Mamaos Journal: Journal of Physical Education, Sports and Arts
Volume 2, Number 2, (2026)
e-ISSN 3090-7209 (Online)

Biomotor ecosystem model in futsal performance: correlational analysis of flexibility, speed, and body mass index on futsal player agility

Deni Mudian[1ABCDE], **Arif Fajar Prasetiyo** [2ABCDE] *

[1] University of Subang, Indonesia

*Author's correspondent: Arif Fajar Prasetiyo, Universitas Subang, Indonesia, Email: ariffajarprasetiyo@unsub.ac.id

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Info article

Filed in: *2026-04-02*
Accepted: *2026-05-29*
Published: *2026-05-31*

Keyword:
Flexibility; speed; body mass index; futsal agility

Abstract

Futsal requires players to have good physical abilities, especially agility to change direction quickly and precisely during the match. Agility is influenced by several biomotor components, such as flexibility, speed, and body composition, which can be measured through Body Mass Index (BMI). This study aims to analyze the relationship between flexibility, speed, and Body Mass Index (BMI) on the agility of futsal players. The study used a quantitative approach with a correlational design. The research sample consisted of 30 players who are members of the Futsal Student Activity Unit (UKM) at Subang University and were selected using a purposive sampling technique. Data collection was carried out through a sit and reach test to measure flexibility, a sprint test to measure speed, height and weight measurements to calculate BMI, and the Illinois Agility Test to measure agility. Data were analyzed using descriptive statistics and Pearson Product Moment correlation. The results showed that speed had the strongest relationship with agility (r = 0.58), followed by flexibility (r = 0.42) and Body Mass Index (r = 0.36). These findings indicate that futsal player agility is influenced by several interrelated biomotor components. Therefore, training programs need to address speed, flexibility, and body composition to improve futsal player performance

1. INTRODUCTION

Futsal is a team sport that has developed very rapidly in many countries, including Indonesia. The characteristics of futsal, which is played at a high speed, high intensity, and on a relatively small court, require players to possess optimal technical abilities and physical conditioning (Koota et al., 2021). In match situations, futsal players must be able to perform rapid acceleration, quick changes of direction, and maintain body balance while executing both attacking and defensive movements (Koota et al., 2021). Therefore, physical or biomotor components become important factors that influence the performance of futsal players. Biomotor abilities such as speed, flexibility, strength, endurance, and agility serve as the fundamental foundation that supports players in meeting the various movement demands that occur during a match (Raden Dadan Pra Rudiana & Arif Fajar Prasetiyo, 2024).

In the context of sports science, agility is considered one of the most dominant biomotor components in futsal performance. Agility can be defined as the ability of an Individual ability to change direction and body position quickly and accurately without losing balance is defined as agility (Daharis et al., 2021). This ability is crucial for futsal players when performing dribbling movements, avoiding opponents, intercepting the ball, and executing rapid transitions from attacking to defensive situations. Agility does not function independently; rather, it is influenced by several other biomotor components such as speed and flexibility, as well as body composition factors that can be measured using the Body Mass Index (BMI) (Fleksibilitas et al., n.d.). Therefore, agility performance in futsal can be understood as part of a biomotor system or ecosystem in which multiple physical components interact to support effective movement performance during high-intensity gameplay. The novelty of this perspective lies in the integrative approach that positions agility not merely as a single physical attribute, but as an interconnected biomotor construct influenced simultaneously by speed, flexibility, and body composition variables, providing a more comprehensive framework for analyzing futsal performance (Mendes et al., 2022).

Speed is the ability to perform movements in the shortest possible time. In futsal, speed is essential for executing short sprints, chasing the ball, and creating space during offensive and defensive situations. Players with higher levels of speed tend to demonstrate more effective movement when changing positions and adapting to the fast dynamics of the game (Pauzi et al., 2023). In high-intensity team sports such as futsal, speed is closely related to players' ability to react quickly, accelerate over short distances, and maintain high performance throughout the match (Pauzi et al., 2023). **The novelty** in this context emphasizes the role of speed not only as an isolated biomotor component but as a key determinant that dynamically interacts with agility and other physical factors within the biomotor ecosystem, thereby enhancing overall game efficiency and responsiveness (Rifan et al., 2023).

Meanwhile, flexibility refers to the ability of muscles and joints to move through their maximum range of motion. Good flexibility allows players to perform movements more efficiently, improves the quality of motion, and helps reduce the risk of injury during sports activities. Adequate flexibility is particularly important in sports that involve rapid directional changes, stretching movements, and dynamic body control, as it supports movement efficiency and functional performance during gameplay (Mudian & Prasetiyo, 2023).

In addition to biomotor abilities, body composition also plays an important role in supporting the physical performance of futsal players. One commonly used indicator to assess body composition is the Body Mass Index (BMI), which represents the ratio between an individual's body weight and height. BMI provides a general description of an individual's weight status, whether categorized as underweight, normal, or overweight. In the context of sports performance, an ideal body composition significantly influences movement ability, speed, and energy efficiency during physical activity. Athletes with an optimal body composition tend to demonstrate better physical performance and movement efficiency during high-intensity activities (Sousa-Sá et al., 2024).

Furthermore, body composition is closely related to agility and speed performance in team sports. Excess body mass, particularly body fat, may reduce movement efficiency, slow acceleration, and limit an athlete's ability to perform rapid directional changes (Sousa-Sá et al., 2024). Conversely, maintaining an appropriate body composition can support better neuromuscular performance and enhance agility in sports that require high-intensity and multidirectional movements such as futsal.

Several previous studies have shown that biomotor components have a close relationship with athletes' performance in various team sports (Wikstrom et al., 2020). Some studies have found that speed has a significant contribution to improving players' agility, as the ability to perform acceleration and deceleration is an important part of changing movement direction (Sousa-Sá et al., 2024). Other studies have also shown that good flexibility can improve the quality of body movements and support agility performance (Chaari et al., 2025). In addition, several studies on body composition indicate that a Body Mass Index (BMI) within the normal category tends to support more optimal physical performance compared to individuals who have BMI levels that are too low or too high (Piras et al., 2021).

However, most previous studies have still examined biomotor components separately. Studies that integrate several biomotor components such as flexibility, speed, and body mass index within a comprehensive analytical framework related to the agility of futsal players are still relatively limited (Tertuliano et al., 2025). In practice, the physical performance of a player is not only influenced by a single biomotor component, but also by the interaction of various components that form an ecosystem of physical abilities (Wei et al., 2025). Therefore, the biomotor ecosystem model approach becomes important in understanding the relationship between various physical condition components that contribute to the performance of futsal players.

Based on the above explanation, **the novelty** of this study lies in the biomotor ecosystem model approach that examines the relationship between flexibility, speed, and body mass index simultaneously in relation to the agility of futsal players. This

approach is expected to provide a more comprehensive understanding of the physical condition factors that influence the performance of futsal players, particularly in the aspect of agility as one of the main abilities required in futsal games (Stewart et al., 2025).

2. METHOD

This study employed a quantitative approach with a correlational research design. This design was used to determine the relationship between flexibility, speed, and Body Mass Index (BMI) and the agility of futsal players. The correlational approach was chosen because this study aims to analyze the relationships between variables without providing any specific treatment to the research subjects.

The study was conducted on the futsal court used by the Futsal Student Activity Unit of Universitas Subang. The population in this study consisted of all players who were members of the Futsal Student Activity Unit of Universitas Subang. The research sample consisted of 30 players who actively participated in training activities. The sampling technique used was purposive sampling, which involves selecting samples based on certain criteria such as actively participating in training and being in a healthy condition during the testing process.

Data measurement was carried out through several physical condition tests. Flexibility was measured using the sit and reach test, speed was measured using the sprint test, while agility was measured using the Illinois Agility Test. Body Mass Index was obtained through measurements of body weight and height, which were then calculated using the following formula:

$$IMT = \frac{Berat\ Badan\ (kg)}{Tinggi\ Badan\ (m)^2}$$

Figure 1
Body Mass Index (BMI) Formula

3. RESULTS AND DISCUSSION

This study involved 30 players from the Futsal Student Activity Unit of Universitas Subang as the research sample. The data collected included flexibility, speed, Body Mass Index (BMI), and agility of the futsal players. Descriptive analysis was conducted to determine the general overview of the physical condition of the research respondents.

Table 1. Descriptive Statistics of Physical Condition Variables of Futsal Players

Variable	N	Mean ± SD
Flexibility (cm)	30	22.35 ± 5.14
Speed (second)	30	4.78 ± 0.36
Body Mass Index (kg/m^2)	30	21.67 ± 2.15
Agility (second)	30	16.42 ± 0.85

Based on Table 1, the average flexibility of the players was 22.35 cm, the average speed was 4.78 seconds, and the average Body Mass Index (BMI) was 21.67 kg/m^2. The average agility score of the futsal players, measured using the Illinois Agility Test, showed a completion time of 16.42 seconds.

Before conducting the correlation analysis, prerequisite tests were first performed, namely the normality test and the homogeneity test of the data.

Normality Test

The normality test was conducted using the Shapiro–Wilk Test to determine whether the research data were normally distributed.

Table 2. Normality Test Results

Variable	Statistic	P-Value	Interpretation
Flexibility	0.964	0.412	Normal
Speed	0.971	0.536	Normal
Body Mass Index	0.958	0.327	Normal
Agility	0.969	0.487	Normal

Based on Table 2, all research variables have a p-value > 0.05, therefore it can be concluded that the data on flexibility, speed, Body Mass Index, and agility are normally distributed.

Homogeneity Test

The homogeneity test was conducted using the Levene Test to determine the similarity of variance in the research data.

Table 3. Homogeneity Test Results

Variable	Levene Statistic	P-Value	Interpretation
Flexibility – Agility	1.284	0.265	Homogeneous
Speed – Agility	1.103	0.301	Homogeneous
BMI – Agility	1.214	0.278	Homogeneous

Based on Table 3, all variables show a p-value > 0.05, therefore it can be concluded that the research data have homogeneous variance.

After the prerequisite tests for analysis were fulfilled, a correlation analysis was then conducted to determine the relationship between flexibility, speed, and Body Mass Index and the agility of futsal players.

Table 4. Correlation Between Flexibility, Speed, Body Mass Index and Agility

Variable	**Agility (r)**	**P-Value**
Flexibility	-0.42	0.021
Speed	0.58	0.003
Body Mass Index	0.36	0.048

Based on Table 4, the speed variable shows the strongest correlation with the agility of futsal players with a value of r = 0.58, followed by Body Mass Index with a value of r = 0.36. Meanwhile, flexibility shows a negative relationship with agility with a value of r = -0.42.

The visualization of the relationship model between biomotor variables and the agility of futsal players can be seen in Figure 1, which illustrates the biomotor ecosystem model in futsal performance.

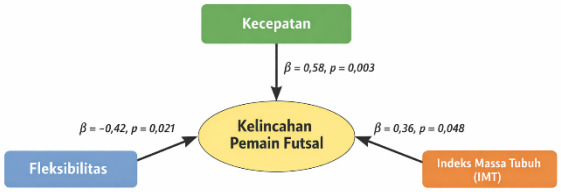

Figure 2. Biomotor Ecosystem Model Affecting Futsal Agility

Discussion

The results of this study indicate that flexibility, speed, and Body Mass Index (BMI) are related to the agility of futsal players who are members of the Futsal Student Activity Unit at Subang University. Agility is one of the most important components of physical condition in futsal because the fast and dynamic characteristics of the game require players to be able to perform changes in movement direction quickly and accurately (Umar et al., 2023). Therefore, agility ability does not stand alone but is influenced by several interconnected biomotor components (Giese et al., 2024).

Based on the results of the correlation analysis, the speed variable showed the strongest relationship with the agility of futsal players, with a correlation value of $r = 0.58$ and a significance value of $p = 0.003$. This result indicates that speed ability has a considerable contribution to improving players' agility. In futsal games, players frequently perform short sprints, accelerations, and changes of direction in a very short time. Therefore, players who possess good speed ability tend to find it easier to perform movement transitions and change body direction effectively. These findings are consistent with several studies in the field of sport science which state that speed is one of the main factors influencing agility performance in team sports (Makaruk et al., 2024).

In addition to speed, flexibility also showed a relationship with the agility of futsal players, with a correlation value of $r = 0.42$ and a significance value of $p = 0.021$. Flexibility is the ability of muscles and joints to move optimally within a certain range of motion. Good flexibility allows players to perform various movements more efficiently, especially when making rapid changes in movement direction. In the context of futsal games, flexibility helps players maintain body balance and improve the quality of movement when performing dribbling, avoiding opponents, or executing defensive movements. Therefore, players who have good flexibility tend to possess more optimal agility abilities (Coker & Kaminski, 2020).

Meanwhile, Body Mass Index (BMI) also showed a relationship with the agility of futsal players with a correlation value of r = 0.36 and a significance value of p = 0.048. Although the relationship shown is not as strong as the variables of speed and flexibility, this result indicates that body composition still plays a role in supporting players' agility performance. Body Mass Index reflects the balance between an individual's body weight and height. In sports that demand high mobility such as futsal, an ideal body composition can help players move more quickly and efficiently. Players with proportional body composition tend to have better movement ability compared to players who are overweight or have less ideal body composition (Kowalski et al., 2021).

When viewed as a whole, the results of this study indicate that flexibility, speed, and Body Mass Index (BMI) are biomotor components that interact with each other in shaping the agility ability of futsal players. This is consistent with the concept of the biomotor ecosystem, which explains that an athlete's physical performance is the result of the interaction of various physical condition components that support one another. In the context of futsal games, agility ability is not determined by a single factor, but is influenced by a combination of speed ability, flexibility, and the body composition condition of the players (Singe et al., 2023).

The results of this study provide important implications for futsal coaches and sports instructors, particularly in planning training programs. Training programs designed to improve players' agility should not only focus on agility training, but also need to systematically integrate speed and flexibility training (Singe et al., 2023). In addition, the management of players' physical condition through the regulation of training patterns and monitoring of body composition also needs to be considered so that players can maintain optimal physical condition (Latash, 2025).

Thus, it can be concluded that improving the agility performance of futsal players needs to be carried out through a comprehensive training approach by considering various interconnected biomotor components. This approach is expected to support the development of futsal players' performance more effectively and

contribute to improving the quality of futsal coaching in educational environments as well as in sports clubs (Cummings et al., 2023; Latash, 2025).

4. CONCLUSION

Based on the results of the study conducted on members of the Futsal Student Activity Unit at Universitas Subang, it can be concluded that flexibility, speed, and Body Mass Index have a relationship with the agility of futsal players. The speed variable shows the strongest relationship with agility, followed by flexibility and Body Mass Index. The results of this study indicate that the agility ability of futsal players is influenced by several interrelated biomotor components. Therefore, improving players' agility needs to be carried out through integrated training programs that consider aspects of speed, flexibility, and body composition so that the performance of futsal players can develop optimally.

5. REFERENCES

Chaari, F., Rahmani, A., Peyrot, N., Harrabi, M. A., Fendri, T., Rebai, H., Boyas, S., & Sahli, S. (2025). Does Core Training Improve Agility Performance in Soccer Players With Groin Pain? A Randomized, Single-Blind Study. *International Journal of Sports Physiology and Performance*, *20*, 385–392. https://doi.org/10.1123/ijspp.2024-0259

Coker, E., & Kaminski, T. (2020). Effect of visual condition on performance of balance-related tasks in Elite dance students. *Motor Control*, *24*, 397–407. https://doi.org/10.1123/MC.2019-0032

Cummings, M., Doshi, A., & Madhavan, S. (2023). Understanding the Interaction of Transcranial Direct Current Stimulation and Visual Feedback During an Ankle Movement Task. *Motor Control*, *27*, 751–764. https://doi.org/10.1123/mc.2022-0105

Daharis, Rahmadani, A., Makorohim, M. F., & Putra, G. N. (2021). Block Practice Vs Random Practice: Bagaimana perbedaannya terhadap peningkatan gerakan senam forward roll? *Edu Sportivo: Indonesian Journal of Physical Education*, *2*, 198–205. https://doi.org/10.25299/es:ijope.2021.vol2(3).7973

Fleksibilitas, K., Tubuh, M., Kelincahan, D., Pemain, T., Arif, F., Prasetiyo, F., Dadan, R., & Rudiana, P. (n.d.). *Biormatika : Jurnal ilmiah fakultas keguruan dan ilmu pendidikan*. 2580–6335. https://doi.org/10.35569

Giese, M., Haegele, J. A., & Maher, A. J. (2024). The Ableist Underpinning of Normative Motor Assessments in Adapted Physical Education. *Journal of Teaching in Physical Education*, *43*, 72–78. https://doi.org/10.1123/jtpe.2022-0239

Koota, E., Kääriäinen, M., Kyngäs, H., Lääperi, M., & Melender, H. L. (2021). Effectiveness of Evidence-Based Practice (EBP) Education on Emergency Nurses' EBP Attitudes, Knowledge, Self-Efficacy, Skills, and Behavior: A Randomized Controlled Trial. *Worldviews on Evidence-Based Nursing*, *18*, 23–32. https://doi.org/10.1111/wvn.12485

Kowalski, K. L., Boolani, A., & Christie, A. D. (2021). State and trait fatigue and energy predictors of postural control and gait. *Motor Control*, *25*, 519–536. https://doi.org/10.1123/MC.2020-0106

Latash, M. L. (2025). Useful and Useless Misnomers in Motor Control. *Motor Control*, *29*, 69–98. https://doi.org/10.1123/mc.2024-0082

Makaruk, H., Makaruk, B., Starzak, M., Chmielewski, K., & Porter, J. M. (2024). The learning of sprint hurdles: A comparative study on increasing contextual interference and blocked practice schedules. *PLoS ONE*, *19*(1 January). https://doi.org/10.1371/journal.pone.0289916

Mendes, D., Travassos, B., Carmo, J. M., Cardoso, F., Costa, I., & Sarmento, H. (2022). Talent Identification and Development in Male Futsal: A Systematic Review. In *International Journal of Environmental Research and Public Health* (Vol. 19). MDPI. https://doi.org/10.3390/ijerph191710648

Mudian, D., & Prasetiyo, A. F. (2023). Korelasi Kecepatan Dan Kelincahan Terhadap Keterampilan Dribbling Futsal. *Biormatika : Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan*, *9*, 59–67. https://doi.org/10.35569/biormatika.v9i1.1433

Pauzi, A. M., Permadi, A. A., Arifin, Z., Ishak, M., & Fernando, R. (2023). Upaya meningkatkan hasil belajar sepakbola melalui model pembelajaran teaching game for understanding. *Bima Loka: Journal of Physical Education*, *3*, 74–83. https://doi.org/10.26740/bimaloka.v3i2.26929

Piras, A., Timmis, M. A., Trofè, A., & Raffi, M. (2021). Visual Strategies Underpinning the Spatiotemporal Demands During Visuomotor Tasks in Predicting Ball Direction. *Journal of Sport and Exercise Psychology*, *43*, 514–523. https://doi.org/10.1123/jsep.2020-0345

Raden Dadan Pra Rudiana, & Arif Fajar Prasetiyo. (2024). Pengaruh Latihan Small Side Games Terhadap Keterampilan Bermain Sepakbola. *Guruku: Jurnal Pendidikan Dan Sosial Humaniora*, *1*, 195–203. https://doi.org/10.59061/guruku.v1i4.603

Rifan, A., Permadi, A. A., & Arifin, Z. (2023). LATIHAN FIRST TOUCH TERHADAP KETERAMPILAN DASAR SEPAK BOLA. *Jambura Journal of Sports Coaching*, *5*, 99–109. https://doi.org/10.37311/jjsc.v5i2.18897

Singe, S. M., Cairns, A. H., & Eason, C. M. (2023). Perceptions of Self-Care and Work–Life Balance Among Secondary School Athletic Trainers. *International Journal of Athletic Therapy and Training*, *28*, 308–314. https://doi.org/10.1123/ijatt.2022-0010

Sousa-Sá, E., Lander, N., Alqumsan, A. A., Alsanwy, S., Nahavandi, D., Toomey, N., Mohamed, S., Lewis, S., & Barnett, L. M. (2024). Physical Education Teachers' Perceptions of a Motor Competence Assessment Digital App. *Journal of Teaching in Physical Education*, *43*, 276–291. https://doi.org/10.1123/jtpe.2022-0222

Stewart, H. E., Alcantara, R. S., Farina, K. A., Hahn, M. E., Grabowski, A. M., Kram, R., Wilcox, R. R., & McNitt-Gray, J. L. (2025). Can Ground Reaction Force Variables Preidentify the Probability of a Musculoskeletal Injury in Collegiate Distance Runners? *Journal of Applied Biomechanics*, 1–8. https://doi.org/10.1123/jab.2023-0226

Tertuliano, C. V. M., Gonçalves, R. S. dos S. A., Macêdo, S. G. G. F., & Maciel, Á. C. C. (2025). Relationship Between Cognitive Deficit and Physical Performance in Older People: Results from Pro-Eva Study. *Journal of Aging and Physical Activity*, 1–8. https://doi.org/10.1123/japa.2023-0240

Umar, Alnedral, Ihsan, N., Mario, D. T., & Mardesia, P. (2023). The effect of learning methods and motor skills on the learning outcomes of basic techniques in volleyball. *Journal of Physical Education and Sport*, *23*(9), 2453–2460. https://doi.org/10.7752/jpes.2023.09282

Wei, X., Zheng, X., Zhu, H., Vigh-Larsen, J. F., Mohr, M., Krustrup, P., & Chen, X. (2025). Comparison of Intrasession Reliability and Sensitivity Across Different Deceleration-Test Results in Male and Female Soccer Players. *International Journal of Sports Physiology and Performance*, 1–7. https://doi.org/10.1123/ijspp.2024-0432

Wikstrom, E. A., Song, K., Migel, K., & Hass, C. J. (2020). Altered vertical ground reaction force components while walking in individuals with chronic ankle instability. *International Journal of Athletic Therapy and Training*, *25*, 27–30. https://doi.org/10.1123/ijatt.2018-0117