Journal of Physical Education and Sport ® (JPES), Vol. 23 (issue 6), Art 181, pp. 1481 - 1487, June 2023
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Analysis of physical variables as an indicator of performance in a sample of Colombian women's soccer players: influence of being a starter and a non-starter

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Published online: June 30, 2023
(Accepted for publication June 15, 2023)
DOI:10.7752/jpes.2023.06181

Abstract:
Introduction: The physical variables related to strength, changes of direction, agility direction, and speed are determinant variables in physical performance in female soccer players, which is why characterizing their manifestations are an essential input for methodological consideration in training plans. Objective: For this reason, the objective of this study was to analyze the relationship between the physical variables of Squat Jump, Counter Movement Jump, Counter Movement with arms, right leg-left leg asymmetry, hamstring strength, change of direction, and speed in 5, 10 and 15 meters as an influence of being a starter and non-starter in a Colombian youth women's soccer team. Each test was evaluated using the "My Jump Lab" mobile application. Methods: The study included 22 players from the Bogotá national team with an average age of 17.12±0.93 years, a height of 163.84±4.70 cm, and a body mass of 56.56±7.45 kg. The study had a quantitative, descriptive-correlational approach and a non-experimental design. The sampling was non-probabilistic by convenience. The statistical treatment was done with the ® program version 4.1.0, using univariate and bivariate analysis tests, normality tests, and the Kruskall-Wallis test. Results: The results indicate that the starting players show better performance in SJ, CMJ, CMJB, asymmetries, hamstring strength, and CoDTimer, while the non-starting players show better performance in the speed test. However, although there are differences between starting and non-starting players, there is no variable significant at 5%, with only leg asymmetry being the only one that proved significant at 10%. Conclusions: The findings of the present research ratify the need to continue deepening the performance evaluation for female soccer players, leading to thinking that the player's performance depends on many factors that should integrate the physical with other indicators, processes, and capabilities. This investigation is the first study in women's youth soccer in Colombia that sought to evaluate the differences between starting and non-starting players based on physical variables; providing a conceptual and research basis can help build lines of research that focus more attention on the sporting performance of female soccer players in the various categories and sporting levels.
Key Words: sport, women's soccer, strength, velocity, asymmetry

Introduction

Soccer is a sport in which each of the actions performed by players interacts with a series of physical abilities and cognitive and decisional processes conditioned by changing game situations (Becerra Patiño, 2021a; Becerra Patiño, 2021b; Becerra-Patiño et al., 2023). There, players must be able to increasingly manifest a performance following the same evolution of women's soccer (Harkness-Armstrong et al., 2022).

In this way, women's soccer has been expanding its horizons, levels of participation, and competition (Okholm et al., 2020), leading to significant changes in the preparation processes for researchers and medical departments aimed at generating a better understanding of physiological processes, physical demands, health needs and development of sports performance (Randell et al., 2021). At the same time, these manifestations of physical demands are closely related to technical-tactical actions (Arjol-Serrano et al., 2021; Díez et al., 2021). For this reason, it is necessary to continue developing research, this time aimed at analyzing the physical variables as an indicator of performance in a sample of Colombian women's soccer players as an influence of being a starter and non-starter.

Colombian women's soccer has been improving its international participation in different tournaments, primarily due to the sub-championship of the FIFA U-17 Women's World Cup, sub-championship of the Copa America in 2022, and the qualification to the U-20 and senior women's World Cups. All this forces science to be more and more related to the development of sports processes, mainly so that the advances in science allow the further development of women's soccer (Becerra-Patiño & Escorcia-Clavijo, 2023). The above-mentioned reflects the importance of research to develop studies focused on the characterization of sociodemographic

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variables and their relationship with physical variables (Becerra et al., 2023) and the study of morpho-functional characteristics in response to game positioning in U-15 players (Becerra et al., 2022). This same research strengthens the development of women's soccer in a context such as Colombia.

Likewise, there have been several studies that have been carried out to analyze the influence that physical variables associated with performance have on female soccer players (Datson et al., 2014; Sanz & Frattarolla, 2017; Hammami et al., 2019; Becerra Patiño, 2021a; 2021b). Many of these variables are related to the analysis of repeated sprint sequences during women's soccer matches using fixed and individual speed thresholds (Nakamura et al., 2017), acceleration and deceleration profiles of elite female soccer players during competitive matches (Mara et al., 2017), relationships between sprinting, agility and jumping ability in female athletes (Vescovi & McGuigan, 2008) and, finally the study of physiological characteristics of projected starters and non-starters in outfield positions in first division soccer players (Risso et al., 2017).

At the same time, there is literature with detailed descriptions of the most crucial performance variables in women's soccer. These have been investigated from the comparison of aerobic performance and body composition in response to game positioning in professional female soccer players (Barrera et al., 2022), anthropometric and capacitative analysis of players of the senior women's national team in Ecuador (Manangón Pesantez et al., 2022), analysis of the running pattern in female soccer players on artificial and natural grass (Ariza-Viviescas et al., 2020) and the importance of physical qualities for speed and change of direction ability in elite soccer players (Emmonds et al., 2019).

Precisely, the ability to develop actions at high intensity depends on the ability to integrate speed and changes of direction, which is positively correlated with match physical performance, measured by very high-intensity running and sprint distance (Rampinini et al., 2007; Okholm et al., 2020). However, although there is much evidence to describe performance indicators associated with physical abilities in elite female soccer players, more work still needs to be aimed at the youth population. For this reason, the objective of this study was to analyze the relationship between the physical variables of a squat jump, countermovement jump, counter movement with arms, right leg-left leg asymmetry, hamstring strength, change of direction, and speed in 5, 10, and 15 meters as an influence of being a starter and non-starter in a Colombian women's youth national soccer team.

Material & methods

Methodological Design and statistical analysis

This investigation consists of a quantitative approach study, descriptive-correlational study type, and non-experimental Design (Monje, 2011). The descriptive and inferential phases were considered for the statistical analysis. The statistical analysis was performed by Version 4.1.0 of the ® program.

Descriptive statistics were performed, in which the primary measures of central tendency were reviewed, such as mean, median, standard deviation, and quartiles. Next, a bivariate analysis was performed for each of the variables. Finally, a boxplot was made for these bivariate analyses to understand where this study will go. Subsequently, due to the sample size, a nonparametric test was run to see if there was a significant difference between the variables depending on whether it was a headline.

Participants

The population comprised the players of the Bogota under-17 soccer team. Twenty-three players participated in the study with an average age of 17.12±0.93 years, a height of 163.84±4.70 cm, and a body mass of 56.56±7.45 kg. Likewise, the measurements requested by the "My Jump 2" application were taken, which consisted of leg length (100.72±6.10 cm), squat height at 90° (66.61±6.04 cm), and lever (1.19±0.04 cm). The type of sampling is by convenience, given that the selection of the sample followed the parameters of the research group and the objectives of the study.

Thus, the sample was selected in a non-probabilistic manner, having as a reference that each of the 23 selected athletes met the inclusion criteria, which were: i) to be a representative player of the Bogotá national team for the national tournament organized in 2022, ii) to have a minimum experience of three years playing competitive soccer, iii) to fill out and sign the informed consent, iv) to present health affectations during the process and v) not to have previous injuries in less than six months, neither an upper nor lower limbs to guarantee the reliability of the results and safeguard the integrity of the athlete. In turn, the exclusion criteria were: i) not complying with each one of the evaluations performed and ii) not being selected from the list of 23 players who represented Bogota in the national U-17 tournament.

Each participant signed the informed consent form, agreeing to participate voluntarily in the study. A meeting was held to fill out the consent form, in which they were informed of the scope of the study and the procedure, as well as the benefits and effects of the evaluations. It is also necessary to mention that each evaluation was developed under the principles established by the Declaration of Helsinki (World Medical Association, 2013) and considering resolution number 8430 of 1993 (Colombian Ministry of Health), which establishes the scientific, technical, and administrative standards for health research using non-invasive procedures.

Instrument

An Omron scale (Kyoto, Japan) was used for weight determination, and height was evaluated with a Seca 213 portable stadiometer (Hamburg, Germany), which has an accuracy of 0.1 cm. The selected method for the evaluation of SJ, CMJ, and CMJB strength was used the cellular app through "My Jump 2" video camera recording, which has an intraclass correlation coefficient = 0.997, $p<0.001$; Bland-Altman bias =1.1±0.5 cm, $p<0.001$ and validity for height r= 0.995, $p<0.001$ (Balsalobre et al., 2015; Gallardo-Fuentes et al., 2016). Asymmetries were assessed from single-leg countermovement jumps (SLCMJ) from the smart app, concordance between test sessions for jump height during single-leg high jump (Kappa = 0.72) (Bishop et al., 2022). Changes of direction (CODS) were evaluated through the COD-Timer iPhone app, which shows a total time measurement (r=0.964; 95 % confidence interval (CI) =0.95-1.00; standard error of the estimate =0.03 s.; $p<0.001$) (Balsalobre-Fernandez et al., 2019) and to measure running mechanics the Runmatic iPhone app was used, degree of correlation (r=0.94-0.99, $p<0.001$) (Balsalobre-Fernández et al., 2017).

Controlling biases

The research group considered three essential aspects to ensure the success of the evaluations. Firstly, to develop pilot tests to familiarize themselves with this application, mainly to ensure homogeneity in data collection. On the other hand, body mass and height collection was done using calibrated equipment. The second point was focused on standardizing a specific warm-up before the development of the test, which consisted of five minutes of joint mobility and adaptive exercises for each of the evaluations. Thus, the research group's work was divided to direct the warm-up, test evaluation, and data recording. Ultimately, the third aspect was related to evaluating and collecting information. Thus, each player participating in the study was evaluated according to the list the coach in charge provided. The recording of the data according to the value achieved in each test by each subject was completed exclusively by the research group members, thus guaranteeing their confidentiality.

Procedure

The evaluations were carried out in two weeks, with a test every other day. These evaluations were developed in the pre-competitive period prior to the U-17 national tournament. Data was collected through the squat jump test (SJ), countermovement jump (CMJ), countermovement jumps with arms (CMJB), 5-0-5 direction change test (COD TIMER), asymmetries were evaluated from single leg countermovement jumps (SLCMJ), 5, 10 and 15-meter running mechanics (Runmatic) and hamstring strength (Nordics). For this purpose, the "My Jump Lab" application was used.

There, to start with the evaluations, in the first session, the weight, height, and data requested by the device were evaluated, which were: name, weight in kilograms, and leg length in extension taken in centimeters from the trochanter of the right side to the ground, the distance in centimeters executing a 90° squat, taking the same reference points of the leg in extension and lever.

The cell phone used for the test was the iPhone 11 (USA). A schedule of activities was designed to carry out the research. Initially, it began with the development of the pilot test, seeking to familiarize the research group with the correct use of the "My Jump Lab" application.

The following protocol was established for each assessment: 1. The test was set up with the respective materials (cell phone, tripod), where the camera was placed two meters away from the reference point where the athlete was located and at the height of 40 centimeters concerning the ground, 2) the recording was taken on synthetic grass, 3) the specific eight-minute warm-up was developed for each athlete, 4) each player was called one by one, 5) two repetitions were taken for each test to each player, 6) once the video was taken, the analysis of the same was carried out.

Results

Table one reveals the measures of central tendency, showing the differences between the starting players and the non-starters. For body mass and height, it is found that the non-starter players are taller (164.57±4.34 cm) and heavier (58.24±9.40 kg). Concerning jumping ability, it is found that the starting players have better values in each of the jumps: SJ (31.10±5.53 cm), CMJ (40.19±3.46 cm), and CMJB (35.68±3.09 cm), with the CMJ being the test that showed the highest value in both groups.

Regarding the values of the asymmetries between the right leg-left leg, there is a better performance expressed by the starting players, both in left contact time and flight time with both legs. For the production of strength and torque of the hamstrings through the evaluation of the Nordics test, it is found that the initial players also show better values (329.20±44.87 N) compared to the non-initial players (319.14±62.92 N).

On the other hand, in the change of direction test evaluated through CODTimer, it was determined that the initial players took less time to cover the distance of 10 meters with stop (3.106±0.154 s), better average speed (7.651±0.255 m/s), and a lower COD deficit.

Finally, in the speed test, it is found that it is the non-starter players have better records in the different sections of 0-5 meters (1.624±0.102 s), 5-10 meters (0.853±0.034 s), and the total time to run the 15 meters (3.179±0.087 s) compared to the starter players (3.247±0.206 s). On the contrary, the initial players are better than the non-starter players in the third record of the speed test, between 10-15 meters (0.694±0.045 s).

Table 1. Measures of central tendency for each variable related to age, height, weight, asymmetric strength, hamstring strength, CODTimer, and speed.

	starter	count	mean	std	min	25%	50%	75%	max
Age	No	11.0	17.509800	1.05	15.485284	17.033539	17.453799	18.168378	19.115674
	Yes	11.0	17.434634	0.83	15.726215	16.996578	17.508556	18.088980	18.647502
Height	No	11.0	164.57	4.34	157.2	162.8	164.0	165.35	173.5
	Yes	11.0	162.56	3.16	156.0	161.8	163.2	164.35	167.0
Body mass	No	11.0	58.24	9.40	50.4	51.9	54.2	61.7	81.3
	Yes	11.0	54.87	4.66	48.2	51.9	54.3	56.8	63.8
Strength									
SJ	No	11.0	28.88	2.48	25.2	27.7	28.4	29.87	34.3
	Yes	11.0	31.10	5.53	24.8	26.7	29.1	35.75	40.0
CMJ	No	11.0	38.39	5.12	32.10	33.56	37.77	43.70	44.74
	Yes	11.0	40.19	3.46	34.84	39.16	40.68	40.91	46.99
CMJB	No	11.0	34.58	2.98	29.1	32.83	34.80	35.88	40.0
	Yes	11.0	35.68	3.09	31.7	33.80	34.84	37.13	42.3
Asymmetry									
Contact asymmetry right	No	11.0	334.45	61.67	242.0	293.5	338.0	350.0	442.0
	Yes	11.0	351.36	51.95	258.0	329.0	350.0	379.5	450.0
Contact asymmetry left	No	11.0	304.90	56.03	217.0	271.0	300.0	331.0	421.0
	Yes	11.0	332.27	48.94	250.0	300.0	325.0	354.0	410.0
Flight asymmetry right	No	11.0	369.27	40.22	312.0	333.5	375.0	389.5	433.0
	Yes	11.0	388.00	40.68	312.0	381.0	388.0	396.0	472.0
Flight asymmetry left	No	11.0	366.72	26.69	325.0	348.0	371.0	387.5	400.0
	Yes	11.0	388.00	40.68	312.0	381.0	388.0	396.0	472.0
Hamstring Strength									
Nordics	No	11.0	319.14	62.92	225.4	279.05	312.6	357.7	426.2
	Yes	11.0	329.20	44.87	262.8	297.65	319.2	368.9	391.6
CODTimer									
Total time	No	11.0	3.106	0.154	2.88	2.970	3.12	3.22	3.34
	Yes	11.0	3.050	0.143	2.81	2.955	3.02	3.16	3.30
Average speed	No	11.0	7.651	0.255	7.26	7.435	7.72	7.88	7.95
	Yes	11.0	7.751	0.248	7.39	7.555	7.78	7.920	8.17
Contact time	No	11.0	342.41	170.47	100.35	206.04	367.87	462.08	600.25
	Yes	11.0	281.00	109.73	120.83	222.71	273.47	339.37	450.38
COD deficit	No	11.0	1.489	0.187	1.20	1.345	1.53	1.615	1.77
	Yes	11.0	1.475	0.170	1.19	1.400	1.48	1.580	1.72
Velocity									
Time 0-5 meters	No	11.0	1.624	0.102	1.42	1.55	1.65	1.695	1.77
	Yes	11.0	1.681	0.146	1.53	1.58	1.64	1.710	1.98
Time 5-10 meters	No	11.0	0.853	0.034	0.79	0.83	0.87	0.87	0.90
	Yes	11.0	0.870	0.043	0.80	0.84	0.86	0.90	0.95
Time 10-15 meters	No	11.0	0.700	0.068	0.61	0.65	0.69	0.76	0.81
	Yes	11.0	0.694	0.045	0.63	0.66	0.68	0.74	0.76
Total time 15 meters	No	11.0	3.179	0.087	3.04	3.135	3.19	3.215	3.31
	Yes	11.0	3.247	0.206	3.06	3.075	3.21	3.305	3.67

However, although the measures of central tendency reveal differences between the starting and non-starting players, the significance tests (p=0.05) do not reveal statistical differences for any of the variables analyzed in this study. Table 2 shows that the only variable that becomes significant with a significance value of 10% (p=0.1) is the contact in the proper leg-left leg asymmetry test.

Table 2. Significance values for each of the variables analyzed.

N°	Variable	Statistics	p value
1	Age	0.052821	0.818226
2	Height	0.972372	0.324089
3	Body mass	0.242956	0.622080
4	SJ	0.182487	0.669245
5	CMJ	0.318917	0.572259
6	CMJB	0.475924	0.490275
7	Contact asymmetry	2.805393	0.093948
8	Flight asymmetry	0.621615	0.430448
9	Nordics	0.182178	0.669509
10	Average speed	0.787176	0.374955
11	Contact time	0.729122	0.393168
12	COD deficit	0.026980	0.869530
13	Time 0-5 meters	0.242818	0.622178
14	Time 5-10 meters	0.394947	0.529711
15	Time 10-15 meters	0.017336	0.895249
16	Total time 15 meters	0.390693	0.531936

Discussion

The objective of this study was to analyze the relationship of the physical variables of the Squat Jump, Counter Movement Jump, Counter Movement with arms, right leg-left leg asymmetry, hamstring strength, change of direction, and speed in 5, 10, and 15 meters as an influence of being a starter and non-starter in a Colombian youth women's soccer team. Findings in various investigations have reported that there are differences in the expression of performance throughout a competitive season (Kraemer et al., 2004) concerning the muscular stimulus that occurs throughout a match (Stevens et al., 2017), styles of effort manifested by starting players versus non-starters (Bradley et al., 2014).

Soccer is a sport loaded with uncertainty, and the competition's demands and requests generate the players' adaptations in that same way. Consequently, the manifestation of sports performance may vary among players. The scientific literature has reported that there are differences between initialist and non-starter players when evaluated in competition, demonstrating that non-starters covered a greater match distance within categories >3.3≤4.2 m/s, >4.2≤5 m/s and >5≤6.9 m/s, and, the average values of acceleration and deceleration were similar for initialists and non-starters (Giménez et al., 2019).

On that same track, the study developed by Jaspe et al. (2017) revealed that performances not only differ between starters and non-starters in response to physical performance but to the positive or negative changes that can be produced by the pace of play and other factors that condition the athletes' responses.

Soccer is a sport that requests many capabilities in favor of a collective solution; the ability to change direction is essential to adapt to changing game situations. However, some studies refer that there are no differences between the accelerations and decelerations of starters and non-starters, reasons that may be due to the dominance of these capabilities by both groups of players and the high volume of specific technical training (Anderson et al., 2016). These results can be contrasted with those found in the present study, referring that no differences were found in strength capacities and change of direction between starters and non-starters.

Other studies have detailed that there are differences between the manifestations of performance expressed in competition and training (Hoff & Helgerud, 2004; Giménez et al., 2020), specifically in actions related to changes of direction, speed, and strength, so that the manifestation of the capabilities in training does not necessarily reflect what is requested by the competition. In this sense, this type of study is essential in the Colombian context to relate the demands of players in training between starters and non-starters in order to be able to relate this performance in competition in future studies. About women's soccer, it was found that the study developed by Risso et al. (2017) reveals that in Division I female soccer players, no statistically significant differences were reported for the tests of long jump, 30-meter sprint with intervals of 0-5, 0-10, 0-30 meters), pro-agility and the Yo-Yo intermittent recovery test level I, a similar case to the results found in the present study with female youth soccer players where no statistically significant differences were found in the jump strength tests in SJ, CMJ, CMJB, asymmetries, change of direction and speed in intervals 0-5, 5-10 and 10-15 meters. These findings related to not finding significant differences between starting and non-starting players, may respond to the physical qualities of the players themselves (Lockie et al., 2016) and the development of their sporting processes that, in one way or another, are related to the development of their sporting processes.

In virtue of what has been found, the fact that starting and non-starting players show similar performance may allow for greater tactical flexibility demanded by the demands of the competition (Hencken & White, 2006). The COD capacity is a necessary element to evaluate in female soccer players since it has been reported that up to a total of 1300 changes of direction can be developed per game, and the evaluation of these measures may allow a better understanding of the athlete's performance (Lockie et al., 2016).

Conclusions

According to the objective set for this research, the variables under study do not show that there are differences between starting and non-starting players.

Thus, in the present study, it is found that the starting and non-starting players show similar physical performance evaluated from strength, asymmetries, hamstring strength, change of direction, and speed, which leads to thinking about the importance of other factors beyond the physical in the sports performance of women's soccer players. This demonstrates the importance at the sports level of a women's team, where both the starting players and the non-starting players must have similar physical performances to meet the demands of the competition.

The findings of the present research ratify the need to continue deepening the performance evaluation for female soccer players, leading to think that the performance of the player depends on many factors that must integrate the physical with other types of indicators, processes, and capabilities, leaving the door open to continue investigating other groups of variables that integrate the sporting performance of female players—seeking to establish differences and similarities to continue promoting knowledge about the female soccer player. This is the first study in women's youth soccer in Colombia that sought to evaluate the differences between starting and non-starting players based on physical variables. This allows us to lay a conceptual and research foundation that can help to build lines of research that focus more attention on the sporting performance of female soccer players in the various categories and sporting levels.

Limitations

The study's main limitations focus on not considering other performance variables associated with physical capacities, such as aerobic power and sprint repetition capacity, among other variables.

Recommendations

For future studies that seek to differentiate the variables, capacities, and processes that differentiate the sporting performance of starting players from non-starters, it is suggested that it could be evaluated from longitudinal studies that help to clarify how performance changes over time and that, in turn, consider physiological tests. Likewise, it would be essential to consider the performances achieved in the competition and compare them with those expressed in the performance evaluations made outside the competition. Thus, it would be possible to integrate whether the capacities evaluated in training correspond to the demands of the competition.

Conflicts of interest The authors have no conflict of interest

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