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RESEARCH ARTICLE

Physiological, Morphological Characteristics and Blood Profile of Female Elite Brazilian Soccer Players According to Position

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Abstract:

Background: This study was carried out with the aim of showing the physiological and morphological characteristics of women's soccer of a country assigned as level 1 by FIFA.

Purposes: The first aim was to identify the performance parameters and blood profile found among elite female soccer players. The second aim was to examine if there were any systematic differences between players assigned to different playing positions.

Methods: Thirty-six elite female soccer players (age: 23.7±3.5y; weight: 61.9± 5.7kg; height: 165.7±6.2cm) from Brazilian national time participated in this study. All athletes underwent a set of laboratory tests (cardiopulmonary exercise test, skinfold measurements, Wingate test, sit-and-reach test, and blood biochemical tests).

Results: maximal oxygen uptake (53±3.9 mL/kg/min), second ventilatory threshold (11.5±0.8 km/h), body fat (14.1±2.9%), Wingate anaerobic test (peak power:9.5± 0.8w/kg; mean power: 7.3±0.4 w/kg and fatigue index: 55.5± 4.9%), flexibility test [sit-and-reach] (18.1±2.9 cm) and biochemical parameters of blood (haemoglobin:13.9±0.3 g/dL; iron: 85.2±12.6µ/dL; calcium: 9.2±0.5 mg/dL; total cholesterol: 204.7±34.7 mg/dL; high-density lipoprotein (HDL) cholesterol: 50.7±3.6 mg/dL; low-density lipoprotein (LDL) cholesterol: 125.8±23.3 mg/dL; triglycerides:96.8±18.5 mg/dL). We can see that although some studies have used the position profile based on morphological skills and athletic performance, this pattern is not absolute and does not always include a high-level result in women's football (soccer).

Conclusions: The finding from the results gives standards and a baseline for an appreciation of our data by coaches, trainers, therapists, players, and future investigators.

Keywords: Exercise, Athlete, Maximal oxygen uptake, Playing positions, Blood analyses.

Introduction

Football (soccer) is played in all parts of the world and is undoubtedly the number one sport on the globe [1]. Women's soccer has flourished in recent decades, and Fédération Internationale de Football Association (FIFA) is helping to propel the sport forward around the world. The women's football (soccer) ecosystem is currently receiving increasing momentum from world associations [1]. FIFA has revealed several development activities, including the FIFA Women's Development Program, which allows member associations to have access to additional resources and expertise. However, there are still challenges ahead in the scientific area for women's soccer and its growing community.

The identification and measurement of morphological and physiological qualities are essential for elite women soccer and will provide standards and a baseline for physical trainer, coaches, players, and future researchers. The scientific literature on the female physiological response to high-performance physical activity is still being studied. Generic studies, as well as specific disciplines in other sports, have been published, but there are still few studies on women's football (soccer) considering its evolutionary dimension. Investigations on women soccer specifically related to the topics of player characteristics of the game has considerably increased in recent years due to the enhanced popularity of the women's game worldwide, although they are not yet as numerous as scientific investigations on men´s soccer [1].

Physical capacity diagnostics of soccer players is a necessary part of the professionally conducted training process. To optimize the physical fitness process, it is necessary to have an insight into the current state of all soccer players' skills, especially their functional capabilities [2].

Nowadays, the functional capacity levels required to meet the needs of the top-level sport are becoming greater, and the situation regarding women's soccer is no exception. Therefore, knowledge of the physiological profile of top-level athletes is important for sports scientists and coaches. Such information may be helpful as a reference point for enabling adjustments, comparisons, and improvements to physical fitness. The results from physiological profile thus form a tool to motivate athletes to achieve excellence through a multidisciplinary approach which will lead to talent identification in soccer and physical attributes to be a routine in the sport. Performance parameters as maximal oxygen consumption (VO2max), ventilatory threshold, body fat, flexibility, and anaerobic power among others should be monitored regularly.

Therefore, the main aim of this study was to describe the performance parameters and blood profile found among Brazilian elite female soccer players.

The second aim was to examine if there were any systematic differences between players assigned to different playing position.

Materials and methods

Study design and participants

This study is descriptive and cross-sectional. The research was performed for convenience on a sample of 36-elite female soccer players from Brazilian women's soccer team can be seen in Table 1. The athletes had an experience of 6 ± 2 years (range: 4-15 yr) in organized soccer training and an average of 10 ± 2 hours per week of supervised training in their teams, and at least one game per week took part in this study. The players were in phase 2 (competitive phase) of the periodization cycle. The assessment in this period made it possible to identify needs and corrections in physical performance variables. All athletes were registered as professionals in the Brazilian Football (Soccer) Confederation (CBF), they were in Championship for their clubs in April were called for participation in a major FIFA tournament. The following inclusion criteria were: (i) actively participate in sports competitions; (ii) be formally registered with a local, regional or national sports federation; (iii) have training and competition as their main activity (way of life), (iv) focus of personal interest, dedicating several hours in all or most days to these activities, generally exceeding the time allocated for other types of professional or leisure activities (v), and no locomotor limitation capable of affecting performance in the exercise test. All athletes were interviewed before the tests to validate the history and to assess the current health status. All subjects were free from cardiovascular, pulmonary, and metabolic diseases after medical assessment. All female soccer athletes were informed about the potential risks and discomforts associated with the experiment and, after explaining the objectives of the study and its importance, the players signed an informed consent form for participation. University of São Paulo, School Medicine Ethics Committee approved this study for Research on Human subjects (case #1251/07). The study followed the recommendations of Declaration of Helsinki (1975) for the study in humans and follow ethics, consent, and permissions practices.

Testing procedure

Before each testing session, subjects were instructed not to eat for at least 2 hours before testing and not to drink coffee or beverages containing caffeine for at least 8 hours before physical testing. Players were also asked to follow a nutritional plan developed to ensure an adequate carbohydrate intake in the week before testing. To avoid the influence of one another test, all tests were performed on alternate days, except for blood, fat, and flexibility tests, respectively. All testing procedures were completed in April, before the travel to a FIFA tournament.

Measurement of body fat percentage

The percentage of body fat was investigated by means of skinfold measurement, using the Cescorf device (Cescorf® instruments, Brazil). The anatomical points were measured three times, always on the same side of the body (the right side) and by the same evaluator. The sites where the body fat measurements were taken include the subscapular, triceps, supra iliac, and abdominal skinfolds, measured using standard procedures. The percentage of body fat was determined according to the Yuhasz the formula, as modified by Faulkner, by means of the following equation: [% body fat = % of four skinfolds * 0.153 + 5.783] [3].

Flexibility Test (sit-and-reach)

For the flexibility evaluation was carried out using a traditional protocol (sit-and-reach), as follows. Before starting the test, all the players performed a five-minute warm-up consisting of stretching exercises and a trial practice of the position. They removed their shoes and sat on the floor with their heels against the edge of the equipment and their legs fully extended on the floor. They launched slowly forwards with the palms of their hands downwards, in order to touch a graduated ruler (marked from -25 to +25 cm) with their fingertips. They needed to hold the position for two seconds for the test to be considered valid. Ballistic movements were not permitted and the fingertips had to remain level and the legs flat. This reaching action was done three times in total, and the maximum distance reached (best of the three attempts) was recorded as a measurement of the individual's flexibility. This test measured only the flexibility of the lower back and extensibility of the hamstring muscles. The same investigator conducted all these measurements. The flexibility test (sit-and-reach) was performed utilizing Wells-Dillon apparatus: a box of height 28.5 cm, width 31 cm and length 40 cm. The score was recorded as the distance before (negative) or beyond (positive) the toes (cm) [4].

Biochemical parameters

Blood samples for assessing haematological and biochemical parameters were collected in plain vacuum tubes from a forearm vein with minimum stasis. The individuals were in a seated position during this procedure and had previously remained at rest for approximately 15-min. The samples were taken between 8:00 and 9:30 am, after overnight fasting and at least 24 hours since the last workout. An aliquot of 20 mL from the venous blood samples was immediately mixed with EDTA the solution to prevent clotting for blood testing. The rest of the sample was left to coagulate for 30-min at room temperature and was centrifuged at 1500 × g for 10 min in order to separate the serum for biochemical analysis. The serum was then stored at -20°C in our hospital laboratory. The following parameters were measured: haemoglobin, glucose, total cholesterol, fractions of cholesterol (HDL-c and LDL-c), triglycerides, iron, and calcium [5]. Blood parameters were determined by standard clinical laboratory techniques.

Cardiopulmonary exercise testing

The exercise capability was tested working on a motor-driven treadmill (ATL 10200, Inbramed® Instruments, Porto Alegre, Brazil) using a continuous graded exercise test while the grade was kept constant at 3% (1.71°) to replicate outdoor over-ground running on grass [6]. In this protocol, the players remained at rest for two minutes and then warmed up for four minutes at velocities of 4, 5, 6, and 7 km/h (one minute each). The test began at 8 km/h and the velocity was increased by 1 km/h every two minutes until they reached voluntary fatigue. The subjective perception of their effort was determined for each test period using Borg's 15-point linear scale for a rating of perceived exertion. Verbal encouragement was given to the athletes to help motivate them to perform up to their maximum limits throughout the test. The test was terminated when the female players were unable to keep up the pace with further increments in exercise intensity. During the test air temperature ranged from´20°C´ to ´24°C´ with the relative air humidity ranging from 50 to 60%. Ventilation (VE), oxygen uptake (VO2), carbon dioxide production (VCO2) and respiratory exchange ratio (RER) were continuously monitored by means of a breath-by-breath metabolic cart (Vmax 29c, SensorMedics®, Yorba Linda, CA, USA). Expired volume was measured at the mouth with a pneumotachograph, which was calibrated with a 3-L calibration syringe (Hans Rudolph®Inc, Kansas City, USA). The gas analysers were also calibrated before and after each test in relation to room air and medically certified calibration gases (16% and 26% O2 and 4% CO2, respectively). During the incremental exercise test, heart rate rhythm was monitored using a 12-lead ECG (6.4, HeartWare® Instruments, Belo Horizonte, Brazil) and blood pressure was measured and recorded every 2-min. All values were averaged over 30-s periods. All stress tests were performed with the presence of a sports cardiologist.

Maximal oxygen uptake (VO_2max) was achieved if two of the following criteria occurred: a plateau in VO_2 (< 2.1 mL/kg/min) with an increased work rate between the penultimate and the last stage of the test, the respiratory exchange ratio ≥ 1.10, the HR within 10 beats of age-predicted maximum (208 - [0.7*age]), volitional fatigue, and more than 18 on Borg's scale.

Second ventilatory threshold, VT_2, (i.e., respiratory compensation point), was determined as the point which ventilation (V_E), the ventilatory equivalent of carbon dioxide (VE/VCO_2), the ventilatory equivalent of oxygen (VE/VO_2), and end-tidal oxygen pressure ($PETO_2$) concomitantly increase and end-tidal carbon dioxide pressure ($PETCO_2$) decreased. Those two variables were related to the power outputs above this threshold: hyperventilation with respect to carbon dioxide production had to occur [7].

Wingate anaerobic test

The estimated anaerobic alactic and lactic power, as well as the fatigue index, were evaluated noninvasively using the Wingate Anaerobic Test (WAnT). The equipment used was a computerized bicycle (Bike, Cybex®, USA) with the Wingate Power software program. The players were also asked to refrain from intensive exercise sessions on the day before testing. The seat height was then adjusted according to individual preference (approximately 15° knee flexion). Before performing the test, the players underwent a three-minute warm-up consisting of an exercise with varying cycling velocity (60 and 100 rpm), with a workload of 50-w. After a one-minute rest, when the tension was set (7.5%, 0.075 kg) of body mass), the player began pedalling with maximal effort and speed, with consistent verbal encouragement provided by the examiner, for a timed 30-sec interval. The verbal encouragement was personalized (i.e., the names of the subjects were used) and positive in nature (e.g., "go, go, go!", "you can do it!", "push through it!", etc.) [8]. The data was subsequently processed; taking a running average of 0.5-s. Relative peak power (PP) was defined as the highest power output during the test averaged over 5 consecutive seconds during the 30-s test. Generally, this occurred within the first 5 to 6-s. Relative mean power (MP) was determined from the average power output of six successive 5-s periods in the 30-s test. Fatigue index (FI) was calculated as a percentage of peak power minus minimum power divided by peak power and multiplied by 100. To prevent dizziness and syncope following the exertion of the test, each subject pedalled for 2-3 minutes against a light resistance immediately after the test to cool down.

Statistical analysis

The resulting data for the normality of distribution of all the examined groups was tested using the Kolmogorov-Smirnov test. Thus, descriptive statistics were calculated and reported as mean ± standard deviations (SD) in general and for each playing position (goalkeepers, centre-backs, midfielders, and forwards) for each variable. If the data followed a normal distribution, the differences in the characteristics of the variables between the groups were compared using a one-way ANOVA, followed by a Tukey post hoc test. If the data were not found to follow normality, the non-parametric Kruskal-Wallis test was used, followed by the Mann-Whitney test. The level of significance was set at $p \leq 0.05$ for all statistical analyses. If differences were detected, a Tukey post hoc test was assessed to determine which playing positions were expressing these differences. Statistical analyses were performed using Sigma Stat (version 3.5; Systat Software, Inc, Point Richmond, CA, USA). A p-value < 0.05 (95%) was considered significant.

Results

Age, weight, height, body fat and flexibility

No significant differences were observed in age values between the positions. The group was very homogeneous. The mean age was similar among the players ranging from 19-31 years (Table 1). Significant differences were observed among weight. The FB had significantly ($p<0.05$) higher weight values than MF players. The weight among positions ranged between 52-71 kg (Table 1). We also observed that the height values of the goalkeepers was significantly ($p<0.05$) higher than those of midfield players. The height among positions ranged between155-180 cm (Table 1). The body fat among positions ranged between 11-19% (Table 1).The FB had significantly ($p<0.05$) higher body fat values than GK, FW and, MF players; and CD higher than GK and FW players. The flexibility among positions ranged between13-23 cm (Table 1). The GK had significantly ($p<0.05$) higher flexibility values than FB players (21.5 vs. 16 cm), but there were no differences among any positions.

Table 1: Baseline physical characteristics among players according to playing position and in general of the Brazilian women's soccer players (Mean ± SD)

Field Playing Position	Age (y)	Weight (kg)	Height (cm)	Body Fat (%)	Flexibility (cm)
GK (n=6)	23.0±5.6	63.5±0.7	171±1.4 *	11.5±0.7	21.5±0.7 *
CD (n=6)	23.7±5.2	65.0±6.9	170.2±6.8	15.5±1.2 *	17.2±2.8
FB (n=6)	24.2±2.6	67.0±5.5 *	168.5±5.7	17.5±1.2 *	16.0±2.1
MF (n=10)	24.0±3.4	57.8±5.5	161.1±5.2	13.5±1.0	18.1±2.9
FW (n=8)	23.2±3.5	59.8±4.4	163.2±4.0	12.6±0.8	19.2±3.1
All players (n=36)	**23.7±3.5**	**61.9±5.7**	**165.7±6.2**	**14.1±2.9**	**18.1±2.9**

ANOVA with Tukey post hoc Test was applied among positions * $p < 0.05$ (body mass: FB > MF), * $p < 0.05$ (height: GK > MF), * $p < 0.05$ (body fat: FB > GK, FW and MF and CD > GK and FW), * $p < 0.05$ (flexibility: GK > FB). Legend: GK, goalkeepers; CD, central-defenders; FB, Fullbacks; MF, Midfielders; FW, Forwards

The maximal oxygen uptake (VO_2max): The mean VO_2max (53ml/kg/min) of this group of players was similar to that found in elite teams. The VO_2max among positions ranged between 48.2-61.7 mL/kg/min during the maximum exercise testing (Table 2). There was a significant difference ($p<0.05$) in VO_2max among the positions. In MF, VO_2max was 12% higher ($p<0.05$) than GK and was 10% than CD players (Table 2).

Table 2: Performance parameters among players according to playing position and in general of the Brazilian women's soccer players (Mean ± SD)

Field Playing Position	VO_2max (mL/kg/min)	sVO_2max (km/h)	sVT_2 (km/h)	VO_2VT_2 (%)	HRVT_2 (beats/min)
GK (n=6)	49.0±0.2	13.1±1.0	10.5±0.7	77.5±3.5	176.2±2.8
CD (n=6)	49.7±1.2	13.9±1.5	11.0±0.8	79.7±2.2	176.0±3.9
FB (n=6)	52.2±4.5	14.1±1.2	12.2±0.8	84.0±4.9	183.2±3.0
MF (n=10)	55.4±4.3*	14.5±1.3	12.5±0.5 *	86.0±4.7*	177.5±5.7
FW (n=8)	54.0±3.6	14.1±1.2	11.2±0.4	84.4±6.3	181.4±3.9
All players (n=36)	**53.0±3.9**	**13.5±1.2**	**11.5±0.8**	**82.3±4.3**	**179±6.1**

ANOVA with Tukey post hoc Test was applied among positions * $p < 0.05$ vVT_2 (MF > GK); %VO_2VT_2 (MF > GK); VO_2max (MF > GK and CD).

Legend: GK, goalkeepers; CD, central-defenders; FB, Fullbacks; MF, Midfielders; FW, Forwards; speed at second ventilatory threshold (sVT_2), percentage of maximum oxygen uptake at the second ventilatory threshold (VO_2VT_2), heart rate at the second ventilatory threshold (HRVT_2), speed at the maximum oxygen uptake (sVO_2max), and maximum oxygen uptake (VO_2max)

The speed at the maximal oxygen uptake (sVO_2max): The mean peak sVO_2max of female players during exercise testing was (13.5±1.2 km/h), whereas no difference was observed among positions (Table 2).

The speed at the second ventilatory threshold (sVT2): The sVT_2 among positions ranged between 10-13 km/h in VT_2 during the exercise testing (Table 2).Significant differences ($p<0.05$) were observed in sVT_2 values between MF and GK players (+16%; 12.3 vs. 10.5 km/h), MF and CD (+12%;12.5 vs. 11.2 km/h) and, MF and FW (+10%;12.5 vs. 11.2 km/h) (Table 2). In FB players, sVT_2 was 14% higher ($p<0.05$) than GK and was 10% higher than CD players (Table 2).

The percentage of maximum oxygen uptake at the second ventilatory threshold (%VO2VT2): The percentage among positions ranged between 75%-92% of VO_2max in VT_2 during the exercise testing (Table 2). The mean percentage was relatively high among players (> 82%). Significant differences ($p<0.05$) were observed in MF and GK players (86% vs. 77.5%), whereas no difference was observed for other positions (Table 2).

The heart rate at the second ventilatory threshold (HRVT2): The mean HR at VT_2 was relatively high among players (>179 beats/min) and ranged 173-185 beats/min, whereas no difference was found among positions (Table 2).

Wingate anaerobic test: Peak power and anaerobic capacity in relative to body weight (w/kg) were determined for the WAnT in female soccer players.

Relative peak power (PP, w/kg): We did not find differences among positions when muscle power output was expressed in relative values at w/kg. The mean PP observed in this group of players was (9.5±0.8 w/kg) and it was not different among the positions (Table 3). Relative mean power (MP, w/kg): There was a difference among positions. The results in MF players were higher ($p<0.05$) in MP (7.6±0.4 w/kg) compared with CD, FB and, GK, whereas no difference was observed among other positions (Table 3).

Percentage fatigue index (FI, %): The mean FI observed in this group of players was (55.5±4.9%). No significant differences were found among positions (Table 3).

Table 3: Wingate anaerobic test among players according to playing position and in general of the Brazilian women's soccer players (Mean ± SD)

Field Playing Position	Relative PP (w/kg)	Relative MP (w/kg)	FI (%)
GK (n=6)	9.9±1.2	7.0±0.5	57.5±3.5
CD (n=6)	10.1±0.9	7.0±0.2	58.2±2.2
FB (n=6)	9.9±0.8	7.0±0.1	55.2±5.1
MF (n=10)	9.1±0.6	7.6±0.4*	53.1±6.0
FW (n=8)	9.3±0.4	7.5±0.4	55.6±5.7
All players (n=36)	**9.5±0.8**	**7.3±0.4**	**55.5±4.9**

ANOVA with Tukey post hoc Test was applied among positions * $p < 0.05$ MP (MF >CD; MF>FB and MF>GK).
Legend: GK, goalkeeper; CD, central-defenders; FB, Full-Back; MF, Midfielder; FW, Forward
Abbreviations: peak power (PP), mean power (MP) and fatigue index (FI)

Blood profile

The blood and metabolic biochemical parameter's concentration are shown in Table 4. Several of the most important ions concentration at rest in blood, including calcium (Ca), iron (Fe), and haemoglobin (Hb), as too as glucose, fraction high-density lipoprotein (HDL) cholesterol, fraction low-density lipoprotein (LDL) cholesterol, and triglycerides were not found to be altered and were within the normal range. However, we observed isolated in some athletes a higher total cholesterol (>200 mg/dL) above the recommended standard.

Discussion

As the practical application of this study, the authors suggest that determining the functional profile of elite teams around the world can be useful for evaluating technical commissions in addition to having a complete idea of performance indicators for doctors, physiotherapists, fitness trainers, and technical coaches. In short, from a battery of tests coaches and physical trainers must differentiate between the individual and collective physical fitness of the team as too as identify and quantify performance indicators for each type of physical fitness.

The main results from the present study are that the physical capacity of the Brazilian elite female soccer players is comparable to the capacity of players in other countries with a greater culture of women's soccer [11,13-14,16]. Studies of adult players showed that defenders and goalkeepers tended to be the tallest and the heaviest, while midfielders and forwards tended to be the shortest and the lightest, also verified in our work [9]. In our study, weight and height of female fullbacks and goalkeepers were higher than the midfielders and this finding is similar to another studies [9, 10]. The average age did not differ among positions (Table 1).

It is known that VO_2max is important for achieving athletic performance in soccer [11,12]. The mean values for VO_2max in the present study achieved levels between 48.2 and 61.7 mL/kg/min and on average, these players achieved values of˜53 mL/kg/min and were similar to those found among other international-level female soccer players [13-16]. The aerobic level was well-developed and includes international literature for our athletes [15,16]. Our results were not lower than indicated by national-team players'VO_2max values reported for the Danish national team [11]. In the present study, VO_2max, sVO_2max and $\%VO_2max$ at VT_2 for MF players were higher than GK and CD players, probably motivated by connecting constant offensive and defensive transition shifts and covering higher distance during matches and agree with authors [10, 15-16]. Similar results were found by other researchers with female soccer players in past times [17, 18]. Bishop et al. [19] states that a higher VO_2max in soccer is an obligatory condition to prolong high-intensity displacements due to the greater contribution of aerobic metabolism to the performance of late sprinters. Position shared by several researchers [11, 20-21] who verify a faster recovery process in those with higher VO_2max. Therefore, it can be seen in some studies on international sports teams that this physiological parameter ranged from 45.1 to 55.5 mL/kg/min [16, 22]. A study shows an average VO_2max of˜57 mL/kg/min and that women soccer is more competing currently [23]. It can also be said that the profile of activities within women soccer current is more intense than it was a decade passed [24]. Currently, the distance that players cover in matches exceeds 10km with a mean VO_2max about 50 mL/kg/min which demonstrates the physiological development of the female soccer game [24]. VO_2max in soccer players has been correlated with increased work on the field during a match; therefore we believe that this data can be used as a benchmark for training and improvement in physical fitness. It appears that the VO_2max level in well-trained players is dependent on the level of competition [25].

These findings have practical implications for soccer performance, as previous research has indicated that the highest scores in the cardiopulmonary system might be predictive of athletic performance enabling athletes to attack and defend more effectively as likewise as faster recuperation [11,21]. This is important because the endurance capacity of soccer players appears to be related to improvements in the level of play. Thus, it has been shown that players with higher VO_2max are able to be participating in more circumstances during a game. [11,20,26]. National-team players have 5% higher VO_2max than 1st-division players [27]. In modern women's soccer, top-class international players perform more high-intensity running during games than elite players at a lower level [28], and that a relative VO_2max of ˜55 mL/kg/min is sufficient to perform at a high international level in female soccer [27]. Our average result was just 4% below that amount. Therefore, our data on VO_2max in female soccer compare well with the findings founded in the literature on elite female soccer [11, 15-16]. We can briefly state that athletes with higher VO_2max, VT_2, and lower VO_2submaximal as indicator of running economy, in aerobic-anaerobic sports, are able to work at a high percentage of their VO_2max without getting tired quickly [11,19-20].

The percentage of VO_2max at VT_2 has been of great importance for top-level soccer players [20, 29]. VT_2 marks a metabolic transition and supplies physiological support for individualized control over the intensity of the effort performed by players during their training programmes. In the present study, the female soccer players reached VT_2 at 83.1% of their VO_2max, with an average velocity of 11.5 km/h, and HR of 182 bpm (Table 2). These values were slightly below to those found in one study conducted by Krustrup et al. [11], in which at this intensity of workout they found the average speed of 13.4 km/h. In the present study, only midfield players came close to this sea. However, older studies have found higher values, with average values of 13.4 km/h among Danish female players and 14.4 km/h and among Italian female players [29]. Those results were compared with those of top-level male soccer players [29]. Regarding the running speed at VT_2, the only apparent differences between playing positions were that goalkeepers ran significantly slower ($p < 0.05$) than central-defenders, fullbacks, midfielders, and forwards at VT_2. The submaximal aerobic demand in women's soccer is high [11, 30]. The average VO_2 consumed by athletes varies from 77% to 80% with peak values of 96%. In practice, it means that an VT_2 below 75% of VO_2max will have difficulty maintaining the high-intensity of the game [11]. Our findings on VT_2 exceed 83% and agree with the previous statements by Krustrup et al. 2005 [11].

In many sports, like soccer, the players need high power in the legs and high anaerobic capacity. For example, in order to meet the diverse demands of each discipline, athletes must develop various qualities, such as muscular strength and power. This can increase their ability to withstand the high forces and loads on the muscular system during the match, and further decrease their risk of lower limbs injuries [31]. Comparisons of mean values from this study for relative peak power, relative mean power, and fatigue index with those of Baker et al. [32] in women athletes were 14%, 45%, and 2.5% higher, respectively. One possible reason for the smaller results could be that resistance settings equivalent to 8.5% (0.085 kg) have been shown to elicit relative maximal peak power output and relative maximal mean power, respectively. The higher fatigue index in our study (59.9% vs. 53.23%) could be due to anaerobic fitness differences between the subjects or differences in muscle mass [33]. In contrast, a study published with American female soccer players showed similar results to the present study [33]. These differences were most likely caused by physiological adaptations of training and specificity of the energy system predominantly involved in the exercise (Zebrowska et al. 2012). In a table of classification developed for women intercollegiate athletes, the results of this present study were considered average [33]. It is important to point out that soccer is a type of sport that demands long-duration intermittent muscle effort, with intermittent low and high-intensity exercise throughout the match [33]. The WAnT is not a field test but estimates possible deficiencies in anaerobic conditions. It allows planning for training in accordance with the characteristics found in the test, in order to reach higher metabolic efficiency in relation to the given metabolic conditions.

Body fat is another very important variable in controlling physical fitness among high-level sports players. The percentage of body fat is now lower than previously observed and reflect greater training intensity and volume of modern female soccer current [34]. Some studies have demonstrated high degrees of correlation between fat percentage and physical fitness since competitive excellence and adiposity are incompatible [35]. There have been studies investigating the percentage profile of this variable among female soccer players that have found values between 12% and 28% [36] (Martin et al. 2006). The average percentage of fat of 14.1% in the present study is in conformity with the most appropriate values in high-level female players, which is 13.7%-19% [11, 16, 37-39]. Contrary to the study by Sporis et al. [39] that found in midfielders the lowest values of fat, at present study, the lowest values were for goalkeepers and attackers, 11.5% and 12.6%, respectively (Table 1). The fat percentage for the female soccer players in this study was below average according to body fat standards for females [15, 41].

A flexibility evaluation by the Wells and Dillon method was included in the testing protocol to investigate the relationship between flexibility and the risk of injury to the posterior thigh muscles. According to Albert [31] a consistent complaint among soccer players is lower extremity muscle-tendon strains, which account for as many as 34% of all reported soccer injuries. It was observed in the present study that several players presented relatively low levels of flexibility, especially in the hamstring and adductor groups. It is possible that soccer players require more hamstring length to participate in this sport [42]. Flexibility is an important physical quality, particularly when muscles and joints are continually subjected to explosive movements, as in the case of soccer. A joint reduction in flexibility and a 15% strength imbalance in the lower limbs are related to a 2.6 higher frequency of injury [42]. However, there are few studies on soccer flexibility in the literature. Two studies found means of 12.8 cm and 15.4 cm, respectively [43]. The comparative average of the values of the present study was slightly higher (18.1cm vs. 15.4cm and 18.1cm vs. 12.8cm), but lower than the findings among female players in other sports, using the same method, the results were not comparable [44]. It is important to bear in mind that muscle flexibility in the lower limbs of soccer players has important practical implications: (i) higher muscle elasticity increases the efficiency of the movement, and (ii) deficiency of muscle elasticity increases the incidence of muscle injuries. Some researchers [45] demonstrated that soccer players with greater muscle tightness in the hamstrings were at higher risk of subsequent musculoskeletal injuries. Due to the specific physical demands of soccer, the incidence of injuries is significantly higher than in other team sports such as field hockey, volleyball, and basketball [46]. The functional activities required for soccer include acceleration, deceleration, jumping, cutting, turning, and twisting/turning, all of which place great demands on the knee joint. Therefore, it takes balance and flexibility of the muscles around the joints [47].

Blood analysis measurements were made in this group of female soccer players. Several researchers have shown that biochemical and haematological parameters in various sports played by women are influenced by physical training, age, androgen affection on erythropoiesis, field positioning, diet, and matches [40]. However, it could be stated that there is no significant difference in all the biochemical variables, except serum total cholesterol, probably due to no controlled diet (Table 4).

Table 4: Blood biochemical parameters after 12-hour overnight fasting among players according to playing position and in general of the Brazilian women's soccer players (Mean ± SD)

Field Playing Position	Hb ($g{\cdot}dL^{-1}$) **[reference values** [12-16]	Fe^{++} ($\mu{\cdot}dL^{-1}$) **[reference Values** [37-145]	Glucose ($mg{\cdot}dL^{-1}$) **[reference values** [70-100]	Ca^{++} ($mg{\cdot}dL^{-1}$) **[reference values** [8.4-10.2]	Total cholesterol ($mg{\cdot}dL^{-1}$) **[reference values** [120- 200]	HDL-c cholesterol ($mg{\cdot}dL^{-1}$) **[reference values** [> 45]	LDL-c cholesterol ($mg{\cdot}dL^{-1}$ **[reference values** [< 130]	TG ($mg{\cdot}dL^{-1}$) **[reference values** [30-150]
GK	13.3	94.8	84.5	8.9	192.5	49.0	116	107.5
(n=6)	±0.2	±7.5	±6.3	±0.2	±10.6	±1.4	±19.7	±3.5
CD	13.9	92	89.7	9.2	198	51.2	122.2	97.0
(n=6)	±0.1	±12.8	±2.6	±0.5	±36	±2.6	±29.2	±15.6
FB	13.9	91.2	86.5	9.8	206.7	51.0	129.7	87.5
(n=6)	±0.3	±1.9	±2.3	±0.2	±38	±1.4	±21.0	±27.5
MF	14.1	85.9	89.8	9.0	215.8	51.8	140.1	96.6
(n=10)	±0.5	±10	±5.9	±0.5	±29.3	±4.5	±21.5	±22.6
FW	13.9	70.2	88.8	9.2	200	49.6	112.2	100
(n=8)	±0.3	±10.8	±4.2	±0.4	±49.8	±5.4	±21.4	±12.7
All players (n=36)	**13.9**	**85.2**	**88.4**	**9.2**	**204.7**	**50.7**	**125.8**	**96.8**
	±0.3	**±12.6**	**±4.2**	**±0.5**	**±34.7**	**±3.6**	**±23.3**	**±18.5**

ANOVA with Tukey post hoc Test was applied among positions: haemoglobin (Hb), High-density lipoprotein (HDL) cholesterol, Low-density lipoprotein (LDL) cholesterol, Triglycerides (TG), iron (Fe++), calcium (Ca++). Legend: GK, goalkeepers; CD, central-defenders; FB, Fullbacks; MF, Midfielders; FW, Forwards;

The physical fitness level influences the lipid profile once fit individuals engaged in regular physical activity tend to have lower lipid levels (e.g. lower plasma levels of triglycerides and increased high-density lipoprotein cholesterol) [48]. In the present study, the average serum lipid concentration of physically trained individuals was within the normal range. The present observation is congruent with other studies that have shown the baseline level of serum triglycerides and LDL cholesterol lower in physically active women [45]. However, in this study, several athletes had total cholesterol above the reference values which may indicate food with saturated fat (Table 4). Metabolic effects of a soccer match in female players reveal oxidative stress, muscle damage, and biochemical and hormonal variations [40]. These other studies show that medical attention for elite sports players is needed so that their diet can be better adjusted. Gravina et al. [40] verified a higher cholesterol intake (340 mg/day) than recommended (<300 mg) in female players. Epidemiological surveys have shown that serum total cholesterol levels are continuously correlated with coronary artery disease risk over a broad range of cholesterol values [36]. The well-known cardioprotective benefit of regular exercise could be based, at least in part, on a less atherogenic lipid and lipoprotein profile and an enhanced cellular cholesterol efflux [49]. Regular monitoring of these parameters in elite athletes during a competitive season might be useful for detecting possible deficiency, like anaemia or other health problems, in addition to exercise planning and training programming [50]. Overall, our results are within a normal variant and do not provide evidence that female soccer's are more affected by the values of biochemical parameters than sedentary individuals and are in agreement with other studies [5].

Performance in soccer depends upon a myriad of aspects, such as technical, tactical, physical, and mental parameters. As with other sports, soccer is not a science, but science can assist to improve performance and preventing injury [31]. Sport and exercise scientists engaged in soccer research are interested in a multitude of factors that determine the performance of a player as well as the related underlying phenomena that explain how each factor influences that performance. Understanding profiles as rules and methods can be used to prepare a player or team for competition in a professional manner. Profiles are therefore important for coaches to understand the needs of soccer players in the competition in order to maximize performance and minimize the chances of failure. A major limitation of this study is the limited number of investigated subjects in the field positions.

Conclusion

The main finding from the study was that all the results give standards and a baseline for an appreciation of coaches, trainers, therapists, players, and future investigators. The performance parameters and blood profiles of Brazilian female soccer players had been within the normal range just like other elite teams. The differences found between our results and that of other studies on several factors such as: gender, characteristics of the players and level of competitiveness, structure of administrative support of the country, playing conditions, and methodological differences among other possibilities. Therefore, the Brazilian players had general results that were similar to those of world-level female soccer players. However, some data showed that different positions had significant differences in physical capacity and anthropometric parameters, but consistent with previous work. Soccer is dynamic and random, although attempts are made to select and manage the athlete to a specific position based on their physical profile, not always the best results contemplate athletes in relation to morphological and/or physiological differences. It is very important to apply tests performed during the pre-season, in the middle of the season and at the end of the season; the idea is to accumulate data on the evolution of the athlete's performance. We believe that our results can be used as a reference.

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