the SCOPUS database present a trend of research on biomechanical analysis of kicking accuracy in futsal athletes that is dynamically increasing. Various countries, such as the United States and the United Kingdom, are at the top of the list in terms of article publications, with 15 and 8 studies, respectively. Then, the results of the systematic review are divided into 5 discussion topics based on the conclusions of the 10 articles systematically reviewed in this study. The discussion of the systematic review is presented as follows:

### Identification and extraction of study selection

Articles selected for review are the result of a screening process using the PRISMA method (Moher et al., 2015). The selection of articles with the most citations and the most relevant was carried out by researchers by giving special notations to the articles that had been reviewed. The results of the review obtained the 10 best articles that fit the criteria and objectives of this study (Table 1)

Table 1. Study characteristics were extracted and grouped into tables

Author	Objective	Sample	Method	Result
(Kassim Jawad, 2021)	To get the value of some biokinematics variables and penalty kicking skills in Futsal	10 Athletes	Descriptive Approach	The results show that there is a positive relationship between the back angle of the flexed hip joint when kicking a ball and the back angle of the kicker's knee.
(Huang et al., 2013)	This study's objective was to examine the biomechanical characteristics of the instep kick in relation to a particular futsal goal target.	12 Athletes	Experimental Study	According to the results, under accuracy conditions, players might choose lower targets to score with higher ball speed.
(Abd Rahman & Shahrudin, 2018)	The purpose of this study was to compare the biomechanical traits and futsal-specific skills of female futsal players at the club and collegiate levels.	20 Athletes	Experimental Study	The findings showed that, other from shooting ability, both groups' lower limb strength and power were comparable.
(Eom, 2016)	This study was designed to compare the ability of dynamic balance and kick accuracy between soccer and futsal players with recreational level.	22 Athletes	Correlational study	Overall, the results of this study can show the importance of dynamic balance ability in sports such as soccer and futsal for kick accuracy.
(Hassan et al., 2020)	Knowing the awareness of creativity, speed and accuracy to the skill of kicking a futsal game ball in college students	14 Students	Descriptive method	The speed and precision of futsal ball handling abilities are significantly correlated with creativity awareness.
(Kristiyadi & Jariono, 2022)	To see the difference in the effectiveness of kicks using the instep and toe of the foot on the accuracy of penalty shooting.	20 Students	Comparative Research	The results of the study show that shooting using the instep is more effective than shooting using the tip of the foot in making Penalty shots.
(Naji & Aseel, 2024)	This study aims to build a composite test (ball control and goal scoring accuracy) and prepare a scale and determine the relationship between the composite test (ball control and goal scoring accuracy).	20 Athletes	Experimental Study	The researcher also recommends the use of this test as a measuring tool to evaluate the level of players by coaches and workers in the field of futsal sports training.
(Agustiyanta et al., 2023)	Finding a relationship between momentum and ball speed in female futsal players' shooting motion was the aim of this study.	5 Players	Correlational study	The quickest ballspeed was attained with 106° backswing flexion angle, 57° kicking leg angle, and 14° hip and shoulder tilt angle, according to the shooting motion study.
(Daikh et al., 2021)	To identify the values of some biochemical variables in kicking the ball and control mechanisms when scoring goals into the goal from different situations	10 Players	Experimental Study	The results showed that there was a significant difference in the maximum bending variable of the knee angle of the fulcrum leg at the time of kicking the ball between different assessment cases
(Prasetya et al., 2021)	Focuses on producing a training model for basic futsal passing and shooting skills based on biomechanical studies	35 students	Development research	Based on biomechanical research, can be deemed a viable product, and the outcomes of the product effectiveness test are deemed successful and efficient to be utilized as a model for training abilities for futsal passing and shooting techniques.

## Study Quality

To ensure a thorough and rigorous assessment of the methodological soundness of the studies included in this review, the PEDro scale was used, as described in (de Morton, 2009). The PEDro scale facilitates an objective and standardized assessment so that we can ensure the reliability and validity of the results selected for analysis. The PEDro scale adopts a binary scoring system (0 for negative responses, 1 for affirmative), setting a high methodological quality threshold at a score equal to or greater than five out of a total of 10 points. The studies considered in this review fall in the range of five to eight points on this scale, which places them in the "high quality" range according to the standards proposed by (de Morton, 2009), thus proving their methodological relevance and reliability.

Table 2. Item scores and final PEDro scale scores of the studies included in the review.

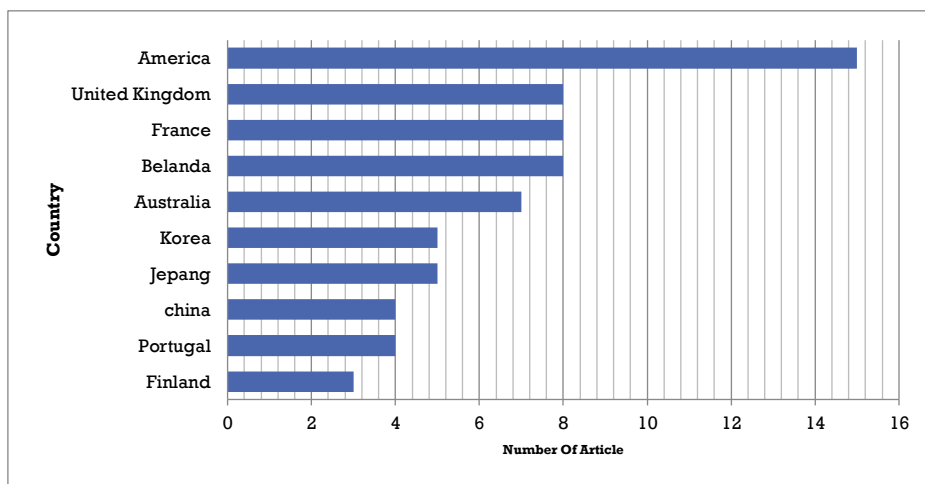
Studi	1	2	3	4	5	6	7	8	9	10	11	PF
(Kassim Jawad, 2021)	1	0	0	1	0	1	0	1	0	1	1	6
(Huang et al., 2013)	1	1	1	1	0	0	0	1	1	1	1	7
(Abd Rahman & Shahrudin, 2018)	1	0	0	1	0	0	0	1	0	1	1	5
(Eom, 2016)	1	0	0	1	0	0	0	1	1	1	0	5
(Hassan et al., 2020)	1	0	0	1	0	0	0	1	0	1	0	4
(Kristiyadi & Jariono, 2022)	1	1	0	1	0	0	0	1	1	1	1	7
(Naji & Aseel, 2024)	1	1	0	1	0	0	1	1	0	1	1	7
(Agustiyanta et al., 2023)	1	0	0	1	0	0	0	1	0	1	1	5
(Daikh et al., 2021)	1	1	1	1	0	1	0	1	1	1	0	8
(Prasetya et al., 2021)	1	1	0	1	0	0	0	1	1	1	0	6



### Determination Of Articles By Country

Based on the results presented (Figure 2), America is the country that contributes the most in the field of sports biomechanics in hurdling. This is evidenced by the number of publications totaling 15 articles, more than double that of the United Kingdom (UK). The UK is ranked second with 8 publications. European countries occupy the top position and are followed by Australia in fifth place. Asian countries are also no less existent, ranking 6th and 7th, namely Korea and Japan. The results presented show that publications in the field of sports biomechanics are dominated by countries in the American region.

Figure 2. Countries contributing to futsal kick biomechanics and accuracy



### Discussion

This systematic review aims to investigate the scientific evidence regarding the use of biomechanical analysis approaches to kick accuracy in futsal athletes. This is a systematic review that presents the highlights of biomechanical analysis of kicking accuracy comprehensively. The article database consists of 10 studies relevant to biomechanical analysis of kicking accuracy. The summary of the research findings shows that the biomechanical analysis approach to kicking accuracy proves to have a significant influence on scoring goals into the goal. The analysis and synthesis results of the included scientific articles are summarized as follows:

#### Biomechanical Analysis of futsal kicks

Biomechanical studies must be carried out by sports coaches to learn certain techniques, both basic, intermediate, and high-level techniques. The sport of futsal games is categorized as having very complex skills because, in performing a game, movements must involve all muscle segments and joints effectively and efficiently and be carried out correctly. Futsal sports involve complex biomechanical and mechanical dynamics that affect player performance, especially in running, kicking, and passing (Baena-Raya et al., 2021). The results of another study specifically explained that kinematic variables, such as fixed foot angle and body position, significantly impact kick accuracy during penalties, highlighting the importance of body mechanics in futsal (Rodrigues et al., 2017). These studies collectively underscore the intricate interplay of mechanical and biomechanical factors in futsal, informing training and performance optimization strategies. Based on the results of the study, related to the description of research kinematic data in the form of distance, time, angle of kick, and speed data for each athlete, basically, there are 3 phases of movement in the shooting kick technique using the instep including the preparation phase, the implementation phase (impact), and the followthrough phase (Augustus et al., 2024). Other research also suggests that the angle of inclination of a kick that is too large will have an impact on slowing the speed of the ball in soccer; in line with this theory, sample 6 is able to achieve the highest speed of 23.40 m/s with the smallest starting angle of 66.8° which in the results of the kick can produce goals (Yeung et al., 2024). This is supported by research (Bouchareb et al., 2024), which shows that to produce effective and efficient kicking techniques, athletes need to improve physical components such as speed, accuracy, and reaction speed. Football players need to focus on two key factors:

positioning the supporting leg as close to the ball as feasible and maximizing the force used in the kick's first phase to get the kicking leg moving quickly (Khalid et al., 2025).

Figure 3. Shooting Kick Movement Sequence



### *Analysis of futsal kick accuracy*

Literally, accuracy is the accuracy of the ball to the intended target with a good and perfect landing. Accuracy is closely related to the accuracy of the distance of the shooting point and the strength of the shot; therefore, to improve the accuracy of the kick, kicking practice and physical training of the leg muscles are needed (Hunter et al., 2022). The accuracy of a kick is an important attribute that can determine a match. Whether in the form of a pass or shooting into a direct goal (Doewes et al., 2022). Thus, the accuracy of a kick to goal in futsal is a person's ability to control or direct a ball kick with a good foot or part of the foot against the opponent's goal as a target or target that must be hit precisely or accurately (Amani-Shalamzari et al., 2020). Athletes can use a variety of methods and approaches to increase the accuracy of their kicks. First, it's crucial to practice consistently. Muscle memory will be developed by frequently practicing kicks and concentrating on accuracy, leading to more accurate kicks in game conditions. Second, vision is a crucial component. By enhancing attention and concentration, players can increase their accuracy by visualizing the target and mentally practicing the kicking motion (Machado et al., 2024)

### *Importance of the research results*

From some of the research results above, it is stated that kicking in futsal sports must-see analysis and some accuracy training to achieve the desired target. This is reinforced by the results of research that a coach must have knowledge of biomechanics in the preparation of training programs, both micro, and macro, which are realized in training methods and applied in training sessions (Herman et al., 2009). Learning a technique is a very important part of the training process, and it must be done in collaboration with various fields of science. A trainer must be able to identify the segments in a particular technical sequence of motion (Myer et al., 2007). Accuracy training is also needed here; one of the key factors in achieving accuracy as a kicker is mastering the basics of kicking techniques (Scurr & Hall, 2009). Other research also suggests that professional kickers emphasize the importance of starting with a solid foundation. This means making sure your body position is balanced, your feet are in the correct position, and your body is parallel to the target (Finnoff et al., 2002). Therefore, achieving accuracy as a kicker requires a combination of proper technique, consistency, mental preparation, and continuous improvement (Hidalgo-De Mora et al., 2025). Overall, the research findings suggest that many interconnected biomechanical factors affect kicking accuracy and that customized training programs are needed to meet the unique technical needs of each person and group.

### *Practical applicability of the research results*

Generalizations or ideas received from some of the Research above provide insight into the role of biomechanics in determining kick accuracy. The results of the study state that kinematic and kinetic parameters contribute greatly to improving kick accuracy (Meamarbashi & Hossaini, 2010). Then, the moment of the hip joint of the supporting leg is very important in calculating the swing of the leg and the angle of the shot when aiming at the goal target (Park et al., 2016). The next idea is that Research shows that exercise programs that increase frontal stability and co-flexion of the hip and knee improve movement quality (Pollard et al., 2004). The conclusion is that studying biomechanical analysis not only creates good kick accuracy, but mechanics movements can also avoid some movements that cause injury when kicking the goal.

## Prospects for further research

For further research prospects, by analyzing all the research results related to biomechanics on futsal kicking accuracy, it becomes clear that precision is very important in terms of improving kicking ability. Whether a Futsal player, soccer kicker, or even a martial artist, honing precision can make a significant difference in overall performance. Precision in kicking is essential for athletes across a range of sports. Focusing on proper technique, visualization, biomechanical analysis, and consistent practice can improve kicking ability to a higher level of accuracy.

## Conclusions

This study concludes that analyzing futsal kick biomechanics can improve understanding of kick movement patterns and create good kick accuracy. The use of the literature review method in this study will prove the use of a biomechanical analysis approach to kick accuracy on futsal goal kick performance. Ultimately, this study enriches our understanding of how interrelated biomechanical factors affect kick accuracy and make athletes skilled and continue to develop their abilities. Future research should (i) combine various research methods to explore kick accuracy analysis through biomechanical analysis, (ii) use a broader article database, and (iii) utilize more sophisticated applications or software in collecting, selecting, and analyzing research data.

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