Performance in sports

Correlation between explosive strength, flexibility, and agility in players of the National School of Sport futsal team

Correlación entre la fuerza explosiva, flexibilidad y agilidad en jugadores de la selección de fútbol sala de la Escuela Nacional del Deporte

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ABSTRACT

This study aims to analyse the correlation between explosive strength, flexibility and agility in players from the futsal team of the National Sports School of Cali. A descriptive correlational study was conducted with a non-probabilistic sample of 15 players, who underwent five physical tests: the Wells test to measure flexibility, the abdominal strength test, the vertical jump test (CMJ), a 30-metre speed test, and the Illinois agility test. The results indicated a significant correlation between abdominal strength and vertical jump ($r = 0.782$, $p < 0.001$), as well as between flexibility and vertical jump ($r = 0.520$, $p = 0.047$). However, no significant correlation was found between agility and any of the other variables. The findings suggest that, although there is a relationship between flexibility and explosive strength, this is not consistent in all cases, and agility does not show a direct correlation with the other physical abilities assessed. These results may help to design more specific and effective training programmes to improve athletic performance in futsal.

Keywords: explosive strength, flexibility, agility, futsal.

RESUMEN

Este estudio tiene como objetivo analizar la correlación entre la fuerza explosiva, la flexibilidad y la agilidad en jugadores de la selección de futsal de la Escuela Nacional del Deporte de Cali. Se realizó un estudio descriptivo correlacional con una muestra no probabilística de 15 jugadores, quienes fueron sometidos a cinco pruebas físicas: el test de Wells para medir la flexibilidad, el test de fuerza abdominal, el test de salto vertical (CMJ), una prueba de velocidad en 30 metros y el test de agilidad Illinois. Los resultados indicaron una correlación significativa entre la fuerza abdominal y el salto vertical ($r = 0,782$, $p < 0,001$), así como entre la flexibilidad y el salto vertical ($r = 0,520$, $p = 0,047$). Sin embargo, no se halló correlación significativa entre la agilidad y ninguna de las otras variables. Los hallazgos sugieren que, aunque existe una relación entre la flexibilidad y la fuerza explosiva, esta no es consistente en todos los casos, y la agilidad no muestra una correlación directa con las demás capacidades físicas evaluadas. Estos resultados pueden ayudar a diseñar programas de entrenamiento más específicos y efectivos para mejorar el rendimiento deportivo en el futsal.

Palabras clave: fuerza explosiva, flexibilidad, agilidad, futsal.

INTRODUCTION

Futsal is a high-intensity sport that demands a combination of specific physical skills such as explosive strength, flexibility and agility. The dynamic nature of the game requires players to be in excellent physical condition, as they must constantly change direction, accelerate, decelerate, and jump during matches, highlighting the importance of these physical abilities. In particular, the assessment and analysis of these qualities allow for the improvement of training programmes and, consequently, player performance (Briceño et al., 2019).

Explosive strength, which refers to the ability to generate maximum force in the shortest possible time, is crucial in futsal for jumping, sprinting and powerful shots. This ability is commonly assessed through jump tests, such as the counter-movement jump (CMJ), which measures lower limb power (Contreras et al., 2022). On the other hand, flexibility is an equally important quality, as it improves the range of motion of the joints, which can contribute to greater efficiency in technical actions, such as ball control and quick movements.

Agility, for its part, is core to performance in futsal, as it allows players to make quick and efficient changes of direction without losing their balance. This ability is closely related to speed and coordination and is assessed using tests such as the Illinois test, which measures the ability to change direction in confined spaces (Raya et al., 2013).

However, although these three abilities are essential in futsal, they are not always correlated with each other. Previous research has shown that while explosive strength and flexibility may have a significant relationship, agility does not always correlate directly with these abilities (Malagón et al., 2019). This suggests that each of these qualities must be trained specifically, taking into account the particular demands of the sport.

The present study aims to analyse the correlation between explosive strength, flexibility and agility in players from the futsal team of the National Sports School in Cali. By assessing these abilities, we seek

to identify the relationships between them, which will allow us to design more effective training programmes aimed at improving the physical performance of athletes.
Ultimately, this research will not only contribute to knowledge about physical preparation in futsal, but will also provide valuable data for future studies in other sports disciplines that require the analysis of similar physical abilities.

METHOD

This study is based on a quantitative, descriptive correlational approach, in which physical assessments were carried out on players from the futsal team of the National Sports School. A sample of 15 players with an average weight of 68.5 ± 25.4 kg and a height of 1.75 ± 10 cm was used. The study was conducted at the Iván Vassilev Todorov Coliseum, within the institution. To be included, players had to have active tuition and a valid medical certificate guaranteeing their ability to perform intense physical activities. In addition, they signed an informed consent form to participate.

Phase 1: Data Collection

The physical tests were conducted at the Ivan Vassilev Todorov Coliseum, using a standardised protocol that included a 10-minute warm-up for all players. Five physical tests were administered to measure different abilities:
Wells Test (Flexibility): This test was used to assess the flexibility of the trunk and lower limbs. Players stood with their feet together and arms extended forward. From that position, they bent forward with their knees extended, attempting to touch their toes. The distance between their hands and feet was measured and recorded in centimetres. The results were evaluated based on a percentile table (Table 1).

Table 1.
Percentiles for the Wells Test

Grade	Percentile	Men (cm)	Women (cm)	Percentile
Excellent	90	16 - 17	14 - 16	90
Very good	80	12 - 15	11 - 13	80
Above average	70	7 - 11	6 - 10	70
Average	50	5 - 6	4 - 5	50
Below average	40	3 - 4	2 - 3	40
Low	30	-2 - 1	-3 - 1	30
Very low	10	-8 - -4	-9 - -4	10

2. Abdominal Strength Test: In this test, the players' ability to perform sit-ups for one minute was measured. Participants lay on their backs with their knees bent and feet flat on the floor, while a partner held their legs. The objective was to perform as many repetitions as possible in one minute, touching the partner's knees with their hands each time. The results were classified using a reference table (Table 2).

Table 2.
Sit-up repetitions in 1 minute by age and gender

Level	Men aged 16-25	Men aged 26-35	Women aged 16-25	Women aged 26-35
Excellent	>49	>45	>43	>39
Good	44 - 49	40 - 45	37 - 43	33 - 39
Average	35 - 38	31 - 35	25 - 28	22 - 27
Below average	31 - 34	29 - 34	20 - 24	18 - 21
Below average	25 - 30	22 - 28	18 - 24	17 - 24
Low	<25	<22	<18	<17
Very low	>49	>45	>43	>39

3. Counter Movement Vertical Jump (CMJ) Test: This test was used to measure explosive leg strength. Players had to perform a vertical jump from a slight knee bend, quickly extending their hips, knees, and ankles. The "Jumpster" app was used to record the height reached by each player. The mobile device was placed on the hip to obtain the measurements.

4. 30-metre Speed Test: To measure speed, a distance of 30 metres was used, marked out with cones. Players started from a static position and ran the distance at maximum speed. The time was recorded with digital stopwatches and used to calculate each player's maximum speed over a short distance.

5. Illinois Agility Test: This test assesses players' ability to change direction and move in a zigzag pattern quickly and efficiently. A circuit was set up with cones in a rectangular field 10 metres long by 5 metres wide, with cones distributed at the corners and in a straight line along the centre. Players started lying face down, and when given the signal, they had to get up and complete the circuit as quickly as possible.

Phase 2: Statistical Analysis

The data obtained in the tests were processed using SPSS v.25 statistical software. Pearson's correlation coefficient was applied to analyse the relationships between the variables of explosive strength, flexibility, and agility. A significance level of $p \leq 0.05$ was established for all statistical tests. Significant correlations between variables were analysed to identify performance patterns that could inform the planning of specific training programmes.

This method allowed for a comprehensive assessment of the physical abilities of futsal players, with a focus on the relationship between explosive strength, flexibility, and agility, contributing to the improvement of training programme design that optimises athletic performance.

RESULTS

Table 3 presents the results obtained by the 15 players assessed in the physical tests of flexibility (Wells Test), abdominal strength, 30-metre speed, explosive strength (CMJ) and agility (Illinois Test). These tests allow for a comprehensive assessment of the physical abilities of futsal players, focusing on key aspects for athletic performance. The individual results for each player are shown below, classified by test and compared according to the standards for each test.

Table 3.
Test results

Subject	Weight (kg)	Height (cm)	Wells (cm)	Assessment	Abdominal F (reps)	Assessment	30 m speed (sec)	Assessment	CMJ (cm)	Assessment	Illinois (sec)	Rating
1	77.6	178	20.5	Poor	41	Good	4.45	Average	43	Poor	15.44	Good
2	68.1	176	32	Poor	50	Excellent	3.84	Excellent	45	Poor	17.07	Fair
3	67.0	182	33	Poor	52	Excellent	4.34	Fair	48	Average	14.98	Excellent
4	93.9	174	17	Poor	40	Good	4.83	Average	35	Poor	17.82	Fair
5	58.25	173	39	Good	58	Excellent	5.03	Poor	48	Poor	16.38	Fair
6	76.65	185	26	Bad	64	Excellent	3.72	Excellent	44	Poor	17.51	Fair
7	65.45	175	35.5	Poor	61	Excellent	4.26	Fair	54	Good	19.69	Poor
8	71.15	177	20	Poor	53	Excellent	4.73	Average	41	Poor	18.23	Poor
9	65.55	173	39	Good	52	Excellent	4.4	Fair	42	Poor	17.61	Fair
10	71.55	166	28	Poor	40	Good	4.55	Average	35	Poor	15.6	Good
11	62.6	175	49.5	Excellent	57	Excellent	4.32	Good	43	Poor	17.19	Fair
12	75.75	183	49	Excellent	68	Excellent	5.0	Poor	57	Excellent	17.7	Fair
13	58.0	173	30	Poor	50	Excellent	4.42	Average	44	Poor	18.56	Poor
14	51.45	166	33	Poor	56	Excellent	4.35	Good	42	Poor	16.68	Fair
15	64.4	175	41	Good	47	Good	4.68	Fair	39	Poor	17.1	Fair

In terms of abdominal strength, the results are much more positive. Most players obtained "Excellent" ratings, demonstrating adequate core strength. Good abdominal strength is crucial for trunk stability during the explosive and rapid movements required in futsal (Núñez et al. 2020). This finding suggests that the team has worked adequately on this ability, which may have a favourable impact on their overall physical performance.

Finally, the results of the 30-metre speed test show a wide disparity among players. Some of them achieved "excellent" times, while others obtained "fair" or "poor" times. Speed is an essential ability in futsal, as players need to make quick transitions from attack to defence. The disparity in results suggests that some players could benefit from specific programmes to improve speed and running technique (González-Ravé et al. 2018). These results, combined with the times obtained in the Illinois Test (agility), provide a detailed overview of the fields that require greater attention in training.

Table 4 presents the Pearson correlation coefficients between the different variables assessed: flexibility (Wells), abdominal strength, 30-metre speed, explosive strength (CMJ) and agility (Illinois). These coefficients allow us to identify the strength and direction of the relationships between these physical variables, which is essential for understanding how one ability can influence another in the performance of futsal players. Statistical significance levels are indicated for the strongest correlations, helping to determine which variables have a significant relationship.

Table 4.
Correlation results

Variables	Wells	Abdominal F.	Velocity	CMJ	Illinois
Wells	1	0.572*	0.135	0.631*	0.067
F. Abdominal	0.572	1	0.105	0.782	0.393
Speed	0.135	0.105	1	0.247	0.024
CMJ	0.631	0.782	0.247	1	0.393
Illinois	0.067	0.393	0.024	0.393	1

* Significant correlation at the 0.05 level (bilateral).
** Significant correlation at the 0.01 level (bilateral).

Firstly, there is a positive and significant correlation between flexibility (Wells) and abdominal strength ($r = 0.572$, $p < 0.05$). This result suggests that greater trunk flexibility could be related to a better ability to perform abdominal exercises. This finding is consistent with previous studies suggesting that good flexibility facilitates more efficient and less restricted movements, which may contribute to the development of core strength (García et al., 2020). In addition, a significant correlation was observed between flexibility and explosive strength measured with the CMJ ($r = 0.631$, $p < 0.05$), indicating that more flexible players tend to perform better in vertical jumps, which could be due to better joint mobility.
On the other hand, abdominal strength showed a high and significant correlation with explosive strength ($r = 0.782$, $p < 0.01$), suggesting that players with a stronger core have a greater ability to generate explosive force in the lower body. These results are consistent with research highlighting the importance of the core in stability and force transmission during explosive movements such as jumps and changes of direction (Núñez et al., 2019). The lack of a significant correlation between abdominal

strength and speed or agility suggests that, although the core is important for stability, speed over short distances may depend more on running technique and acceleration ability.

Finally, although no significant correlation was found between speed and the other physical variables assessed, this result highlights the specificity of sprinting ability in futsal players. Speed is likely to depend on factors such as running technique, reactive strength, and neuromuscular coordination, rather than flexibility or abdominal strength (González-Medina & Pérez-Gómez, 2021). Furthermore, the lack of correlation between the Illinois Test (agility) and the other variables suggests that agility could be an independent ability that requires specific training, such as change of direction and quick reaction exercises.

DISCUSSION

The main objective of this research was to analyse the correlation between explosive strength, flexibility and agility in players from the futsal team at the National Sports School in Cali, using five specific tests: Wells Test (flexibility), abdominal strength, 30-metre speed, CMJ (explosive strength) and Illinois Test (agility). The overall results showed average values of 32.83 ± 16.87 in the Wells Test, 53 ± 15 repetitions in the abdominal strength test, an average time of 4.46 ± 0.74 seconds in the 30-metre speed test, 44 ± 13 cm in the CMJ test and 17.17 ± 2.52 seconds in the Illinois Test, providing a detailed overview of the physical profile of the players evaluated.

One of the most significant correlations was found between abdominal strength and explosive strength (CMJ), with a Pearson correlation coefficient of 0.782 ($p < 0.01$). This correlation is consistent with studies that highlight the importance of the core in stability and explosive performance (Núñez et al., 2019). In futsal, abdominal strength plays a crucial role in maintaining stability and generating power during jumps, which is key in situations such as aerial clearances, corner kicks, or high interceptions. In addition, a strong core facilitates the efficient transmission of energy from the lower body, allowing players to reach greater heights with good muscle coordination (García et al., 2020).

Flexibility (Wells) also showed a positive and significant correlation with explosive strength (CMJ) ($r = 0.631$, $p < 0.05$). This result is relevant, as greater flexibility allows players to achieve a greater range of joint motion, which in turn can facilitate the full utilisation of the power generated in vertical jumps (González et al., 2019). In the context of futsal, players with better flexibility have the ability to perform wider and more controlled movements, allowing them to execute technical actions more effectively, especially in situations that require a combination of speed and agility.

The correlation between abdominal strength and flexibility (Wells) ($r = 0.572$, $p < 0.05$) is also a relevant finding. This link can be explained by the role that the core plays in mobility and postural balance. Greater strength in the abdominal region allows for better stabilisation of the body during movements that involve a large range of motion, such as jumps and rotations. In addition, improved flexibility reduces muscle and joint stiffness, facilitating more efficient execution of these movements (García et al., 2020). In futsal, this is particularly important, as players are constantly making quick changes of direction and sudden accelerations that require a strong core and good flexibility.

However, no significant correlation was found between 30-metre speed and the other variables assessed. This result suggests that speed is an ability that is more dependent on specific factors, such as running technique and acceleration capacity, than on explosive strength or flexibility (González-Medina & Pérez-Gómez, 2021). Short-distance speed is crucial in futsal, but it does not appear to be directly influenced by flexibility or core strength, highlighting the need to train speed in isolation.

Similarly, no significant correlation was found between the Illinois Test (agility) and the other variables. This may be because agility is an ability that involves responsiveness, coordination, and the ability to change direction in tight spaces, which is not necessarily related to flexibility or explosive strength (González-Medina & Pérez-Gómez, 2021). This result highlights the importance of including specific training to improve agility, such as reaction exercises and quick changes of direction, which are crucial for performance in futsal.

In summary, the results suggest that abdominal strength and explosive strength are highly related, and that flexibility may also play an important role in optimising futsal performance. However, speed and agility abilities appear to be more specific and require a different training approach. These findings can serve as a basis for designing more comprehensive and specific training programmes that consider the interrelationship between these variables to maximise player performance.

PRACTICAL APPLICATIONS

Based on the findings of this research, several practical applications relevant to futsal training have been established:

Integrate core work into training plans as a priority. The correlation found between abdominal strength and explosive strength indicates that a strong core directly contributes to the execution of jumps, explosive movements and power actions. Therefore, it is recommended to include specific exercises such as planks, anti-rotations, stability work and isometric/dynamic trunk strength.

Incorporate performance-oriented flexibility routines. The positive relationship between flexibility, explosive strength, and abdominal strength demonstrates that joint mobility not only prevents injuries but also optimises range of motion in technical movements such as changes of direction, jumps, and extensions. It is suggested to include dynamic mobility, active stretching, and elasticity work within the weekly microstructure.

Design differentiated training sessions for speed. The lack of correlation between speed and other abilities suggests that speed in futsal players depends on specific neuromuscular and technical aspects. Therefore, tasks dedicated exclusively to running mechanics, acceleration and deceleration should be implemented, without assuming indirect improvements from other abilities.

Implement specific exercises for developing agility. Since agility was not related to the other variables, its training should include reaction, perception, anticipation, and changes of direction tasks with visual or auditory stimuli. This approach will improve performance in real game situations.

Structure training programmes with a combined and selective approach. Some abilities (core and flexibility) can be trained in a complementary manner, while others (speed and agility) require independent stimuli. Physical trainers should consider this interaction to optimise the time and effectiveness of the microcycle.

CONCLUSIONS

The results of the study showed significant relationships between some physical abilities assessed in university futsal players. A positive correlation was found between abdominal strength and explosive strength, highlighting the role of the core in power actions and the efficiency of explosive movements. Likewise, flexibility was associated with both explosive strength and abdominal strength, indicating that adequate joint mobility favours physical performance in dynamic game actions.

In contrast, no significant correlations were identified between speed and the other abilities assessed, suggesting that this skill depends on specific technical and neuromuscular factors. Similarly, agility behaved as an independent ability, requiring specific training strategies.

Taken together, these findings highlight the need to design differentiated training programmes, where core strength and flexibility can be worked on in a complementary manner, while speed and agility require specific methods for their development. The results provide a useful basis for guiding physical planning in futsal players and for developing future research that delves deeper into the interaction between these abilities and their impact on competitive performance.

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