Daniela Craveiro da Costa

FEMALE SOCCER PLAYER:

body and cardiac size, 4-component body composition, short- and middle-term metabolic fitness, isokinetic strength and goal orientations

Master Dissertation in Youth Sports Training

March 2017

· U C ·

UNIVERSIDADE DE COIMBRA

Faculty of Sport Sciences and Physical Education

University of Coimbra

FEMALE SOCCER PLAYER:

body and cardiac size, 4-component body composition, short- and middle-term metabolic fitness, isokinetic strength and goal orientations

Dissertation submitted to the Faculty of Sport Sciences and Physical Education of the University of Coimbra, for the degree of Master in Youth Sports Training

Supervisors: PhD Manuel João Coelho e Silva and PhD Luis Manuel Pinto Lopes Rama

Daniela Craveiro da Costa

Coimbra, 2017

Costa, D. (2017). FEMALE SOCCER PLAYER: body and cardiac size, 4-component body composition, short- and middle-term metabolic fitness, isokinetic strength and goal orientations. Dissertation for the degree of Master in Youth Sports Training. University of Coimbra. Coimbra, Portugal.

ACKNOWLEDGEMENTS

We are the sum of who we met and all of the moments that we live.

To **Professor Manuel João Coelho e Silva**, thank you for accepting to supervise this study. Thank you for the opportunities and challenges that have been given to me and that made me improve.

To **Professor Luis Manuel Pinto Lopes Rama**, thank you for accepting to supervise the study and for the care, attention and availability that always had towards me.

To **Professor João Duarte** (Hulk), thank you for being a friend always prepared to help and for being such an example of effort and dedication.

To **Professor Joaquim Castanheira**, **Professor Rui Soles Gonçalves**, **Medic Óscar Tavares**, **Laboratory technician Fátima Rosado**, **Vinicius Morato**, **Arturo Osório**, **Paulo Silva** and all members of the **journal club** thank you for the contribution on the research team and to make me grow so much in the past year.

To the soccer teams, coaches and mostly to the **athletes** thank you for accepting to be part of the sample in the study and for the friendship.

To my **friends**, thank you for being always with me and for always giving me strength to make my choices.

Last but not the least, to my **family**, thank you to my **grandmother**, to my **grandfather**, to my **parents** and to my **sister**, for leading me through the best paths.

ABSTRACT

Women soccer has been increasingly recognized in Portugal. In the present season (2016/2017), the Portuguese Football Federation (FPF) reported 1018 senior female soccer athletes federated. The main aim of this study was to obtain a multidimensional profile of Portuguese female soccer players. The sample comprised twenty female soccer players (n=20) from the highest competitive level in the country (aged 23.09 ±6.11 years, stature 163.0±6.5 cm and body mass 58.9±6.5 kg) that were submitted to anthropometry of the whole body, air displacement plethysmography (ADP), dual energy x-ray absorptiometry (DXA), hand morphology, echocardiography, bioimpedance (BIA), food frequency questionnaire (FFQ), task and ego orientation in sport questionnaire (TEOSQ), aerobic fitness, wingate anaerobic test, dynamometry isokinetic (flexors and extensors of the knee 60, 180 $°\cdot s^{-1}$) and dynamometry manual tests. The results provided a profile of the body size, anthropometry, body composition, food intake, metabolic pathways, muscle strength and motivational orientation of the athletes. At the end of the study each participant had an individual report that can be useful in the planning of the training and the definition of goals for those that work directly with the female soccer athletes.

Keywords: female athlete, soccer, body composition, anthropometry, metabolic pathways, muscle strength, motivational orientation, food intake.

RESUMO

O futebol feminino tem vindo a ser cada vez mais reconhecido em Portugal. Na presente época (2016/2017), a Federação Portuguesa de Futebol (FPF) reportou 1018 atletas seniores femininas federadas. O objetivo do presente estudo foi obter um perfil multidimensional de atletas portuguesas de futebol feminino. A amostra foi composta por 20 atletas (n=20) do mais alto nível competitivo no país (23.09 ±6.11 anos, 163.0±6.5 cm e 58.9±6.5 kg). As atletas foram sujeitas a avaliações da antropometria do corpo todo, pletismografia de ar deslocado (ADP), absorciometria de raio-x de dupla energia (DXA), morfologia da mão, ecocardiografia, bioimpedância (BIA), questionário de frequência alimentar (FFQ), questionário de orientação para a tarefa e para o ego (TEOSQ), *performance* aeróbia, teste anaeróbico de wingate, dinamometria isocinética (flexores e extensores do joelho 60, 180 $^{\circ} \cdot s^{-1}$) e dinamometria manual. Os resultados permitem traçar um perfil do tamanho corporal, antropometria, composição corporal, ingestão nutricional, vias metabólicas, força muscular, orientação motivacional. No final do estudo cada participante fica com um relatório individual que pode ser útil no planeamento do treino e definição de objetivos daqueles que trabalham diretamente com as atletas de futebol feminino.

Palavras-chave: atleta feminina, futebol, composição corporal, antropometria, vias metabólicas, força muscular, orientação motivacional, ingestão nutricional.

ABBREVIATIONS LIST

% - Percentage

ADP – Air Displacement Plethysmography

ASE – American Society of Echocardiography

BIA – Bioimpedance

BMC- Bone Mineral Content

BMD – Bone Mineral Density

Ca – Calcium

CI – Confidence Interval

Chol – Cholesterol

CV – Coefficients of variation

DAR – Diameter of the aortic root

DAE – Diameter of the left atrium

DSM-BIA – Bioimpedance measurement method segment direct multi-frequency

DXA – Dual energy x-ray absorptiometry

EAE – European Association of Echocardiography

EtOH – Ethanol

FIFA – Fédération Internationale de Football Association

FFM-ADP – Fat free mass by air displacement plethysmography

FFM-BIA - Fat free mass by bioimpedance

FFM-DXA – Fat free mass by dual energy x-ray absorptiometry

FFQ – Food Frequency Questionnaire

FIB- Fibers

FM-ADP – Fat mass by air displacement plethysmography

FM-BIA - Fat mass by bioimpedance

FM-DXA – Fat mass by dual energy x-ray absorptiometry

FPF – Portuguese Football Federation

HRmax – maximum heart rate

Kcal – calories

LST – Lean soft tissue

LV – Left ventricle

LVM – Left ventricle mass

LVPWD – Left ventricle posterior wall in diastole

R – Reliability coefficients

RC – Respiratory compensation point

RER – Respiratory exchange ratio

Rz – Resistance

SD – Standard deviation

SE – Standard error

SIV – Thickness of the interventricular septum

TAPSE – Tricuspid annular systolic excursion

TBW – Total body water

TEOSQ – Task and Ego Orientation in Sport

VE – Ventilation equivalent

$VECO_2$ – Carbon dioxide release

$VEVO_2$ – Respiratory equivalents of oxygen uptake

VO_2max – Maximal oxygen uptake

VT1 – First Ventilatory Threshold

WAnT – Wingate Anaerobic Test

Xc - Reactance

TABLES LIST

TABLE OF CONTENTS

INTRODUCTION

Female soccer

Female soccer has grown and become one of the most popular women's sport worldwide (Haugen, Tonnessen, & Seiler, 2012). When compared with men, women have a smaller performance, and can be declared that this differences comes from cardiovascular, respiratory, hormonal and metabolic systems and body composition (Oliveira, J., Soares, J., & Marques, A., 2000). Women soccer has been increasingly recognized in Portugal, not only by the population but also by agencies that manage the sport at the highest level in the country. Data published in the magazine *W Women Football* in 2015 indicated that several objectives had been met by the Professional Football Players Union, over the past few years. On the season of 2014/2015, figures from this magazine showed the growth and impact that women soccer had in the country. Among these, they highlighted an increase of 24% applications in the federation in the last six years, reaching in 2015, 2116 players, in a total of 50 teams. At the moment, in Portugal there are only two competitive levels in the senior female soccer. The highest one is the Allianz Women Soccer League (14 teams), and the second one is the Promotion National League (50 teams).

Previous studies can be found in databases such as PubMed and B-On regarding the female soccer player. In a brief literature review, can be noticed that most of the research in the area took place after 2000 with an exponential increase in the last five years. The majority of the field studies were descriptive and considered on elite athletes, who are at the highest competitive level of the country where they are federated.

Taking as reference the Women's International Ranking of the *Fédération Internationale de Football Association* (FIFA), in ascending order, the top ten world's national teams are: United States, Germany, France, England, Australia, Sweden, Japan, Brazil, Democratic People's Republic of Korea and Canada. (Last updated data 24 June 2016 on the official FIFA website). These data have similarities with the countries where can be found the main women's soccer studies, showing that these were the ones that carry investment research on the sport. So, the question was: Do these countries conduct research because they were the best in the sport or, on the opposite, were they the best in the sport because previously there was an investment in research?

However, in this list of the best 50 teams of the world, Portugal was only in the 40th position and the research in the female soccer in the country had some weaknesses. It is important to look at sport in the developed countries and at the work that they develop for the women's soccer growth in its territory.

The effort in soccer is predominantly intermittent with players performing aerobic activities at low intensity during most of the time in a match and separated for numerous episodes of high-intensity anaerobic work (Bangsbo, Mohr, & Krustrup, 2006). The physical capacity and tactical role of a team induces individual differences in the physical demands during a game, and that’s why science has been so important in the planning and execution of the training process (Bangsbo et al., 2006; Kirkendall, 2011). Soccer coaches need to know the athletes biological and physiological to adapt the training process and to achieve the goals of the competition level (Castelo, 1996).

Body Composition

The body composition in a soccer player changes across the season. The percentage of fat mass increase in the off-season and the most notable decrease is in the pre-season period (Reilly & Doran, 2003). Capacities such as power and endurance show a decrement when the body mass and fat mass increases in female soccer players (Milanović et al., 2012). Because of the sport muscular demands, soccer players have, usually, a greater development in the lower limbs muscles than in the upper limbs (Reilly & Doran, 2003).

The most frequent method for assessing body composition is the dual energy x-ray absorptiometry (DXA). This exam calculates the bone mineral density (BMD), which depends on the individual bone mineral composition and is influenced by age, gender and race. If adulthood is reached with a low BMD the person has greater risk of osteoporosis in the future (Katharina G., 2004). A comparative study between swimmers and female soccer players showed that soccer players had higher bone mineral density and strength parameters than swimmers. The training influences this component and the geometric parameters of the hip. This study concluded that higher impact sports, such as soccer, were better to increase bone mineral density (Ferry et al., 2011).

Physiology of Female Soccer Player

Soccer is characterized as a high-intensity intermittent game which requires the use of oxidative and nonoxidative systems (Reed, De Souza, & Williams, 2012). The average distance covered per game in women's soccer elite athletes is approximately 10 km, however, the majority of this distance is covered by low intensity (Datson et al., 2014; Bangsbo et al., 2006). This distance depends on the position that the athlete plays on the field. Central defenders cover less total distance at high-intensity running than the rest of the players, the attackers cover an equal distance than the full-back and midfield players but they do more sprints at high-intensity. The full-backs cover a considerable distance at a high-intensity and by sprinting but do less headers and tackles than the other players. The midfield player covers an equal distance than the attackers and full-backs and do more headers and tackles than the other positions (Bangsbo et al., 2006).

The biological characteristics of women reduce their physical capacities when compared with men, so they cannot do the same intensity training (Katharina G., 2007). Women have physiological differences, such as the lower engine capacity, because they have less muscle mass, smaller hearts, less total blood volume, and less hemoglobin (Kirkendall, 2011). In a FIFA document for the development of women’s soccer, Katharina G. (2007), reported that women can train at a relative intensity between 70-75% of their VO_2max.

With all the high-intensity episodes that the soccer players have to do during a game, they must be prepared to have short periods of recovery between episodes, so they need to have a high anaerobic capacity using the anaerobic glycolysis (Reilly & Doran, 2003). During a match, as result of the anaerobic metabolism, the lactate production is high and the blood lactate level can be high even though the muscle lactate concentration is relative low. (Bangsbo et al., 2006; Kirkendall, 2011).

Task and ego orientation in sport

Task and ego orientation are both related to the intrinsic motivation of a subject. In a state of task involvement, the athlete is focused on the process in order to enjoy and achieve the goals of the activity. It should correspond to adaptive cognitions and positive achievement behaviors, regardless the person's level ability in sport. On the other hand, ego-involved athletes do the exercise look to meet a performance standard rather than appreciate the task, this subjects have a high motivation and confidence in the sport ability. (Duda, Chi, Newton, Walling, & Catley 1995).

TEOSQ (Task and Ego Orientation in Sport Questionnaire) was developed to assess individual differences in tendency for emphasizing task and ego involving criteria for defining success in sport. In the questionnaire, ego orientation was hypothesized to have less significantly correlation with scores on the enjoyment/interest subscale, and task orientation, on the opposite, with more significantly correlation (Duda et al., 1995; Castillo et al., 2010).

Echocardiography

Echocardiography has become the dominant cardiac imaging technique (Lang et al., 2005). At the end of the 6th week of fertilization, the heart general structure it's formed and after the 8th week we can already contrast the main blood vessels. The heart mass has a continuous growth until the end on the 3rd or 4th decade of life. (Malina, Bouchard, & Bar-Or, 2004). The left ventricular mass (LVM) is similar in both sexes until age nine to twelve, but after it grows faster in boys than the girls. This mass is influenced by sports performance and the work performed by the heart muscle. (Malina, Bouchard, & Bar-Or, 2004). With sports practice there are changes in the diameter of the heart cavities and walls thickness, this process is called cardiac remodeling. The left ventricle it is the most studied heart cavity (Castanheira et al., 2014). The myocardium hypertrophy increases the stroke volume and the left ventricular cavity size, which increases the volume during the systole (Reilly & Doran, 2003).

Aim

The main aim of this study was to obtain a multidimensional profile of Portuguese female soccer players, completing a set of functional assessments and body composition. This is something that can also promote the women soccer in the country because existing greater investment in the knowledge of which capabilities and needs the athletes have, and providing knowledge to those who work directly with them improvements will be found, not only in the yield of each athlete, but also at a national level in the quality of practice.

METHODS

Study design

The research proposal was submitted to the scientific board and to the Ethics Committee of the Faculty of Sport Sciences and Physical Education of the University of Coimbra. Written informed consent was obtained from all participants after verbal and written explanations of the experimental design and potential risks of the study. All measurements were performed in the laboratories of the Coimbra University Stadium and School of Health, both in Coimbra. The same research team assessed all data in two occasions. The athletes, from each team, were evaluated on the same day and place, on the same conditions and protocols, by experienced technicians. To evaluate the body composition, they were submitted to anthropometry of the whole body, air displacement plethysmography (ADP), dual energy x-ray absorptiometry (DXA), hand morphology, echocardiography and bioimpedance (BIA) tests. A food frequency questionnaire (FFQ) and task and ego orientation in sport questionnaire (TEOSQ) was applied. For functional evaluation the subjects performed: aerobic fitness, wingate anaerobic test, dynamometry isokinetic (flexors and extensors of the knee 60, 180 ° / s) and dynamometry manual tests.

Participants

The sample comprised 20 Portuguese female soccer players (n = 20) of the Allianz Women's Soccer League. All participants showed the right dominant member and were from two teams that achieved the highest competitive level in the year of the measurements (aged 23.09 ±6.11 years, stature 163.0±6.5 cm and body mass 58.9±6.5 kg). The inclusion in the sample ensured: (1) more than two years of training experience and (2) at least three weekly training units. The participants were the following: two goalkeepers, four wingers, five midfielders, four full-backs, two forwards, three center-backs.

Anthropometry

All measurements were performed by a single experienced observer, based on standard protocols (Lohmann, Roche, & Martorell, 1988). The measures that make the anthropometric characteristics of the study were: body mass, stature, sitting height, circumferences, areas, volumes and lengths. The athletes were weighed barefoot and only in shorts and sports top. It was used a *SECA* scale (model 770, Hanover, MD, USA), with an accuracy of 0.1 kg. Stature was measured by *portable stadiometer Harpenden* (model 98603, Holtain Ltd, Crosswell, UK), with an accuracy of 0.1 cm. The observer told the athletes to take the anthropometric position of reference, and ensure the orthogonality of the Frankfurt reference line relative to the scale. The sitting height was measured in *Harpenden sitting height table* (Holtain Lts, Crosswell, UK), with the same precision of 0.1 cm with the observer leveling the platform for support and length of the supporting surface.

Circumferences, volumes and lengths were obtained using an anthropometric tape one the left and right sides of the body with 0.1 cm precision. The subjects were standing with the upper limbs relaxed beside the trunk. The participants were pen marked in six points in the upper limb (the ulnar styloid, the largest girth of the forearm, the olecranon, the largest girth of the arm, the distal insertion of the deltoid and the acromion), after the observer measured the five lengths between the points from distal to proximal (Rogowski, Ducher, Brosseau, & Hautier, 2008). The lower limbs were pen-marked in three points (the inferior gluteal line, maximal perimeter with the member relaxed and the femoral condyle). The two lengths in the thighs were measure between this points from distal to proximal.

<u>Hand morphology</u>

The participant was with the hand in pronation on a transverse plane and with the fingers in maximum extension and maximum distance between each other. The third finger (3D) was in the prolongation of the antebrachial segment. The measurements corresponded to the distances, in centimeters, between the midpoint of the osteo-transverse, at the level of the styloid processes, and each of the distal points. After the ratio 2D:4D was produced for each hand.

Echocardiography

For the evaluation of echocardiography it was used, by the same observer, one transthoracic cardiograph in the left lateral decubitus position, comprising an ultrasound device *Vivid 3*, with a multifrequency probe of 1.5 to 3.6 MHz (GE Vingmed Ultrasound, Horten, Norway). The dimensions of the cardiac cavities and thicknesses were evaluated at rest. The diameter of the aortic root (DAR) was determined by M-mode guided by 2D. The M-mode is the method most used in the literature, because of its ability to largely determine the morphological parameters of the heart. The diameter of the left atrium (DAE) was measured by the incidence of the long axis left parasternal. The telediastolic and telesystolic diameters of the left ventricle (LV). The thickness of the interventricular septum (SIV) and LV posterior wall in diastole (LVPWD) were measured by the incidence of long axis, after the leaflets of the mitral valve, according to the American Society of Echocardiography (ASE) and the European Association of Echocardiography (EAE). Based on the above dimensions, LV mass (LVM) was estimated by the cubic equation of ASE, modified and obtained by the autopsy of 52 cadavers by Devereux et al., (1986).

The study also evaluated accurately: left ventricle based on the diameters and thickness, its fractional shortening and ejection, right and left atrium areas, left ventricular volumes, maximum blood velocity and gradient in aortic valve, mitral and tricuspid valve annulus velocity through the Doppler Tissue, tricuspid annular systolic excursion (TAPSE) and heart rate.

Air displacement plethysmography (ADP)

In order to estimate the body density ($kg \cdot L^{-1}$) through the body volume it was used an air plethysmography offset (Bod Pod Composition System, model Bod Pod 2006 Life Measurement, Inc., Concord, CA, USA). Initially, a scale incorporated into the unit, with an accuracy of 0.01 kg, calculated the body weight. The device was calibrated before each evaluation, using a cylinder of 50,225 L. All players were evaluated using only underwear and a cap, sitting in the chamber of the Bod Pod, motionless while the system estimates the body volume two consecutive times and, when necessary, three times, considered valid if their difference is less than 150 mL. It is then estimated tidal volume for the achievement of the body volume. The body density (body mass/body volume) was calculated and used to estimate the percentage of body fat, using the equation of Siri (1961): (%FM = [(4.95/D) -4.50] x 100). This percentage was finally converted into fat mass (FM-ADP) and then, subtracted from the whole body mass, estimating the fat-free mass (FFM-ADP).

Dual energy x-ray absorptiometry (DXA)

Another method used to assess the body composition of the athletes was the dual energy x-ray absorptiometry (DXA). The measure was made with the equipment *Lunar iDXA* (General Electrics Healthcare, Lunar iDXA, software enCORE version 15, US/CALA). The *Lunar iDXA* bone densitometer provides an estimate of bone mineral density (BMD), fat mass and lean tissue (LST). The values can then be compared to a reference population at the sole discretion of the physician. This is the most used method for the assessment of bone mineral density. This evaluation also estimates the percentage of fat mass and non-fat mass of each subject. The subjects were evaluated in the supine position and all the evaluations carried out on the same day, in a certified laboratory and by the same experienced technician. In the data analysis it was considered to the whole body, lower limbs and thighs: the lean soft tissue (LST, g), the body mineral content (BMC, g), bone area (cm^2), BMD (g/cm^2), fat mass (FM-DXA, kg) and fat free mass (FFM-DXA, kg).

Bioimpedance

The third method of assessing body composition, present in this study was the examination of bioelectrical impedance (BIA 101 System Analyzer, Akern, Florence, Italy), allowing bicompartimental estimation of body composition from the resistance measurement (Rz) and reactance (Xc), impedance and phase angle (Coppini, Bottoni, Silva, & Waitzberg, 1998). From this examination can be estimated the total body water, intracellular and extracellular of the individual as well as their percentage of fat mass (FM-BIA), fat-free mass (FFM-BIA), body cellular mass and muscle mass (Rodrigues, Silva, Monteiro, & Farinatti, 2001; Eickemberg, 2013). In parallel, it was also used the *InBody770 scanner* (In-body Bldg, Seoul, Korea), which has a bioimpedance measurement method segment direct multi-frequency (DSM-BIA), quadrupole with eight electrodes which ensures greater accuracy and minimizes the error, with frequency 1, 5, 50, 250, 500 and 1000 kHz. The measurement time was 60 seconds, with the subjects in a standing position according to the manufacturer instructions after shoes, coats and sweaters had been removed. The report provided by the equipment gives a large amount of data, however, to this study it will only be considered the skeletal muscle (kg), total body water (TBW, L), intracellular water (L), extracellular water (L), proteins (kg), minerals (kg) fat mass (kg and %), fat visceral area (cm^2), fat mass in the upper limbs, trunk and lower limbs (kg), basic metabolic rate (kcal), body cellular mass (kg) and the phase angle of the whole body.

Wingate anaerobic test (WAnT)

The aim to use this method in the study was to evaluate the anaerobic power of the subjects. It consisted in cycling for 30 seconds at maximum speed against a constant resistance force previously determined (body mass x 0.075 kg). It was used a cycle-ergometer *Monark Peak Bike* (model 824e) with a *Baumer sensor* (CH-8500 Frauenfeld model). The seat height was adjusted according to their body size, in order to keep the leg slightly below its maximum extension at the end when the member completes the cycle of movement. The warm-up of the protocol used was the one produced by Armstrong and Welsman (2000), very recurrent in the literature. The test begins with the subject pedaling at a steady pace between 50 and 60 rpm with only the resistance of the ergometer weights support. Once a steady pace is achieved it was given a countdown "3-2-1-go", and applied the resistance force that started the online data collection system. The subject was encouraged verbally making an effort of 30 seconds at maximum speed. Data were extracted of 1 Hz and 50 Hz. For 1 Hz were collected the absolute maximum mechanical power (watt); the relative maximum mechanical power ($watt \cdot kg^{-1}$, $watt \cdot kg_{FFM}^{-1}$, $watt \cdot kg \cdot L^{-}$

^{1}); the absolute average mechanical power (watt); the relative average mechanical power (watt·kg^{-1}, watt·kg$_{FFM}$$^{-1}$, watt·kg·L^{-1}) and fatigue index (%, WAnT FI) (difference between the maximum and minimum values, being expressed as a percentage of the maximum value). In data extracted of 50 Hz were collected the absolute maximum mechanical power (watt); the relative maximum mechanical power (watt·kg^{-1}), time at maximum mechanical power (ms), the absolute average mechanical power (watt); the relative average mechanical power (watt·kg^{-1}), the power drop (watt, watt·kg^{-1}), the maximum speed (rpm), power at maximum speed (watt), time at maximum speed (ms) and decline in power (watt).

Aerobic fitness

The maximum oxygen uptake (VO_2max) was measured using an incremental running test in monitored treadmill (Quasar, HP Cosmos, Germany). This was the first functional method that the subjects performed in the day of the measurements. The warm-up last one minute at a speed of 7 km/h with an inclination of 2%. The test started at a speed of 8 km/h, increasing 1 km/h each minute, maintaining a constant inclination in 2% until exhaustion. Between each level the subject evaluated the previous level through his perception of effort (CR·10-Borg Scale). Blood lactate (mmol·L^{-1}) was collected one and three minutes after completion of the test using a portable analyzer (Lactate Pro Analyser, Arcay, Inc). The criteria used to obtain the value corresponding to the maximum oxygen consumption were: (1) the existence of a "plateau" in oxygen consumption, despite an increase in exercise intensity; (2) lactemia concentration exceeding 6 mmol/L; (3) a respiratory exchange ratio $\geq$ 1.11; (4) Heart rate within 10% of the maximum value expected for the age; (5) impressionist sense of having reached a state of exhaustion (Howley, Basset, & Welch, 1995). Expired oxygen flow and carbon dioxide concentrations were measured breath by breath (Quark Cosmed, Italy). From the data, the study considered the first ventilatory threshold, the respiratory compensation point threshold and the VO_2 max. From each one was extracted: O_2 uptake (mL·min^{-1}; mL·kg^{-1}·min^{-1}; % VO_2 max), heart rate (bpm), time it was occurred (s), speed it was occurred (Km·h^{-1}) and the respiratory exchange ratio (RER).

Sub-maximal ventilatory thresholds were obtained from respiratory equivalents of oxygen uptake ($VEVO_2$) and carbon dioxide release ($VECO_2$), together with pulmonary ventilation equivalent (VE). The lowest workload in which is observed an increase of $VEVO_2$ without concomitant increase of $VECO_2$ was considered the first ventilatory threshold (VT1) (Dekerle et al., 2003; Wasserman & McIlroy, 1964). The lowest workload in which concomitant $VEVO_2$ and $VECO_2$ increase was considered the respiratory compensation point (RC) (Dekerle et al., 2003; Wasserman & McIlroy, 1964). This two thresholds need two coincide with the first and second non-linear increases in ventilation (VE) (Dekerle et al., 2003). VO_2max is defined when there is a plateau defined by an increase of less than 1.5 $mL \cdot kg^{-1} \cdot min^{-1}$ in VO_2 even when the intensity in the exercise increase (Dekerle et al., 2003; Midgley, McNaughton, & Jones, 2007).

Eight reports were used to determine inter-observer variability. Two independent researchers blindly reviewed the plots and determined VT1 and RC individually. For first ventilatory threshold (VT1), respiratory compensation point (RC) and VO_2max reliability coefficients (R) were: 0.93, 0.90 and 1.00, respectively. Coefficients of variation (CV) between researchers ranged from 0.3% to 2.7%.

Isokinetic dynamometry assessment (knee flexors and extensors)

This assessment was carried out in the dominant member in an open kinetic chain by *Biodex System 3 dynamometer* (Shirley, NY, USA) at 60° and 180°/s. In a study for validation of this device it was concluded that it is reliable and that produces valid assessments (Drouin, Valovich-mcLeod, Shultz, Gansneder, 2004) The test carried out with a five minutes warm-up in a cycle ergometer (814E Monark, Varberg, Sweden) with a resistance value corresponding to 2% of the body mass of the subject (Brown, 2000) cycling between 50 and 60 rpm, followed by three exercises of static stretching of the quadriceps, hamstrings and adductors, with a duration of 20 seconds each. The participants sat on the chair, the lever arm was aligned with the lateral condyle of the knee and the fixing strip to the tibial tarsal joint is placed three to five cm of the medial malleolus of the tibia. It was asked to the subject to undertake voluntary maximum extension member and considered the value 0º. Then was asked to perform knee flexion to calibrate the device to 90º. Before the participants performing the test, a correction of the gravity effect of the lower limb and the severity of the lever arm was made by weighing the relaxed member (Osterning, 1986). The participant was also instructed to, that during the test, have the arms crossed on his chest with the hands on his shoulders (Brown, 2000; De Ste Croix, Deighan, & Armstrong, 2003). Participants performed three continuous repetitions for familiarization with the equipment, motion and strength, and then five maximal repetitions with 60 seconds interval between each. The moments of maximum force in flexion and extension were expressed in Newton per meter (N.m), and then the peak torque extracted in both movements, the angle at which it occurred, the mean torque in the five repetitions and the ratio H/Q (hamstrings per quadriceps) using the program *Acknowledge*, version 4.1 (Biopac Systems, Inc.). The peak torque was obtained from the highest point of the isokinetic torque curves, and the peak moment (Perrin, 1993). The conventional ratio H/Q divides the values for the peak torque in the hamstrings in concentric mode, by the peak torque in the quadriceps in the same contraction mode. This ratio it's a great instrument for the injury prevention in athletes and its value must approach 0.60 (Heiser, Weber, Sullivan, Clare, & Jacobs, 1984).

Hand grip dynamometer

For this evaluation it was used a manual dynamometer *Lafayette* (model 78010), adapted to the hand of each subject. The test was performed standing, with arms extended laterally to the trunk, separated approximately 45 degrees. Both hands were evaluated, using three tests and their results expressed in kilograms (kg.f) with one decimal place. During the test, the pressure must be carried out continuously, the arm cannot touch the body while the strength is measured.

Food frequency questionnaire (FFQ)

It was applied a food frequency questionnaire, semi-quantitative, validated by Lopes et al. (2000) by the Department of Hygiene and Epidemiology, Faculty of Medicine, University of Oporto for the Portuguese general population. The questionnaire was structured based on the model of the FFQ of Willet et al. (1998) and was developed by the Department of Public Health of the Faculty of Medicine, University of Alicante (Vioque & Gonzalez, 1991). It has 86 items covering the intake of solid and liquid food during the 12 months before filling it in. In each item the subject chooses an option from a Likert scale (from "never or less than once per month" to "6 or more times a day"). The food intake is calculated after taking into account the frequency and portion of each item. The questionnaire identifies a base amount of calories (kcal) consumed, protein (% PTN), carbohydrate (% CH), total body fat (% TBF), saturated fat (% SF), monounsaturated fat (% F/Mon), polyunsaturated fat (% F/Pol) cholesterol (Chol, mg), dietary fiber (FIB, g), Ethanol (EtOH, g) and calcium (Ca, mg). The food frequency questionnaire was applied to the whole sample. It is an economic tool, simple and able to distinguish the different patterns of inter-consumption (Sampson, 1985; Willett, 1994).

Task and Ego Orientation in Sport Questionnaire (TEOSQ)

For this method it was used the Portuguese version (Fonseca & Biddle, 1996) of the Task and Ego Orientation in Sport Questionnaire (TEOSQ, Chi & Duda, 1995). This questionnaire consists of 13 items with options of choice in a *Likert* scale of five points, ranging from "1 - totally disagree" to "5 - I totally agree." Seven of the items are related to the task orientation and six are related to the orientation of the ego.

Statistical analysis

Descriptive statistics were performed for each variable. It was calculated the range (minimum and maximum), the mean (value, standard error (SE), 95% Confidence Interval 95% (CI) and standard deviation (SD). All the calculations were made using the *SPSS version 22* (IBM SPSS Statistics, Armonk, NY, IBM Corp).

RESULTS

The descriptive statistic tables for every variable of each method on the study showed the range (minimum and maximum), the mean (standard error and confidence interval of 95%) to describe the central tendency and the standard deviation (SD) to describe the dispersion.

Age and training experience

Table 1 shows the descriptive statistics for the chronovariables and body size of the female soccer players observed in the study (n=20). The chronological age averaged 23.09 ±6.11 years. The players have a training experience from 2.0 to 20.0 years with a mean value of 8.7±5.4 years. The stature mean is 163.0±6.5 cm and for body mass 58.9±6.5 kg.

Anthropometry

Tables 2-3 report information on upper limbs circumferences and areas. The axillary circumference mean is 32.0±2.4 cm in the left upper limb and 32.8±2.4 cm in the right, subdeltoid 25.8±1.9 cm and 26.0±1.8 cm, midarm 23.6±1.5 cm and 23.8±1.3 cm, elbow 22.3±1.2 cm and 22.4±1.3 cm, forearm 21.6±1.2 cm and 21.8±1.3 cm, wrist 14.4±0.7 cm and 14.6±0.7 cm. For the areas 81.9±12.4 cm^2 for the axillary in the left upper limb and 86.0±12.4 cm^2 for the right, 53.3±7.8 cm^2 and 53.9±7.3 cm^2 for the subdeltoid area, 44.4±5.7 cm^2 and 45.2±5.0 cm^2 for the midarm, 39.5±4.2 cm^2 and 40.2±4.9 cm^2 for the elbow, 37.2±4.3 cm^2 and 38.0±4.6 cm^2 for the forearm, and the wrist with a mean of 16.4±1.5 cm^2 and 16.9±1.6 cm^2.

Table 4 report the lengths in the upper limbs, the length 1 average on the left upper limb was 11.2±1.1 cm and on the right was 11.3±1.4 cm, length 2 averaged 7.2±1.0 cm on the left and 7.2±0.9 cm on the right, length 3 left side 8.0±1.0 cm and 8.1±0.9 cm on the left side, length 4 shows 7.1±0.9 cm on the left upper limb and 8.2±1.0 cm, the length 5 averaged 14.6±1.2 cm on the left side and 13.9±1.1 cm on the right upper limb.

Table 5 shows the values for the upper limb volumes, obtained from the circumferences, areas and the five lengths. In the left upper limb, the volume range from 1.67 L to 2.78 L and the mean value is 2.09±0.29 L, the right one range from 1.80 L to 2.73 L and average 2.17±0.27 L.

Table 6 report the proximal circumference of the left thigh (57.2±4.7 cm) and on the right thigh (57.6±4.9 cm), the medial circumference averaged 50.1±3.5 cm on the left and 50.6±3.6 cm on the right, and the distal 36.8±1.9 cm on the left and 36.9±1.9 cm on the right thigh. The area of the proximal circumference averaged 262.2±43.6 cm^2 on the left thigh and 266.0±45.9 cm^2 on the right, the left medial 200.4±28.3 cm^2 and the 204.4±29.5 cm^2 and the area of the distal circumference averaged 108.2±10.9 cm^2 on the left and 108.9±11.4 cm^2 on the right.

Table 8 present the two lengths measured on each thigh. The first one proximal 10.5±1.9 cm on the left and 10.6 ±1.9 cm on the right, the second one distal 20.8±4.1 cm in the left and 20.8±4.2 cm in the right. With this measures we could estimate the volume (table 9) for the left thigh 5.60±1.47 L ranging from 3.11 L to 8.96 L and for the right thigh 5.73±1.52 L ranging from 3.22 L to 8.72 L.

Hand Morphology

Table 10 shows the descriptive statistics for the left and right hand morphology. In the left, 1D showed a mean value of 13.43±0.61 cm, 2D 17.79±0.87 cm, 3D 18.32±0.89 cm, 4D 17.28±0.79 cm and 5D 14.79±0.81 cm. The ratio between the second and fourth fingers (2D:4D) averaged 1.029±0.012 cm. On the right hand 1D showed a mean value of 13.35±0.58 cm, 2D 17.75±0.89 cm, 3D 18.34±0.90 cm, 4D 17.28±0.82 cm, and 5D 14.74±0.78 cm. The ratio between the second and fourth fingers (2D:4D) averaged 1.028±0.015 cm.

Ecocardiography

Table 11 describes the echocardiography parameters. The telediastolic diameter of the left ventricle averaged 49.6±2.8 mm and the telesystolic 31.9±1.9 mm. The thickness of the interventricular septum ranging from 6.7 mm to 8.8 mm and averaged 7.7±0.5 mm. The thickness of the posterior wall showed 7.21±0.32 mm and the thickness of the left ventricle wall 0.292±0.018 mm. The left ventricle mass ranging from 61.0 g to 90.0 g and averaged 74.7±9.4 g. The fractional shortening was 73.1±4.1% and the fractional ejection 24.7±2.0%. We also predict the root diameter of the aortic (32.6±3.2 mm), the left atrium diameter (14.0±2.1 mm) and area (13.2±1.7 cm^2) and the right atrium area (121.1±20.0 cm^2). We can also determine the end-diastolic volume (84.1±19.1 mL), the end-systolic volume (97.7±17.0 mL). The velocity of the blood pumped in mitral annulus averaged 2.1±0.5 $cm \cdot s^{-1}$, maximum blood velocity in aorta was 7.1±1.3 $cm \cdot s^{-1}$ and tricuspid annular systolic excursion (TAPSE, 22.6±2.3 mm).

Bioimpedance

Tables 12-13 shows two different technologies, the bioelectric impedance (n=20) and the InBody 770 scanner (n=19). The first one showed that the fat mass of the participants averaged 27.4±4.3% and the second one a mean of 22.8±4.2%, for the body cellular mass the mean is 20.9±1.7 kg in the bioelectric method and 29.9±2.8 kg in the *Inbody 770*. The extracellular water averaged 13.4±1.6 L in the first one and 12.4±1.2 L in the second, the intracellular water 19.1±1.6 L in the first and 20.9±2.0 L in the second. From the bioelectric impedance we can also extract the fat free mass 72.6±4.3% and the muscle mass 43.8±2.6%. From the *Inbody 770* the study observe that the mean on proteins is 9.0±0.8 kg and for the minerals 3.3±0.3 kg, fat mass in left and right upper limbs 0.8±0.3 kg, fat mass in trunk was 6.6±2.0 kg, and fat mass in lower limbs 2.2±0.5 kg. The fat visceral area was 52.3±17.1 cm^2.

Air displacement plethysmography

Table 14 present the descriptive statistics for the air displacement plethysmography (n=20). Body mass averaged 58.949±6.546 kg, thoracic gas volume 3.049±0.274 L, body volume 56.146±6.771 L, body density 1.051±0.143 $kg \cdot L^{-1}$, fat mass 79.1±6.7% and fat free mass 20.9±6.7%.

Dual-energy x-ray absorptiometry

Table 15 shows the descriptive statistics for body composition by dual-energy x-ray absorptiometry. The mean value for the lean soft tissue in the whole body was 40.5±4.0 kg, for the bone mineral content 2.6±0.3 kg, the bone area averaged 2101±131 cm^2, and the bone mineral density 1.216±0.970 g/cm^2. This method also predicts the fat mass (26.6±4.1 %) and the fat free mass (69.1±3.9 %).

Table 16 presents the same variables but, this time, for the lower limbs of the 20 participants. For the study it was considered the lean soft tissue (14.45±1.89 kg), BMC (0.92±0.18 kg), bone area (713±86 cm^2), BMD (1.278±0.154 g/cm^2) and fat mass (30.2±3.9%).

Table 17 reports the descriptive statistics for the same variables but for the right and left tight. All the subjects in the study had as the dominant member the right one, and its lean soft tissue averaged 7.16±0.86 kg, the BMC mean value was 0.48±0.05 kg, bone area 364.0±29.2 cm^2, BMD 1.312±0.069 g/cm^2 and fat mass 30.5±3.9%.

Wingate anaerobic test

Table 18 report the data exported from the wingate anaerobic test. For the 1 Hz extraction we could see that the absolute maximum mechanical power ranging from 474.0 watt to 770.0 watt and averaging 618.3±78.9 watt. The relative maximum mechanical power range was from 8.7 $watt \cdot kg^{-1}$ to 14.1 $watt \cdot kg^{-1}$ with a mean of 10.5±1.3 $watt \cdot kg^{-1}$. The absolute average mechanical power was 419.2±52.9 watt and the relative mean value was 7.1±0.8 $watt \cdot kg^{-1}$. The fatigue index ranging from 15.7% to 40.3% and averaged 31.9±6.5%. For the 50 Hz extraction we also calculated the absolute maximum mechanical power (653.9±84.7 watt) the relative maximum mechanical power (10.8±1.5 $watt \cdot kg^{-1}$), the absolute average mechanical power (437.5±54.9 watt) and the relative average mechanical power (7.5±0.8 $watt \cdot kg^{-1}$). The power drop was 379.4±85.8 watt, the maximum speed was 124±10 rpm and the decline in power averaged 361.0±76.9 watt.

Aerobic fitness

Table 19 shows three different important points from the maximal oxygen uptake in treadmill test. The first one is the first ventilatory threshold (VT1), the second is the respiratory compensation point (RC) and the last one is the VO_2max. In the first ventilatory threshold we can indicate that the O_2 uptake occurred in mean at 9.0±0.6 $km \cdot h^{-1}$ and it averaged 30.73±3.60 $mL \cdot kg^{-1} \cdot min^{-1}$ with a RER of 0.84±0.08. In the respiratory compensation point the O_2 uptake averaged 39.77±4.37 $mL \cdot kg^{-1} \cdot min^{-1}$, occurred at 11.9±0.7 $km \cdot h^{-1}$ and the respiratory exchange ratio was 0.98±0.06. For the VO_2max, the O_2 uptake was 45.08±4.67 $mL \cdot kg^{-1} \cdot min^{-1}$, at 14.5±1.3 $km \cdot h^{-1}$ and the respiratory exchange ratio was 1.14±0.07. The final blood lactate concentration mean value was 11.9±2.9 $mmol \cdot L^{-1}$.

Isokinetic strength of the knee flexors and extensors

Table 20 report the values for the dynamometer isokinetic test. In the first angular velocity (60 °/s), the peak torque mean value during extension was 145.7±25.2 N·m, the mean torque in the five repetitions in all the subjects averaged 136.6±23.4 N·m and the angle were the peak occurs was 61.4±6.0°. For the flexion movement the peak torque mean value was 84.8±12.8 N·m, mean torque for all the subjects in the five maximal repetitions 79.8±13.5 N·m and the angle were the peak occurred was 33.8±8.9°. After the conventional ratio between the muscles doing concentric contraction during de flexion and the muscles doing the same contraction in the extension was determined, ranging from 0.49 to 0.66 N·m and averaged 0.59±0.05 N·m. At 180°/s the peak torque mean value for the extension was 97.4±12.9 N·m, the mean torque in the five repetitions averaged 87.2±15.2 N·m and the peak torque angle 57.0±6.7°. For the flexion the mean value for the peak torque mean value was 66.6±11.2 N·m, the mean torque in the five repetitions was 60.4±8.8 N·m and the angle were the peak torque was 25.8±15.0°. The conventional ratio mean value for this angular velocity was 0.69±0.09 N·m ranging from 0.58 to 0.84 N·m.

Hand grip dynamometer

Table 21 present the descriptive statistic for the manual dynamometer test. To the left hand the strength values ranging from 16.0 kg·f to 37.0 kg·f and the mean value was 26.7±4.9 kg·f. For the right hand, the range values showed from 20.0 kg·f to 42.0 kg·f and averaged 30.2±5.7 kg·f.

Task and ego orientation in sport questionnaire

Table 22 reports the results for the TEOSQ answers. Ego orientation range values were from 1.00 to 4.00 and averaged 1.77±0.72. The subjects were more involved with task orientation, ranging from 3.00 to 5.00 and showing a mean values of 4.16±0.42.

Food frequency questionnaire (FFQ)

Table 23 shows the results for the food frequency questionnaire, that the subjects answered having in mind the last 12 months before the measurement day, we can extract the calories that the subject ingest per day (2671±1030 kcal). Also the nutrients per day, like proteins (21.0±3.5%kcal), carbohydrates (49.1±8.1 %kcal), total fat (31.7±5.6 %kcal), the saturated fat (8.7±2.3 %kcal), monounsaturated fat (13.6±2.6 %kcal), polyunsatured fat (5.1±1.4 %kcal), cholesterol (468.1±269.6 mg), fibers (35.7±18.2 g), ethanol (36±18 g) and calcium (1131±614 mg).

Table 1. Descriptive statistics for the chronovariables and body size (n=20)

		range		Mean			standard deviation
		minimum	Maximum	value	SE	(95% CI)	
Chronological age	years	16.58	37.79	23.09	1.37	(20.65 to 25.84)	6.11
Training experience	years	2.0	20.0	8.7	1.2	(6.5 to 10.9)	5.4
Stature	cm	150.9	176.0	163.0	1.5	(160.4 to 165.7)	6.5
Sitting height	cm	80.9	93.6	86.9	0.7	(85.7 to 88.3)	3.2
Leg length	cm	70.0	83.8	76.0	0.9	(74.6 to 77.6)	3.8
Body mass	kg	49.4	72.5	58.9	1.5	(56.0 to 61.9)	6.5

SE (standard error); CI (confidence interval)

Table 2. Descriptive statistics for circumferences in the upper limbs (n=20)

Variables			range		mean			standard deviation
Laterality	Site	units	minimum	maximum	value	SE	(95% CI)	
Left	axillary	cm	27.8	36.2	32.0	0.6	(30.9 to 33.1)	2.4
	subdeltoid	cm	22.0	29.3	25.8	0.4	(25.0 to 26.7)	1.9
	midarm	cm	21.5	26.8	23.6	0.3	(22.9 to 24.2)	1.5
	elbow	cm	20.5	24.6	22.3	0.3	(21.7 to 22.8)	1.2
	forearm	cm	19.1	24.3	21.6	0.3	(21.1 to 22.1)	1.2
	wrist	cm	13.3	15.6	14.4	0.2	(14.1 to 14.6)	0.7
Right	axillary	cm	28.5	36.9	32.8	0.5	(31.7 to 33.9)	2.4
	subdeltoid	cm	23.0	29.8	26.0	0.4	(25.2 to 26.7)	1.8
	midarm	cm	21.3	26.5	23.8	0.3	(23.2 to 24.4)	1.3
	elbow	cm	20.8	26.0	22.4	0.3	(21.9 to 23.0)	1.3
	forearm	cm	19.6	24.7	21.8	0.3	(21.3 to 22.4)	1.3
	wrist	cm	13.3	15.8	14.6	0.2	(14.3 to 14.9)	0.7

SE (standard error); CI (confidence interval)

Table 3. Descriptive statistics for estimated areas in the upper limbs (n=20)

Variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	axilary	cm^2	61.5	104.3	81.9	2.8	(76.3 to 87.4)	12.4
	subdeltoid	cm^2	38.5	68.3	53.3	1.7	(49.9 to 56.8)	7.8
	midarm	cm^2	36.8	57.2	44.4	1.3	(41.8 to 46.9)	5.7
	elbow	cm^2	33.4	48.2	39.5	0.9	(37.6 to 41.3)	4.2
	forearm	cm^2	29.0	47.0	37.2	1.0	(35.3 to 39.1)	4.3
	wrist	cm^2	14.1	19.4	16.4	0.3	(15.8 to 17.1)	1.5
Right	axilary	cm^2	64.6	108.4	86.0	2.8	(80.5 to 91.6)	12.4
	subdeltoid	cm^2	42.1	70.7	53.9	1.6	(50.8 to 57.1)	7.3
	midarm	cm^2	36.1	55.9	45.2	1.1	(43.0 to 47.3)	5.0
	elbow	cm^2	34.4	53.8	40.2	1.1	(38.2 to 42.3)	4.9
	forearm	cm^2	30.6	48.5	38.0	1.0	(36.1 to 39.9)	4.6
	wrist	cm^2	14.1	19.9	16.9	0.4	(16.2 to 17.6)	1.6

SE (standard error); CI (confidence interval)

Table 4. Descriptive statistics for lengths in the upper limbs (n=20)

Variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	length 1	cm	9.3	13.6	11.2	0.3	(10.8 to 11.7)	1.1
	length 2	cm	5.4	8.9	7.2	0.2	(6.8 to 7.6)	1.0
	length 3	cm	6.6	10.2	8.0	0.2	(7.5 to 8.4)	1.0
	length 4	cm	5.4	8.3	7.1	0.2	(6.7 to 7.5)	0.9
	length 5	cm	12.9	17.0	14.6	0.3	(14.1 to 15.1)	1.2
Right	length 1	cm	8.1	13.6	11.3	0.3	(10.7 to 11.9)	1.4
	length 2	cm	5.6	9.1	7.2	0.2	(6.8 to 7.6)	0.9
	length 3	cm	6.5	10.0	8.1	0.2	(7.7 to 8.5)	0.9
	length 4	cm	6.1	10.4	8.2	0.2	(7.7 to 8.6)	1.0
	length 5	cm	12.2	16.3	13.9	0.3	(13.4 to 14.4)	1.1

SE (standard error); CI (confidence interval)

Table 5. Descriptive statistics for estimated volumes in the upper limbs (n=20)

Variables		range		mean			standard deviation
Laterality	units	minimum	maximum	value	SE	(95% CI)	
Left	L	1.67	2.78	2.09	0.06	(1.97 to 2.22)	0.29
Right	L	1.80	2.73	2.17	0.06	(2.06 to 2.29)	0.27

SE (standard error); CI (confidence interval)

Table 6. Descriptive statistics for circumferences in the lower limbs (n=20)

variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	proximal	cm	49.5	68.4	57.2	1.1	(55.2 to 59.4)	4.7
	medial	cm	43.7	58.6	50.1	0.8	(48.6 to 51.6)	3.5
	distal	cm	34.2	40.5	36.8	0.4	(36.1 to 37.6)	1.9
Right	proximal	cm	50.5	70.0	57.6	1.1	(55.6 to 59.9)	4.9
	medial	cm	45.2	58.2	50.6	0.8	(49.1 to 52.1)	3.6
	distal	cm	34.0	40.4	36.9	0.4	(36.1 to 37.7)	1.9

SE (standard error); CI (confidence interval)

Table 7. Descriptive statistics for estimated areas in the lower limbs (n=20)

variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	proximal	cm^2	195.0	372.3	262.2	9.8	(244.0 to 282.7)	43.6
	middle	cm^2	152.0	273.3	200.4	6.3	(188.2 to 212.8)	28.3
	distal	cm^2	93.1	130.5	108.2	2.4	(103.6 to 112.8)	10.9
Right	proximal	cm^2	202.9	389.9	266.0	10.3	(246.6 to 287.4)	45.9
	middle	cm^2	162.6	269.5	204.4	6.6	(192.1 to 217.3)	29.5
	distal	cm^2	92.0	129.9	108.9	2.5	(104.1 to 113.5)	11.4

SE (standard error); CI (confidence interval)

Table 8. Descriptive statistics for lengths in the lower limbs (n=20)

variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	length 1	cm	7.4	13.0	10.5	0.4	(9.6 to 11.3)	1.9
	length 2	cm	14.9	26.0	20.8	0.9	19.0 to 22.6)	4.1
Right	length 1	cm	7.4	13.2	10.6	0.4	(9.8 to 11.4)	1.9
	length 2	cm	12.5	26.4	20.8	0.9	(19.0 to 22.6)	4.2

SE (standard error); CI (confidence interval)

Table 9. Descriptive statistics for estimated volumes in the lower limbs (n=20)

variables		range		mean			standard deviation
laterality	units	minimum	maximum	value	SE	(95% CI)	
Left	L	3.11	8.96	5.60	0.33	(4.95 to 6.26)	1.47
Right	L	3.22	8.72	5.73	0.34	(5.03 to 6.40)	1.52

SE (standard error); CI (confidence interval)

Table 10. Descriptive statistics for hand morphology (n=20)

variables			range		mean			standard deviation
laterality	site	units	minimum	maximum	value	SE	(95% CI)	
Left	1D	cm	12.50	14.80	13.43	0.14	(13.17 to 13.72)	0.61
	2D	cm	16.80	19.90	17.79	0.19	(17.44 to 18.20)	0.87
	3D	cm	17.10	20.40	18.32	0.20	(17.95 to 18.73)	0.89
	4D	cm	16.30	19.20	17.28	0.18	(16.95 to 17.65)	0.79
	5D	cm	13.40	16.50	14.79	0.18	(14.44 to 15.15)	0.81
	ratio 2D:4D	cm	1.006	1.059	1.029	0.003	(1.024 to 1.035)	0.012
Right	1D	cm	12.40	14.80	13.35	0.13	(13.11 to 13.62)	0.58
	2D	cm	16.30	19.80	17.75	0.20	(17.37 to 18.14)	0.89
	3D	cm	17.10	19.90	18.34	0.20	(17.95 to 18.74)	0.90
	4D	cm	16.10	18.70	17.28	0.18	(16.91 to 17.66)	0.82
	5D	cm	13.50	16.40	14.74	0.17	(14.40 to 15.10)	0.78
	ratio 2D:4D	cm	0.989	1.059	1.028	0.003	(1.021 to 1.034)	0.015

SE (standard error); CI (confidence interval)

Table 11. Descriptive statistics for echocardiography parameters in female soccer athletes (n=20)

variables	units	range		mean			standard deviation
		minimum	maximum	value	SE	(95% CI)	
Telediastolic diameter LV	mm	45.0	54.0	49.6	0.6	(48.3 to 50.7)	2.8
Telesystolic diameter LV	mm	27.0	34.0	31.9	0.4	(31.1 to 32.7)	1.9
SIV	mm	6.7	8.8	7.7	0.1	(7.5 to 8.0)	0.5
Thickness of posterior wall	mm	6.70	8.20	7.21	0.07	(7.09 to 7.36)	0.32
Thickness of LV wall	mm	0.300	0.300	0.292	0.004	(0.284 to 0.299)	0.018
LV mass	g	61.0	90.0	74.7	2.1	(70.6 to 78.5)	9.4
Fractional shortening	%	67.0	80.0	73.1	0.9	(71.5 to 74.7)	4.1
Fractional ejection	%	22.0	28.0	24.7	0.4	(24.0 to 25.6)	2.0
Root diameter of the aortic	mm	27.0	37.0	32.6	0.7	(31.3 to 34.0)	3.2
LA diameter	mm	10.0	17.0	14.0	0.5	(13.0 to 14.9)	2.1
LA area	cm^2	10.0	17.0	13.2	0.4	(12.5 to 13.9)	1.7
RA area	cm^2	93.0	158.0	121.1	4.5	(112.7 to 129.3)	20.0
End-diastolic volume	mL	57.0	122.0	84.1	4.3	(76.6 to 91.9)	19.1
End-systolic volume	mL	70.0	132.0	97.7	3.8	(90.8 to 104.9)	17.0
Mitral annulus velocity	$cm \cdot s^{-1}$	1.3	3.3	2.1	0.1	(1.9 to 2.3)	0.5
Maximum blood velocity	$cm \cdot s^{-1}$	5.3	9.6	7.1	0.3	(6.6 to 7.7)	1.3
Gradient in aortic valve	mm·Hg	1.00	1.80	1.21	0.05	(1.14 to 1.30)	0.20
TAPSE	mm	20.0	27.0	22.6	0.5	(21.6 to 23.5)	2.3

SE (standard error); CI (confidence interval); LV (left ventricle); LA (left atrium); RA (right atrium); TAPSE (tricuspid annular systolic excursion); SIV (thickness of interventricular septum)

Table 12. Descriptive statistics for measurements of body composition by bioelectric impedance analysis (n=20)

variables	units	range		mean			SD
		minimum	maximum	value	SE	(95% CI)	
Fat mass	kg	10.6	26.6	16.0	0.9	(14.2 to 18.0)	4.2
	%	21.5	36.7	27.4	1.0	(25.6 to 29.4)	4.3
Fat free mass	kg	36.7	47.6	42.9	0.8	(41.4 to 44.6)	3.7
	%	63.3	78.5	72.6	1.0	(70.6 to 74.4)	4.3
Body cellular mass	kg	18.1	23.5	20.9	0.4	(20.1 to 21.7)	1.7
	%	30.8	39.3	35.6	0.5	(34.5 to 36.5)	2.3
Muscle mass	kg	22.1	28.9	25.7	0.5	(24.8 to 26.7)	2.2
	%	38.1	48.3	43.8	0.6	(42.6 to 44.9)	2.6
Total body water	L	27.2	36.6	32.5	0.7	(31.2 to 33.9)	3.0
	%	49.3	59.4	55.2	0.6	(53.9 to 56.4)	2.9
Extra celular water	L	10.8	16.2	13.4	0.4	(12.7 to 14.1)	1.6
	%	38.4	45.0	41.3	0.4	(40.5 to 42.1)	1.9
Intra celular water	L	16.4	21.4	19.1	0.4	(18.4 to 19.8)	1.6
	%	56.1	61.6	59.0	0.4	(58.3 to 59.7)	1.7

SE (standard error); SD (standard deviation); CI (confidence interval)

Table 13. Descriptive statistics for measurements of body composition assessed using the multifrequency bioimpedance analysis (n=19)

variables	units	range		mean			Standard deviation
		minimum	maximum	value	SE	(95% CI)	
Skeletal muscle	kg	20.9	28.5	25.2	0.6	(24.2 to 26.3)	2.6
Total body water	L	28.4	37.1	33.2	0.7	(32.0 to 34.5)	3.1
Intracellular water	L	17.6	23.4	20.9	0.5	(20.1 to 21.7)	2.0
Extracellular water	L	10.7	13.9	12.4	0.3	(11.9 to 12.9)	1.2
Proteins	kg	7.6	10.1	9.0	0.2	(8.7 to 9.4)	0.8
Minerals	kg	2.9	3.9	3.3	0.8	(3.2 to 3.5)	0.3
Fat mass	kg	8.9	21.9	13.7	0.8	(12.0 to 15.3)	3.7
	%	17.9	33.8	22.8	1.0	(21.0 to 24.7)	4.2
Fat visceral area	cm^2	29.0	86.6	52.3	3.9	(44.7 to 59.5)	17.1
fat mass: left upper limb	kg	0.6	1.5	0.8	0.6	(0.7 to 0.97)	0.3
fat mass: right upper limb	kg	0.5	1.4	0.8	0.6	(0.7 to 0.94)	0.3
fat mass: trunk	kg	3.8	11.3	6.6	0.5	(5.7 to 7.46)	2.0
fat mass: left lower limb	kg	1.6	3.3	2.2	0.1	(2.0 to 2.4)	0.5
fat mass: right lower limb	kg	1.6	3.4	2.2	0.1	(2.0 to 2.5)	0.5
Basic metabolic rate	kcal	1211	1470	1354	21	(1313 to 1393)	91
Body cellular mass	kg	25.2	33.5	29.9	0.6	(28.7 to 31.1)	2.8
Whole body phase angle		5.0	7.1	6.0	0.1	(5.8 to 6.3)	0.6

SE (standard error); CI (confidence interval); *only 19 cases were valid

Table 14. Descriptive statistics for body composition assessed using air displacement plethysmography (n=20)

variables	units	range		Mean			standard deviation
		minimum	maximum	value	SE	(95% CI)	
Body mass	kg	49.620	72.720	58.949	1.464	(56.181 to 61.533)	6.546
Thoracic gas volume	L	2.530	3.590	3.049	0.614	(2.936 to 3.159)	0.274
Body volume	L	46.160	71.370	56.146	1.514	(53.224 to 58.830)	6.771
Body density	$kg·L^{-1}$	1.020	1.080	1.051	0.003	(1.045 to 1.057)	0.143
Fat free mass	kg	39.86	52.36	46.36	0.881	(44.61 to 47.96)	3.94
	%	64.2	92.2	79.1	1.5	(76.3 to 82.0)	6.7
Fat mass	kg	3.85	26.04	12.59	1.128	(10.42 to 14.77)	5.04
	%	7.8	35.8	20.9	1.5	(18.0 to 23.7)	6.7

SE (standard deviation); CI (confidence interval)

Table 15. Descriptive statistics for body composition assessed using dual-energy x-ray absorptiometry (n=20)

variables	units	range		Mean			standard deviation
		minimum	maximum	value	SE	(95% CI)	
Lean soft tissue	kg	34.8	47.2	40.5	1.0	(38.8 to 42.3)	4.0
BMC	kg	1.9	3.0	2.6	0.1	(2.4 to 2.7)	0.3
Bone area	cm^2	1915	2364	2101	29	(2048 to 2159)	131
BMD	g/cm^2	0.915	1.364	1.216	0.217	(1.167 to 1.255)	0.970
Fat mass	kg	9.13	26.61	15.77	0.86	(14.10 to 17.66)	3.85
	%	19.9	36.7	26.6	0.92	(24.87 to 28.52)	4.11
Fat free mass	kg	34.82	47.20	40.51	0.90	(38.79 to 42.34)	4.01
	%	59.9	76.0	69.1	0.86	(67.24 to 70.67)	3.86

SE (standard error); CI (confidence interval); BMC (bone mineral content); BMD (bone mineral density);

Table 16. Descriptive statistics for lower limbs composition assessed using dual energy x-ray absorptiometry (n=20)

variables	units	range		Mean			standard deviation
		minimum	maximum	value	SE	(95% CI)	
Lean soft tissue	kg	11.36	17.86	14.45	0.42	(13.66 to 15.25)	1.89
BMC	kg	0.34	1.14	0.92	0.04	(0.84 to 0.99)	0.18
Bone area	cm^2	441	831	713	19	(677 to 749)	86
BMD	$g.cm^{-2}$	0.764	1.442	1.278	0.344	(1.206 to 1.335)	0.154
Fat mass	kg	4.84	11.41	6.72	0.36	(6.09 to 7.53)	1.62
	%	24.3	39.5	30.2	0.9	(28.7 to 32.0)	3.9

SE (standard error); CI (confidence interval); BMC (bone mineral content); BMD (bone mineral density);

Table 17. Descriptive statistics for thighs composition assessed using dual energy x-ray absorptiometry (n=20)

Variables		range		Mean			standard deviation
laterality	units	minimum	maximum	value	SE	(95% CI)	
Right							
Lean soft tissue	kg	5.72	8.65	7.16	0.19	(6.79 to 7.56)	0.86
	%	56.9	71.0	65.1	0.8	(63.4 to 66.5)	3.6
BMC	kg	0.41	0.57	0.48	0.012	(0.46 to 0.50)	0.05
Bone area	cm^2	317.0	420.0	364.0	6.5	(351.6 to 377.4)	29.2
BMD	$g{\cdot}cm^2$	1.167	1.448	1.312	0.015	(1.282 to 1.340)	0.069
Fat mass	kg	2.38	5.80	3.40	0.18	(3.08 to 3.81)	0.82
	%	24.4	39.8	30.5	0.9	(29.0 to 32.4)	3.9
Left							
Lean soft tissue	kg	5.64	8.54	7.05	0.20	(6.69 to 7.44)	0.88
	%	56.9	71.0	65.26	0.79	(63.63 to 66.71)	3.54
Bone mineral content	kg	0.42	0.58	0.49	0.01	(0.47 to 0.51)	0.05
Bone area	cm^2	310.0	411.0	364.5	6.4	(353.0 to 376.9)	28.4
Bone mineral density	$g{\cdot}cm^2$	1.164	1.435	1.332	0.015	(1.304 to 1.358)	0.067
Fat mass	kg	2.42	5.61	3.30	0.18	(2.98 to 3.70)	0.80
	%	24.3	39.3	30.2	0.9	(28.7 to 32.0)	3.9

SE (standard error); CI (confidence interval); BMC (bone mineral content); BMD (bone mineral density);

Table 18. Descriptive statistics for the wingate anaerobic test variables (n=20)

variables	units	range: minimum	range: maximum	mean: value	mean: SE	mean: (95% CI)	SD
1HZ							
Absolute maximum mechanical power	watt	474.0	770.0	618.3	17.6	(585.0 to 652.0)	78.9
Relative maximum mechanical power	watt·kg^{-1}	8.7	14.1	10.5	0.3	(10.0 to 11.1)	1.3
	watt·kg$_{FFM}^{-1}$	11.0	15.7	13.4	0.3	(12.8 to 14.0)	1.4
	watt·kg^{-1}·L^{-1}	41.4	110.4	57.3	3.3	(52.3 to 64.6)	15.0
Absolute average mechanical power	watt	343.0	522.0	419.2	11.8	(396.5 to 443.2)	52.9
Relative average mechanical power	watt·kg^{-1}	5.8	8.9	7.1	0.2	(6.8 to 7.5)	0.8
	watt·kg$_{FFM}^{-1}$	6.8	10.1	9.1	0.2	(8.7 to 9.4)	0.9
	watt·kg^{-1}·L^{-1}	24.7	69.1	38.9	2.1	(8.7 to 9.4)	9.5
Fatigue Index	%	15.7	40.3	31.9	1.5	(35.3 to 43.2)	6.5
50HZ							
Absolute maximum mechanical power	watt	481.0	785.0	635.9	18.9	(597.3 to 671.1)	84.7
Relative maximum mechanical power	watt·kg^{-1}	8.7	14.6	10.8	0.3	(10.2 to 11.5)	1.5
Time at maximum mechanical power	ms	1.04	3.75	2.44	0.14	(2.17 to 2.72)	0.65
Absolute average mechanical power	watt	358.0	550.0	437.5	12.3	(415.1 to 462.1)	54.9
Relative average mechanical power	watt·kg^{-1}	6.1	9.2	7.5	0.2	(7.1 to 7.8)	0.8
Power drop	watt	213.0	548.0	379.4	19.2	(345.6 to 415.5)	85.8
	watt·kg^{-1}	4.3	10.9	6.5	0.4	(5.87 to 7.28)	1.7
Maximum speed	rpm	106	143	124	2	(120 to 129)	10
Power at maximum speed	watt	481	828	620	21	(581 to 661)	94
Time at maximum speed	ms	4.14	8.58	6.19	0.25	(5.69 to 6.67)	1.12
Decline in power	watt	213.0	533.0	361.0	17.2	(330.3 to 395.0)	76.9

SE (standard error); CI (confidence interval); SD (standard deviation); watt·kg$_{FFM}^{-1}$ (FFM-ADP);

Table 19. Descriptive statistics for aerobic fitness (n=19)

		range		Mean			
variable	units	minimum	maximum	value	SE	(95% CI)	standard deviation
VT1							
O_2 uptake	$L{\cdot}min^{-1}$	1.516	2.190	1.858	0.049	(1.761 to 1.948)	0.214
	$mL{\cdot}kg^{-1}{\cdot}\ min^{-1}$	21.00	36.00	30.73	0.83	(28.98 to 32.19)	3.60
	% VO2peak	56.10	81.90	68.52	1.38	(65.88 to 71.26)	6.01
Heart rate	Bpm	122.0	176.0	153.1	2.7	(147.3 to 158.3)	11.8
Time	S	90	240	134	10	(117 to 153)	43
Speed	$Km{\cdot}h^{-1}$	8.0	10.0	9.0	0.1	(8.3 to 8.8)	0.6
RER		0.65	0.94	0.84	0.02	(0.80 to 0.87)	0.08
RC							
O_2 uptake	$L{\cdot}min^{-1}$	1.932	3.053	2.407	0.068	(2.281 to 2.537)	0.296
	$mL{\cdot}kg^{-1}{\cdot}\ min^{-1}$	27.00	45.00	39.77	1.00	(37.65 to 41.63)	4.37
	% VO2peak	83.50	94.60	88.45	0.73	(87.10 to 89.85)	3.18
Heart rate	Bpm	158.0	194.0	173.6	2.2	(169.3 to 177.9)	9.6
Time	S	240	390	322	10	(302 to 344)	46
Speed	$Km{\cdot}h^{-1}$	11.0	13.0	11.9	0.2	(11.5 to 12.2)	0.7
RER		0.87	1.08	0.98	0.01	(0.95 to 1.00)	0.06
VO_2 max							
O_2 uptake	$L{\cdot}min^{-1}$	2.126	3.413	2.722	0.076	(2.583 to 2.873)	0.333
	$mL{\cdot}kg^{-1}{\cdot}\ min^{-1}$	33.00	51.00	45.08	1.07	(42.96 to 47.00)	4.67
Heart rate	Bpm	172.0	203.0	184.8	2.02	(180.89 to 188.68)	8.78
Time	S	360	600	480	16	(450 to 510)	69
Speed	$Km{\cdot}h^{-1}$	12.0	17.0	14.5	0.3	(14.0 to 15.1)	1.3
RER		0.99	1.25	1.14	0.02	(1.1 to 1.2)	0.07
Final Stage							
Blood lactate	$mmol{\cdot}L^{-1}$	8.0	19.0	11.9	0.7	(10.7 to 13.3)	2.9

SE (standard error); VT1 (ventilatory threshold 1); RER (respiratory exchange ratio); RC (respiratory compensation point); *one data invalid;

Table 20. Descriptive statistics for dynamometer isokinetic for the knee flexors and extensors (n=20)

Variables			range		mean			standard deviation
knee movement	Site	units	minimum	maximum	Value	SE	(95% CI)	
Extension 60 °·s^{-1}	peak torque	N·m	105.0	225.0	145.7	5.6	(134.8 to 156.6)	25.2
	mean torque	N·m	100.3	207.0	136.6	5.2	(126.2 to 146.8)	23.4
	peak torque angle	°	47.0	70.0	61.4	1.3	(58.6 to 64.0)	6.0
Flexion 60 °·s^{-1}	peak torque	N·m	56.8	113.9	84.8	2.9	(78.9 to 90.1)	12.8
	mean torque	N·m	47.1	111.3	79.8	3.0	(73.5 to 85.4)	13.5
	peak torque angle	°	21.0	51.0	33.8	2.0	(29.9 to 37.7)	8.9
	Ratio H/Q		0.49	0.66	0.59	0.01	(0.56 to 0.61)	0.05
Extension 180 °·s^{-1}	peak torque	N·m	68.9	117.0	97.4	2.9	(91.3 to 102.5)	12.9
	mean torque	N·m	50.6	106.8	87.2	3.4	(80.3 to 93.4)	15.2
	peak torque angle	°	49.0	72.0	57.0	1.50	(54.2 to 60.0)	6.7
Flexion 180 °·s^{-1}	peak torque	N·m	48.0	94.0	66.6	2.5	(61.6 to 71.3)	11.2
	mean torque	N·m	44.2	77.9	60.4	2.0	(56.6 to 63.9)	8.8
	peak torque angle	°	11.0	61.0	25.8	3.4	(19.6 to 32.9)	15.0
	Ratio H/Q		0.58	0.84	0.69	0.02	(0.65 to 0.73)	0.09

SE (standard error); CI (confidence interval)

Table 21. Descriptive statistics for hand grip dynamometer (n=20)

variables		range		mean			standard deviation
laterality	units	minimum	maximum	value	SE	(95% CI)	
Left	kg·f	16.0	37.0	26.7	1.1	(27.8 to 32.8)	4.9
Right	kg·f	20.0	42.0	30.2	1.3	(24.5 to 28.8)	5.7

SE (standard error); CI (confidence interval)

Table 22. Descriptive statistics for task and ego orientation in sport questionnaire (TEOSQ) (n=20)

variables	range		mean			standard deviation
	Minimum	maximum	value	SE	(95% CI)	
I'm the only one who can do the play or skill	1.00	3.00	1.50	0.15	(1.20 to 1.80)	0.69
I learn a new skill and it makes me want to practice more	3.00	5.00	4.30	0.16	(3.95 to 4.60)	0.73
I can do better than my friends	1.00	4.00	2.30	0.19	(1.90 to 2.70)	0.87
The others cannot do as well as me	1.00	4.00	1.70	0.21	(1.35 to 2.10)	0.92
I learn something that is fun to do	3.00	5.00	4.65	0.13	(4.40 to 4.90)	0.59
Others mess up but I do not	1.00	3.00	1.25	0.12	(1.05 to 1.50)	0.55
I learn a new skill by trying hard	3.00	5.00	4.20	0.14	(3.95 to 4.45)	0.62
I work really hard	3.00	4.00	3.65	0.11	(3.45 to 3.85)	0.49
I score the most points/goals/hits, etc.	1.00	4.00	2.15	0.24	(1.70 to 2.65)	1.09
Something I learn makes me want to go practice more	3.00	5.00	4.45	0.15	(4.15 to 4.75)	0.69
I am the best	1.00	4.00	1.70	0.23	(1.30 to 2.15)	1.03
A skill I learn really feels right	2.00	4.00	3.20	0.17	(2.90 to 3.55)	0.77
I do my very best	4.00	5.00	4.65	0.11	(4.45 to 4.85)	0.49
Ego orientation	1.00	4.00	1.77	0.16	(1.48 to 2.09)	0.72
Task orientation	3.00	5.00	4.16	0.09	(3.99 to 4.34)	0.42

SE (standard error); CI (confidence interval)

Table 23. Descriptive statistics for macronutrients obtained from the application of the food frequency questionnaire (FFQ) (n=20)

variables	units	range		mean			standard deviation
		minimum	maximum	Value	SE	(95% CI)	
Calories	kcal	1096	4947	2671	230	(2246 to 3127)	1030
Proteins	%	13.0	28.0	21.0	0.8	(19.5 to 22.5)	3.5
Carbohydrates	%	32.0	67.0	49.1	1.8	(45.8 to 52.5)	8.1
Total fat	%	15.0	40.0	31.7	1.3	(29.3 to 33.9)	5.6
Saturated fat	%	4.0	12.0	8.7	0.5	(7.7 to 9.7)	2.3
Monounsaturated fat	%	6.0	18.0	13.6	0.6	(12.3 to 14.6)	2.6
Polyunsaturated fat	%	3.0	7.0	5.1	0.3	(4.5 to 5.7)	1.4
Cholesterol	mg	116.0	127.7	468.1	60.3	(361.5 to 581.4)	269.6
Fibers	g	13.0	79.0	35.70	4.1	(28.2 to 43.7)	18.2
Ethanol	g	0	44	36	4	(3 to 13)	18
Calcium	mg	441	2769	1131	137	(886 to 1376)	614

SE (standard error); CI (confidence interval)

DISCUSSION

To obtain a multidimensional profile in this study, 20 athletes from the Allianz League, the highest competition level of women soccer in Portugal, were evaluated through a multivariate approach. The participants had more than two years of training experience, played in different positions on the field and all of them showed the right dominant member. Six of them had been selected for the young national teams, and one achieved the national team-A. All the measurements were performed at the same day, during the middle season period.

In the present season (2016/2017), the Portuguese Football Federation (FPF) reported 1018 senior female soccer athletes federated. The study cannot represent all the female soccer players in Portugal because it only represents 1.96% of the total senior players federated, but this two teams can be now described across the body size, anthropometry, body composition, food intake, metabolic pathways, muscle strength and goal orientations.

Body Size and Anthropometry

It was already reported that, the women soccer in Portugal has been increasingly recognized and the numbers of athletes federated in the Portuguese Football Federation (FPF) significantly increased in the last decade. However, there are a lot of teams that only have the senior team so there is a high range at the chronological age and training experience on the participants of the study. The results have shown that there are athletes of 17 years old playing with others that have almost 38 years and the range of the training experience goes from 2.0 to 20.0 years.

The stature 163.0±6.5 cm and body mass 58.9±6.5 kg have similarities with other studies from elite female soccer players in other countries, such as: Italy, Norway, Germany, Spain, United States of America and Serbia. (Castagna & Castellini, 2013; Ingebrigtsen, Dillern, & Shalfawi, 2011; Baumgart, Hoppe, M.W., & Freiwald, J., 2014; Haugen et al., 2014; K. Idrizovic, 2014: Čović, Dzenan, & Radjo, 2016; Milanović et al., 2011).

Soccer players tend to show a greater development in the lower limbs than in the upper limbs (Reilly & Doran, 2003). So, the present study reports the volumes for the upper and lower limbs, estimated from the anthropometric measurements. The subjects have reported higher values in the dominant member. The volumes showed mean values of 2.09±0.29 L on the left upper limb and 2.17±0.27 L on the right upper limb. The estimated volume of the left thigh was 5.60±1.47 L and 5.73±1.52 L on the right thigh.

Echocardiography is a noninvasive method used in the study to describe the heart of the female soccer player. Castanheira et al. (2014) and Gjerdalen et al. (2014) had already studied the cardiac parameters in male athletes and non-athletes and they observed that athletes showed important cardiac adaptations when compared with non-athletes, such as, higher values in the telediastolic diameter of the left ventricle, thickness of interventricular septum, thickness of left ventricle wall and diameter of the left atrium. In the present study, echocardiographic parameters, for women, were then compared with reference parameters of the American Society of Echocardiography and the European Association of Cardiovascular Imaging (Updated by Lang et al., 2015). For the left ventricle parameters, the study reported telediastolic diameter 49.6±2.8 mm (reference values: 37.8-52.2 mm), telesystolic diameter 31.9±1.9 mm (reference values: 21.6-34.8 mm), thickness of interventricular septum 7.7±0.5 mm (reference values: 0.6-0.9 cm), thickness of posterior wall 7.21±0.32 mm, thickness of the left ventricle wall 0.292±0.018 mm and mass 74.7±9.4 g (reference values: 66-150 g). From this exam was also observed that the mean value for fractional shortening was 73.1±4.1% and fractional ejection 24.7±2.0%, root diameter of the aortic 32.6±3.2 mm, left atrium diameter 14.0±2.1 mm, left atrium area 13.2±1.7 cm^2, right atrium area 121.1±20.0 cm^2, end-diastolic volume 84.1±19.1 mL (reference values: 46-106 mL), end-systolic volume 91.7±17.0 mL, mitral annulus velocity 2.1±0.5 $cm \cdot s^{-1}$, maximum blood velocity in aorta 7.1±1.3 $m \cdot s^{-}1$, and tricuspid annular systolic excursion (TAPSE, 22.6±2.3 mm). Our results showed similar values when compared with the reference parameters of the American Society of Echocardiography and the European Association of Cardiovascular Imaging and from previous researches, it could be expected that the female athletes have differences in the cardiac parameters when compared with non-athletes, although this was not studied.

Jurimae et al. (2008) evaluate hand morphology in young swimmers (26 boys: 13.0±1.8 years; 29 girls 12.7±2.2 years) and concluded that 4D and 5D were higher in boys and the finger-length ratios were higher in girls. The girls reported a significant correlation of the estradiol and ghrelin concentrations with 2D:4D ratio. However, in female soccer players it was not reported in previous research, the hand morphology or digit ratio (2D:4D). In the study sample, it was measure right hand five finger lengths 1D (13.43±0.61 cm), 2D (17.79±0.87 cm), 3D (18.32±0.89 cm), 4D (17.28±0.79 cm), 5D (14.79±0.81 cm) and the left hand finger lengths 1D (13.35±0.58 cm), 2D (17.75±0.89 cm), 3D (18.34±0.90 cm), 4D (17.28±0.82 cm), 5D (14.74±0.78 cm). After it was calculated the ratio (2D:4D) 1.029±0.012 for the right hand and 1.028±0.015 for the left. This ratios values showed similar results with Manning, Churchill, and Peters (2007) that reported a ratio of 0.994±0.051 to the right hand and 0.993±0.049 in the left hand (n=172.298) and Jurimae et al. (2008) that studied young female swimmers (n=29, aged 10-17 years) and reported 1.040±0.024 for the right hand. The finger-lengths showed differences between the present study and Jurimae et al. (2008) but, the values cannot be compared because in the study with female swimmers age averaged 12.7 years old.

Body Composition and Food Intake

Air displacement plethysmography *(ADP)*, dual energy x-ray absorptiometry (DXA) and bioelectrical impedance (BIA), reported an amount of variables to describe female soccer body composition. For the whole body, all of this methods report fat mass and fat free mass. FM-ADP was 12.59±5.04 kg, FM-BIA 16.0±4.2 kg and FM-DXA 15.77±3.85 kg. FFM-ADP averaged 46.36±3.94 kg, FFM-BIA 42.9±3.7 kg and FFM-DXA 40.51±4.01 kg. From this results can be seen that the three methods showed different mean values for the same variables, but in literature the dual energy x-ray absorptiometry (DXA) is the most precise and reported method to assess the body composition (Duren et al., 2008; Miller et al., 2009; Ferry et al., 2011). ADP also shows the predicted thoracic gas volume 3.049±0.274 L, body volume 56.146±6.771 L and body density mean value 1.051±0.143 $kg{\cdot}L^{-1}$. Bioimpedance showed body cellular mass (BCM) (20.9±1.7 kg), muscle mass (MM) (25.7±2.2 kg), total body water (32.5±3.0 L), basic metabolic rate (1354±91kcal) and shows also the intracellular and extracellular body mass, fat mass in the upper limbs, trunk and lower limbs. The highest value for fat mass is located in the trunk (6.6±2.0 kg). Čović et al. (2016) studied the body composition in fourteen female soccer players (n=14, 22.7±4.4 years) and observed the fat mass percentage (19.1±3%), muscle mass percentage (41.1±2.7%) and basic metabolic rate (1651±112.1kcal), which showed similarity with the present study. High values of muscle mass support the athlete to a better aerobic performance and the fat mass should be lower (Čović et al., 2016).

The study used dual energy x-ray absorptiometry (DXA) to describe the bone parameters, such as the bone mineral content (BMC), lean soft tissue (LST), area and mineral density (BMD). In the whole body, the sample showed a lean soft tissue of 40.5±4.0 kg, BMC 2.6±0.3 kg, bone area 2101±131 cm^2 and BMD 1.216±0.970 g/cm2. Soccer players exhibit improvements in the bone mineral content and density and, specifically at the hip structure parameters (Ferry et al., 2011). The present study showed the lower limbs lean soft tissue (14.45±1.89 kg), bone mineral content (0.92±0.18 kg), bone area (713±86 cm^2), bone mineral density (1.278±0.154 g/cm^2) and fat mass (6.72±1.62 kg). Right and left thighs were specifically assessed and shown similar results. The lean soft tissue of the right thigh (7.16±0.86 kg) was higher than the left thigh (7.05±0.88 kg), bone mineral content was similar in both thighs (0.48±0.05 kg in the right and 0.49±0.05 kg in the left), bone area showed also similar results (364.0±29.2 cm^2 in the right thigh and 364.5±28.4 cm^2 in the left), bone mineral density was higher in the non-dominant member than in the dominant (1.312±0.069 g/cm2 to the right thigh and 1.332±0.067 g/cm^2 to the left thigh) and fat mass showed high mean value in the right (3.40±0.82 kg) than in the left (3.30±0.80 kg).

A study based on ninety female athletes in the United States has shown that the energy available [(energy intake-exercise expenditure)/kg lean body mass] in the participants decreased, on average, nineteen percent (19%) from the pre-season period until the middle of the season and increased thirty-five percent (35%) from the middle season until it ends. This low energy capacity values in women, are often related with the menstrual cycle variations of the athletes and its low bone mineral density, two of the components of the female athlete triad. (Reed et al. 2013). Other component of the triad are the eating disorders, female athletes need to ingest appropriate amounts of iron and calcium to ensure a normal menstrual function and healthy bones and needs to refuel carbohydrates frequently (Kirkendall, 2011). This explains why the dual energy x-ray absorptiometry (DXA) and the food frequency questionnaire (FFQ) were chosen to be part of the methods used in the study.

The food frequency questionnaire showed some weaknesses to describe the female athlete food intake. This method was semi-quantitative, validated by Lopes et al. (2000) by the Department of Hygiene and Epidemiology, Faculty of Medicine, University of Oporto for the Portuguese for general population, so it was not specific to athletes and doesn't consider participants with another diets like the vegans or vegetarians (our sample had one vegan). The results for the female athletes in the study reported a large range in each nutrient. The calories (kcal) per day ranged from 1096 to 4947 kcal, proteins percentage (% PTN) from 13.0% to 28.0%, carbohydrates percentage (% CH) from 32.0% to 67.0%, total body fat (%TBF) from 15.0% to 40.0%, saturated fat (%SF) from 4.0% to 12.0%, monounsaturated fat (% F/Mon) from 6.0% to 18.0%, polyunsaturated (% F/Pol) from 3.0% to 7.0%, cholesterol (Chol, mg) from 116.0 to 127.7 mg, fibers (FIB, g) from 13.0 to 79.0 g, ethanol (EtOH, g) from 0 to 44 g and calcium (Ca, mg) from 441 to 2769 mg. This results shows that there is a high variability of food intake between subjects, so it is not possible to obtain a general profile of food intake for the female soccer athlete, only for each individual.

Metabolic Pathways

Soccer players need high-level capacity to perform aerobically and anaerobically, and to recover from high-intensity episodes during the game. This capacity depends on the playing level and training process of each individual and team (Mara, Thompson, Pumpa, & Ball, 2015; Bangsbo et al., 2006). The player heart rate is rarely stable during a match and most of the time is above 65% of the maximum heart rate (HRmax). This suggest that the blood flow to the muscles is continuously higher than at rest, which means that oxygen delivery is also higher (Bangsbo et al., 2006; Kirkendall, 2011).

The study assessed the anaerobic power through the wingate anaerobic test (WAnT). Data acquisition of 50 Hz reported the absolute maximum mechanical power (635.9±84.7 watt), relative maximum mechanical power (10.8±1.5 watt$\cdot$kg^{-1}), time at maximum mechanical power

(2.44±0.65 ms), absolute average mechanical power (437.5±54.9 watt), relative average mechanical power (7.5±0.8 watt·kg^{-1}), power drop (379.4±85.8 watt), maximum speed (124±10 rpm) and decline in power (361.0±76.9 watt). This values, when we compare with the ones that Fallon et al. (2015) observed in a wingate test under normoxic conditions with nine collegiate athletes, showed a higher peak power (533±90 watt), but a lower average power (465±70 watt) and a higher fatigue index (27±9%).

Previous studies in female soccer players assessed the maximal oxygen uptake (VO_2max) estimated by the intermittent YO-YO recovery test or by a treadmill test (Mujika, Santisteban, Impellizzeri, & Castagna, 2009; Esco, Flatt, & Nakamura, 2015; Haugen et al. 2014; Baumgart et al., 2014; Datson et al. 2014). This capacity shows how much oxygen the body has the ability to consume during exercise (Reilly & Doran, 2003). In these studies, VO_2max range from approximately 45 to 60 mL·kg^{-1}·min^{-1} (Reed et al., 2013; Esco et al. 2015; Datson et al. 2014). In the present study the aerobic fitness was assess by a treadmill test divided in three main points: ventilatory threshold, compensation respiratory point and VO_2 max. The protocol started at 7 km·h^{-1} and the first ventilatory threshold occurred 134±43 s after the beginning of the test, at 9.0±0.6 Km·h^{-1} with 30.73±3.60 ml·kg^{-1}·min^{-1} O_2 uptake and a respiratory exchange ratio (RER) of 0.84±0.08. Compensation respiratory point occurred 322±46 s after the test started, at 11.9±0.7 Km·h^{-1}, with an O_2 uptake mean value of 39.77±4.37 ml·kg^{-1}·min^{-1} and a respiratory exchange ratio (RER) of 0.98±0.06. At the VO_2max the oxygen uptake was 45.08±4.67 ml·kg^{-1}·min^{-1}, at 14.5±1.3 Km·h^{-1}, 480±69 s after the beginning of the test with a respiratory exchange ratio (RER) of 1.14±0.07 and a heart rate 184.8±8.78 bpm. One minute after the end of the test the blood lactate concentration averaged 11.9±2.9 mmol·L^{-1}. Krustrup, Zebis, Jensen and Mohr (2010) assessed the game-induced fatigue patterns in elite female soccer players in the Danish League and reported that after the second half of a match the mean value for the blood lactate concentration (2.7±0.4 mmol·L^{-}1) was smaller than at the end of the first half (5.1±0.5 mmol·L^{-}1), however, this values were related with the intensity of each athlete in the previous minutes before the measures. After this results we can conclude that the VO_2max in the study has a similar value to the other reported studies.

Haugen et al. (2014), published a longitudinal study of the VO_2max characteristics of elite female soccer players from Norway (n=199, 22±4 years, 63±6 kg, 169± 6 cm). The researchers observed that the national team players had a higher VO_2max than players from 1st and 2nd division and that midfielders tend to have high values for this variable than forwards and defenders. In the study sample, the VO_2max ranged from 33.00 to 51.00 ml·kg^{-1}·min^{-1}, so it can be expected that this differences could exist because the athletes play in different positions on the field.

Muscle Strength

All participants performed a concentric isokinetic evaluation of the knee flexors and extensors in concentric mode. At 60 °·s^{-1} the study reported the peak torque 145.7±25.2 N·m for extension and 84.8±12.8 N·m for flexion. At 180 °·s^{-1} the peak torque was 97.4±12.9 N·m for extension and 66.6±11.2 N·m. In the literature there are already studies that assessed the muscle strength through the isokinetic dynamometer, and the values had differences, that could come from the different training and level of each individual or team. This studies reported a peak torque to the extensors at 60 °·s^{-1} of 198.5±44.1 N·m and 116.5±18.8 N·m for the flexors (Silva et al., 1999), 102.0±13.9 N·m for flexors and 181.4±24.6 N·m for extensors (Neto, Simões, Neto, & Cardone 2010) and 101.0±18.7 N·m for flexors and 135.0±36.3 N·m for extensors (Manson, Brughelli, & Harris, 2014) at the same angular velocity. The conventional H/Q ratio has been the most reported in literature. For this ratio, the value 0.60 is the general accepted (Coombs & Garbutt, 2002). Previous studies have been reported this ratio in female soccer players at 60 °·s^{-1} with values of 0.78±0.17 (Manson et al., 2014), 0.561±0.052 (Neto et al., 2010). The present study observed a ratio of 0.59±0.05 at 60 °·s^{-1} and 0.69±0.09 at 180 °·s^{-1}. This calculation have some limitations because the two groups of muscles won't be at the same time in a concentric mode, but is was obtained for the study because only was carried evaluations in the concentric mode.

Hand grip dynamometer was used to assess strength in the upper limb muscles. Visnapuu and Jurimae (2007), study the relation between the hand dimensions and the hand grip strength in sports with higher solicitation of the upper limbs (basketball and handball). They observed that the general anthropometric measures and the hand morphology are related with the hand grip strength. It was observed that there is a large range between subjects. In the left upper limb, the strength ranged from 16.0 to 37.0 kg·f and in the right upper limb ranged from 20.0 to 42.0 kg·f. The participants had higher strength values in the dominant upper limb, which was the right one (30.2±5.7 kg·f on the right hand and 26.7±4.9 kg·f in the left hand).

Goal Orientation

The study observes that the sample is more task-involved (4.16±0.42) than ego-involved (1.77±0.72). This means that the subjects enjoy the task in order to achieve the goals of the activity. Previous researches compare the female and male sport behavior, finding that there are differences and the male players reported less empathy and more antisocial acts than females (Kavussanu, Stamp, Slade, & Ring, 2009). Eubank and Gilbourne (2003) conclude there is more probability of being success in a task when the subjects think that they have a high ability to achieve the goals of the activity.

Practical Applications

This study gives a final report (Attachment I) for each athlete with all of their individual results in each evaluated parameter for the most important variables. The coaches, trainers and clinicians that work directly with this participants will have a multidimensional profile of the body size and composition (assessed with more than one method), which are their capacities in the metabolic pathways and muscle strength, their goal orientation and individual food intake.

Each profile will be a tool for this professionals in the planning of the training sessions, in the definition of the goals for each team and individual, what needs to be improved and in the injury prevention process.

CONCLUSIONS

The present study provided a multidimensional profile of the female soccer players that had been assessed in the study, to those who work directly with them. Each individual report can be now a useful tool to plan the training and to delineate goals to achieve during a season, and the methods can be replied to ensure that these objectives are being met.

The studied sample showed a large range in an amount of variables. This ranges should be lower when the team is doing the same training units with the same exercises. Some athletes need to decrease the body fat mass and increase the muscle mass. The mean values for metabolic pathways and muscle strength showed similarities with previous studies, however they still reported a large range and another methods to assess the food intake in athletes need to be applied. Echocardiography, body composition and isokinetic dynamometer can help the clinicians to prevent some health problems and injuries in the players.

Future research should be done with a larger sample and approach to training and game conditions. Could be also important to compare the different competitive levels, positions on the field, compare players that achieve the national teams to others and repeat the measures in more than one moment during a season.

Soccer is a game that is won by the ones that give attention to the details. If the coaches, trainers and clinicians that work with the female soccer players look at the multidimensional profiles of the athletes they will have the keys to optimize the capacities of their teams and to achieve great levels of performance.

REFERENCES

Armstrong, N., & Welsman, J. R. (2000). Anaerobic Performance. In N. Armstrong & W. Van Mechelen (Eds.), Paediatric Exercise Science and Medicine (1st ed., pp. 37–41). Oxford: University Press.

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of Sports Science*, *24*(7), 665–674. doi:10.1080/02640410500482529

Baumgart, C., Hoppe, M. W., & Freiwald, J. (2014). Different endurance characteristics of female and male german soccer players. *Biology of Sport*, *31*(3), 227–32. doi:10.5604/20831862.1111851

Brown, L. (2000). Isokinetics in human performance. (pp. 20). Human kinetics, Champaign, IL.

Buckley, J. P., & Borg, G. A. V. (2011). Borg's scales in strength training ; from theory to practice in young and older adults, *692*(May), 682–692. doi:10.1139/H11-078

Castagna C, Castellini E. (2013). Vertical jump performance in Italian male and female national teams soccer players. *J Strength Cond Res*.;27(4):1156–61.

Castanheira, J., Valente-dos-Santos, J., Duarte, J., Vaz, V., Figueiredo, A. J., Leite, N., Cyrino, E. S., Coelho-e-Silva, M. (2014). Morfologia do ventrículo esquerdo em adolescentes: comparação entre atletas e não atletas. *Revista Brasileira de Medicina Do Esporte*, *20*(6), 480–485. doi:10.1590/1517-86922014200601888

Castelo.J. (1996). Futebol: A Organização do Jogo. Edição do Autor.

Castillo, I., Tomás, I., Balaguer, I., Fonseca, A. M., Dias, C., & Duda, J. L. (2010). The Task and Ego Orientation in Sport Questionnaire: Testing for Measurement Invariance and Latent Mean Differences in Spanish and Portuguese Adolescents. *International Journal of Testing*, *10*(1), 21–32. doi:10.1080/15305050903352107

Chi, L., & Duda, J. (1995). Multi-sample confirmatory factor analysis of the Task and Ego Orientation in Sport Questionnaire. Research Quarterly for Exercise & Sport, (66), 91–98.

Chrisman, S. P., O'Kane, J. W., Polissar, N. L., Tencer, A. F., Mack, C. D., Levy, M. R., & Schiff, M. A. (2012). Strength and Jump Biomechanics of Elite and Recreational Female Youth Soccer Players. *Journal of Athletic Training*, *47*(6), 609–615. doi:10.4085/1062-6050-47.6.01

Coelho E Silva, M. J., Figueiredo, A. J., Simões, F., Seabra, A., Natal, A., Vaeyens, R., Philippaerts, R., Cummimg, S. P., Malina, R. M. (2010). Discrimination of U-14 soccer players by level and position. *International Journal of Sports Medicine*, *31*(11), 790–796. doi:10.1055/s-0030-1263139

Coombs, R., & Garbutt, G. (2002). Developments in the use of the hamstring/quadriceps ratio for the assessment of muscle balance. *Journal of Sport Sciences Medicine*,, 56-62.

Coppini, L. Z., Bottoni, A., Silva, M. L. T., & Waitzberg, D. L. (1998). Aplicação da análise da impedância bioelétrica na avaliação nutricional. *Revista Brasileira Nutrição Clinica*, 13: 81-89

Covic, N., Dzenan, J., Radjo, I. (October, 2016). *Body composition and aerobic power interdependence in female soccer players.* .Paper presented at the XIX International Scientific Conference "FIS COMMUNICATIONS 2016" in physical education, sport and recreation, Nis, Serbia.

Datson, N., Hulton, A., Andersson, H., Lewis, T., Weston, M., Drust, B., & Gregson, W. (2014). Erratum to: Applied Physiology of Female Soccer: An Update. *Sports Medicine*, *44*, 1225-1240. doi:10.1007/s40279-014-0199-1

Dekerle, J., Baron, B., Dupont, L., Vanvelcenaher, J., & Pelayo, P. (2003). Maximal lactate steady state, respiratory compensation threshold and critical power. *European Journal of Applied Physiology*, *89*(3–4), 281–288. doi:10.1007/s00421-002-0786-y

De Simone, G., Daniels, S. R., Devereux, R. B., Meyer, R. A., Roman, M. J., de Divitiis, O., & Alderman, M. H. (1992). Left ventricular mass and body size in normotensive children and adults: Assessment of allometric relations and impact of overweight. *Journal of the American College of Cardiology*, *20*(5), 1251–1260. doi:10.1016/0735-1097(92)90385-Z

De Ste Croix, M., Deighan, M., Armstrong, N. (2003). Assessment and interpretation of isokinetic muscle strength during growth and maturation. Sports Med, 33(10), 727-743.

Devereux, R., Alonso, D., Lutas, E., Gottlieb, G., Campo, E., Sachs, I., & Al., E. (1986). Echocardiographic assessment of left ventricular hypertrophy: comparison to necropsy findings. Am J Cardiol., (57), 8–450

Doran, D. (2003). Nutrition. In T. Reilly & A. M. Williams (2nd ed.), Science and soccer (pp. 73-95). Abingdon: Routledge.

Drouin, J. M., Valovich-McLeod, T. C., Shultz, S. J., Gansneder, B. M., & Perrin, D. H. (2004). Reliability and validity of the Biodex system 3 pro isokinetic dynamometer velocity, torque and position measurements. *European Journal of Applied Physiology*, *91*(1), 22–29. doi:10.1007/s00421-003-0933-0

Duda, J. L., Chi, L., Newton, M. L., Walling, M. D., & Catley, D. (1995). Task and ego orientation and intrinsic motivation in sport. *International Journal of Sport Psychology*, *26*(1), 40–63.

Duren, D. L., Sherwood, R. J., Czerwinski, S. A., Lee, M., Choh, A. C., Siervogel, R. M., & Cameron Chumlea, W. (2008). Body Composition Methods: Comparisons and Interpretation. *Journal of Diabetes Science and Technology (Online)*, *2*(6), 1139–1146. doi:10.1177/193229680800200623

Eickemberg, M., Oliveira, C.C, Roriz, A.K.C., Fontes, G.A.V., Mello, A.L. & Sampaio, L.R. (2013). Bioimpedância elétrica e gordura visceral: uma comparação com a tomografia computadorizada em adultos e idosos. *Arq Bras Endocrinol Metab*, 57/1.

Esco, M. R., Flatt, A. A., & Nakamura, F. Y. (2015). Initial Weekly HRV Response is Related to the Prospective Change in VO2max in Female Soccer Players. *International Journal of Sports Medicine*, *3*. doi:10.1055/s-0035-1569342

Eubank, M., & Gilbourne, D. (2003). Stress, performance and motivation theory. In T. Reilly & A. M. Williams (2nd ed.), Science and soccer (pp. 21-46). Abingdon: Routledge

Fallon, S., Belcoe, A., Shawcross, C., May, A., Monteverde, C., & McCann, D. (2015). Elite female athletes' ventilatory compensation to decreased inspired O_2 during the wingate test. *Research Quarterly for Exercise and Sport*, *86*(2), 182–189. doi:10.1080/02701367.2014.983448

Ferry, B., Duclos, M., Burt, L., Therre, P., Le Gall, F., Jaffré, C., & Courteix, D. (2011). Bone geometry and strength adaptations to physical constraints inherent in different sports: Comparison between elite female soccer players and swimmers. *Journal of Bone and Mineral Metabolism*, *29*(3), 342–351. doi:10.1007/s00774-010-0226-8

FIFA (2007). Health and Fitness for the Female Football Player: A guide for players and coaches. Acessed on March 2016 at: http://www.fifa.com/mm/document/footballdevelopment/medical/59/78/19/ffb_gesamt_e_20035.pdf.

FIFA (2016). FIFA/ Coca-cola World Ranking: Women's Ranking. Acessed on June 2016 at: http://www.fifa.com/fifa-world-ranking/ranking-table/women/index.html.

FIFA. (2004). Health and Fitness for A guide for players and coaches Health and Fitness, (0).

Figueiredo, A. J., Gonçalves, C. E., Coelho E Silva, M. J., & Malina, R. M. (2009). Youth soccer players, 11-14 years: maturity, size, function, skill and goal orientation. *Annals of Human Biology*, *36*(1), 60–73. doi:10.1080/03014460802570584

Fonseca, A. ., & Biddle, S. J. (1996). Estudo inicial para a adaptacão do Task and Ego Orientation in Sport Questionnaire (TEOSQ) à realidade portuguesa. [Exploratory study to adapt the Task and Ego Orientation in Sport Questionnaire (TEOSQ) to Portuguese reality]. In Proceedings of the IV International Conference on Psychological Assessment: Development and Contexts. Braga: Minho University Press.

Gabrys, T., Szmatlan-Gabrys, U., Plewa, M., Borek, Z., & Banaszczak, A. (2003). Laboratory Methods in Assesment of Anaerobic Capacity in 17-19 Years Old Soccer Players – A comparative Analysis. *Science and Football, 5th World Congress – Book of Abstracts*. Lisbon. Portugal.

Gjerdalen, G.F., Hisdal, J., Solberg,E.E., Andersen, T.E., Radunovic, Z., Steine, K. (2014). The Scandinavian athlete's heart; echocardiographic characteristics of male professional football players. *Scand J Med Sci Sports*. 24, 372-380.doi: 10.1111/sms.12178.

Haase, A. M. (2011). Weight perception in female athletes: Associations with disordered eating correlates and behavior. *Eating Behaviors*, *12*(1), 64–67. doi:10.1016/j.eatbeh.2010.09.004

Haugen, T. A., Tønnessen, E., & Seiler, S. (2012). Speed and Countermovement-Jump Characteristics of Elite Female Soccer Players, 1995-2010. *International Journal of Sports Physiology & Performance*, *7*(4), 340–349. doi:10.1123/ijspp.7.4.340

Haugen, T. A., Tønnessen, E., Hem, E., Leirstein, S., & Seiler, S. (2014). VO_2max Characteristics of Elite Female Soccer Players, 1989–2007. *International Journal of Sports Physiology and Performance*, *9*(3), 515-521. doi:10.1123/IJSPP.2012-0150

Heiser, T. M., Weber, J., Sullivan, G., Clare, P., & Jacobs, R.R. (1984). Prophyiaxis and management of hamstring muscle injuries in intercollegiate football players. *American Journal of Sports Medicine*, 12, 368-370.

Howley, E. T., Bassett D. R. J., & Welch, H. G. (1995). Criteria for maximal oxygen uptake: review and commentary. *Medecine Science Sports Exercise*, *27*(9), 1292–1301. doi:10.1249/00005768-199509000-00009

Idrizovic, K. (2014). Physical and anthropometric profiles of elite female soccer players. *Medicina Dello Sport*, *67*(2), 273–287.

Ingebrigtsen J, Dillern T, Shalfawi SAI. (2011). Aerobic capacities and anthropometric characteristics of elite female soccer players. *J Strength Cond Res*.;25(12):3352–7.

Jürimäe, T., Voracek, M., Jürimäe, J., Lä;tt, E., Haljaste, K., Saar, M., & Purge, P. (2008). Relationships between finger-length ratios, ghrelin, leptin, IGF axis, and sex steroids in young male and female swimmers. *European Journal of Applied Physiology*, *104*(3), 523–529. doi:10.1007/s00421-008-0801-z.

Kavussanu, M., Stamp, R., Slade, G., & Ring, C. (2009). Observed Prosocial and Antisocial Behaviors in Male and Female Soccer Players. *Journal of Applied Sport Psychology*, *21*, 62–76. doi:10.1080/10413200802624292

Kirkendall, Donald T. (2011). Soccer Anatomy. United States of America. Human Kinetics.

Krustrup, P., Zebis, M., Jensen, J. M., & Mohr, M. (2010). Game-Induced Fatigue Patterns in Elite Female Soccer. *Journal of Strength & Conditioning Research*, *24*(2), 437–441. doi:10.1519/JSC.0b013e3181c09b79

Lang, R. M., Badano, L. P., Mor-Avi, V., Afilalo, J., Armstrong, A., Ernande, L., Flachskampf, F. A., Foster, E., Goldstein, S. A., Kuznetsova, T., Lancelloti, P., Muraru, D., Picard, M. H., Rietzschel, E. R., Rudski, L., Spencer, K. T., Tsang, W., & Voigt, J. (2015). Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of cardiovascular Imaging. *European Heart Journal Cardiovascular Imaging*, 16(3), 233-271. doi: 10.1093/ehjci/jev014.

Lang, R. M., Bierig, M., Devereux, R. B., Flachskampf, F. A., Foster, E., Pellikka, P. A., Picard, M. H., Roman, M. J., Seward, J., Shanewise, J.S., Solomon, S.D., Spencer, K. T., St John Sutton, M., Stewart, W. J. (2005). Recommendations for chamber quantification: A report from the American Society of Echocardiography's guidelines and standards committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiograph. *Journal of the American Society of Echocardiography*, *18*(12), 1440–1463. doi:10.1016/j.echo.2005.10.005

Lohmann, T. G., Roche, A. F., & Martorell, R. (1988). Anthropometric Standardization Reference Manual. Champaign, IL: Human Kinetics.

Lopes C. Reprodutibilidade e validação do questionário semi-quantitativo de frequência alimentar. In: Alimentação e enfarte agudo do miocárdio: um estudo caso-controlo de base comunitária. [PhD]. Porto: Faculdade de Medicina da Universidade do Porto; 2000.

Malas, M. A., Dogan, S., Evcil, E. H., & Desdicioglu, K. (2006). Fetal development of the hand, digits and digit ratio (2D : 4D). *Early Human Development*, *82*(7), 469–475. doi:10.1016/j.earlhumdev.2005.12.002

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). Growth, Maturation, and Physical Activity (2nd ed.). Human Kinetics.

Manning, J. T., Churchill, A. J. G., & Peters, M. (2007). The effects of sex, ethnicity, and sexual orientation on self-measured digit ratio (2D:4D). *Archives of Sexual Behavior*, *36* (2), 223–233. doi:10.1007/s10508-007-9171-6

Manning, J. T., Churchill, A. J. G., & Peters, M. (2007). The effects of sex, ethnicity, and sexual orientation on self-measured digit ratio (2D:4D). *Archives of Sexual Behavior*, *36*(2), 223–233. doi:10.1007/s10508-007-9171-6

Manson, S. A., Brughelli, M., & Harris, N. K. (2014). Physiological characteristics of international female soccer players. *Journal of Strength & Conditioning Research*, *28*(2), 308–318. doi:10.1519/JSC.0b013e31829b56b1

Mara, J. K., Thompson, K. G., Pumpa, K. L., & Ball, N. B. (2015). Periodization and Physical Performance in Elite Female Soccer Players. *International Journal of Sports Physiology & Performance*, *10*(5), 664. doi:10.1123/ijspp.2014-0345

Martinez-Lagunas, V., & Hartmann, U. (2014). Validity of the Yo-Yo Intermittent Recovery Test Level 1 for direct measurement or indirect estimation of maximal oxygen uptake in female soccer players. *International Journal of Sports Physiology and Performance*, *9*(5), 825–831. doi:10.4324/9780203131879

Midgley, A. W., McNaughton, L. R., & Jones, A. M. (2007). Training to enhance the physiological determinants of long-distance running performance: can valid recommendations be given to runners and coaches based on current scientific knowledge? *Sports Medicine (Auckland, N.Z.)*, *37*(10), 857–880. doi:10.2165/00007256-200737100-00003

Milanovic, Z., Trajkovic N., Joksimovic A., Sporis, G., Fiorentini, F., Jovanovic M. (2011). Impact Of Body Mass On Power Performance And Endurance In Female Soccer Player. *Gazzetta Medica Italiana*, *In press* (April 2014).

Miller, A., Strauss, B. J., Mol, S., Kyoong, A., Holmes, P. H., Finlay, P., Bardin, P. G., & Guy, P. (2009). Dual-energy X-ray absorptiometry is the method of choice to assess body composition in COPD. *Respirology, 14*(3), 411–418. doi:10.1111/j.1440-1843.2009.01499.x

Miller, B. W., Roberts, G. C., & Ommundsen, Y. (2004). Effect of motivational climate on sports personship among competitive youth male and female football players. *Scandinavian Journal of Medicine and Science in Sports*, *14*(3), 193–202. doi:10.1111/j.1600-0838.2003.00320.x

Mujika, I., Santisteban, J., Impellizzeri, F. M., & Castagna, C. (2009). Fitness determinants of success in men's and women's football. *Journal of Sports Sciences*, *27*(2), 107–114. doi:10.1080/02640410802428071

Neto, M. S., Simões, R., Neto, J.A.G., & Cardone, C. P. (2010). Avaliação Isocinética da Força Muscular em Atletas Profissionais de Futebol Feminino. *Revista Brasileira de Medicina do Esporte*, *16*(1), 65–67. doi:10.1590/S1517-86922010000100006

Oliveira, J., Soares, J., & Marques, A. (2000). Avaliação da resistência em desportos de esforço intermitente. In J. Garganta, A. A. Suarez, & C.L. Peñas. A investigação em futebol. Estudos Ibéricos (pp. 85-101). Faculdade de Ciências do Desporto e Educação Física da Universidade do Porto.

Osterning, L. R. (1986). Isokinetic dynamometry: implications for muscle testing and rehabilitation *Medicine Science Sports Exercise,* 14, 45-80.

Pelliccia, S. P., Proschan, A., Granata, M., Spataro, M., Bellone, P.A., & Maron, B. (1994). Morphology of the "athlete's heart" assessed by echocardiography in 947 elite athletes representing 27 sports. *Am J Cardiol*, 74(8), 802–6.

Perrin, D. H. (1993). Isokinetic Exercise and Assessment. Champaign: Human Kinetics.

Pietraszewski, B., Siemienski, A., Bober, T., Struzik, A., Rutkowska-Kucharska, A., Nosal, J., & Rokita, A. (2015). Lower extremity power in female soccer athletes: A pre-season and in-season comparison. *Acta of Bioengineering and Biomechanics, 17*(3), 129–135. doi:10.5277/ABB-00139-2014-02

Portella, D. L., Cossio-Bolaños, M. A., Hespanhol, J. E., & De Arruda, M. (2014). Fat-free mass and bone mineral content positively affect peak torque production in Brazilian soccer players. *Isokinetics and Exercise Science*, *22*(4), 273–278. doi:10.3233/IES-140548

Reed, J. L., De Souza, M. J., & Williams, N. I. (2012). Changes in energy availability across the season in Division I female soccer players. *Journal of Sports Sciences*, *414* (June 2014), 1–11. doi:10.1080/02640414.2012.733019

Reilly, T., & Doran, D. (2003). Fitness assessment. In T. Reilly & A. M. Williams (2nd ed.), Science and soccer (pp. 21-46). Abingdon: Routledge.

Rodrigues, M. N., Silva, S. C. Da, Monteiro, W. D., & Farinatti, P. D. T. V. (2001). Estimativa da gordura corporal através de equipamentos de bioimpedância, dobras cutâneas e pesagem hidrostática. *Revista Brasileira de Medicina Do Esporte*, *7*(4), 125–131.

Rogowski, I., Ducher, G., Brosseau, O., & Hautier, C. (2008). Asymmetry in volume between dominant and nondominant upper limbs in young tennis players. *Pediatric Exercise Science*, *20*(3), 263–72.

Sampson, L. (1985). Food frequency questionnaires as a research instrument. *Clin Nutr*, 4: 171-8.

Sindicato dos Jogadores Profissionais de Futebol (2015). Futebol Feminino. Acessed on November 2015 at: http://www.sjpf.pt/

Silva, P. R. S., Romano, A., Roxo, C.D.M.N., Machado, G. S., Lolla, J.C.C.R, Lepéra, C., Ponte, F. M., Silva, A. A., Riça, W. O., Rosa, A.F., Costa, S. B., Tavares, E. V., Teixeira, A. A. A., Visconti, A. M., Seman, A. P., Firmino, M. T., Costa, R. R., & Cordeiro, J. R. (1999). Características fisiológicas, músculo-esqueléticas, antropométricas e oftalmológicas em jogadoras de futebol feminino consideradas de elite. *Revista Brasileira de Medicina do Esporte 5*(1).

Siri, W. (1961). Body composition from fluid spaces and density: analysis of methods. In J. Brozek & A. Henschel (Eds.), Techniques for Measuring Body Composition (pp. 223–244). Washington, DC: National Academy of Sciences - National Research Council

Soares, S. M., & Fernandes, R. J. (2013). Aferição das cargas a aplicar a nadadores no teste Wingate em cicloergómetro. *Motricidade*, *9*(4), 82–89. doi:10.6063/motricidade.9(4).1162

Valente-Dos-Santos, J., Coelho-e-Silva, M. J., Vaz, V., Figueiredo, A. J., Castanheira, J., Leite, N., Sherar, L.B., Baxter-Jones, A., Elferink-Gemser, M. T., & Malina, R. M. (2013). Ventricular mass in relation to body size, composition, and skeletal age in adolescent athletes. *Clinical Journal of Sport Medicine : Official Journal of the Canadian Academy of Sport Medicine*, *23*(4), 293–9. doi:10.1097/JSM.0b013e318280ac63

Vescovi, J. D. (2012). Sprint speed characteristics of high-level American female soccer players: Female Athletes in Motion (FAiM) Study. *Journal of Science and Medicine in Sport*, *15*(5), 474–478. doi:10.1016/j.jsams.2012.03.006

Vescovi, J. D., Rupf, R., Brown, T. D., & Marques, M. C. (2011). Physical performance characteristics of high-level female soccer players 12-21 years of age. *Scandinavian Journal of Medicine & Science in Sports*, *21*(5), 670–678. doi:10.1111/j.1600-0838.2009.01081.x

Vioque, J., & Gonzalez, L. (1991). Validity of a food frequency questionnaire (preliminary results). *European Journal of Cancer Prevention*, 1: 19-20.

Vispanuu, M., & Jurimae, T. (2007). Handgrip strength and hand dimensions in young handball and basketball players. *Journal of Strength and Condition Research*, *21*(3), 923–929.

Wasserman, K., & McIlroy, M. (1964). Detecting the threshold of anaerobic metabolism in cardiac patients during exercise. Am J Cardiol., (14), 844–52.

Willett, W.C. (1994). Future directions in the development of food-frequency questionnaires. *Am J Clin Nutr*, 59 Suppl: 171S-4S.

Willett, W.C., Sampson, L., Browne, M.L., Stampfer, M.J., Rosner, B., & Hennekens, C.H. (1988). The use of a self-administered questionnaire to assess diet four years in the past. *American Journal of Epidemiology*, 127:188-99.

ATTACHMENTS

Multidimensional Profile Report

Faculty of Sports Science and Physical Education ● University of Coimbra

Name:		**Body Mass (kg):**
Chronological Age (years):	**Position:**	**Stature (cm):**
Sitting Height (cm):		**Leg Length:**
Measurements day:	**Dominant Member:**	

Circumferences in the upper limbs (cm)		
	right	left
Axillary		
Subdeltoid		
Midarm		
Elbow		
Forearm		
Wrist		

Lengths in the upper limbs (cm)		
	right	Left
Length 1		
Length 2		
Length 3		
Length 4		
Length 5		

Circumferences in the lower limbs (cm)		
	right	left
Proximal		
Medial		
Distal		

Lengths in the lower limbs (cm)		
	right	left
Length 1		
Length 2		

Bioelectric impedance analysis		
	units	value
Fat mass	kg	
Fat free mass	kg	
Muscle mass	kg	
TBW	L	
TBW (total body water)		

Air displacement plethysmography		
	units	value
Body mass	kg	
Body volume	L	
Body density	$kg \cdot L^{-1}$	
Fat mass	kg	
Fat free mass	kg	

Multifrequency bioimpedance analysis		
	units	value
Skeletal muscle	kg	
TBW	L	
Fat visceral area	cm^2	
Fat mass: left UL	kg	
Fat mass: right UL	kg	
Fat mass: trunk	kg	
Fat mass: left LL	kg	
Fat mass: right LL	kg	
BMR	kcal	
TBW (total body water); UL (upper limb); LL (lower limb); BMR (basic metabolic rate)		

DXA (whole body)		
	units	value
Lean soft tissue	kg	
BMC	kg	
Bone area	cm^2	
BMD	g/ cm^2	
Fat mass	kg	
Fat free mass	kg	
DXA (dual-energy x-ray absorptiometry); BMC (bone mineral content); BMD (bone mineral density)		

DXA (thighs)			
	units	right	left
Lean soft tissue	kg		
BMC	kg		
Bone area	cm^2		
BMD	g/cm^2		
Fat mass	kg		
DXA (dual-energy x-ray absorptiometry); BMC (bone mineral content); BMD (bone mineral density)			

Hand morphology			
	units	right	left
1D	cm		
2D	cm		
3D	cm		
4D	cm		
5D	cm		
Ratio 2D:4D			

Echocardiography		
	units	value
Telediastolic diameter LV	mm	
Telediastolic diameter LV	mm	
SIV	mm	
Thickness of posterior wall	mm	
Thickness of LV wall	mm	
LV mass	g	
Fractional shortening	%	
Fractional ejection	%	
Root diameter of aortic	mm	
End-diastolic volume	mL	
End-systolic volume	mL	
Mitral annulus velocity	$cm{\cdot}s^{-1}$	
Maximum blood velocity	$cm{\cdot}s^{-1}$	
Gradient in aortic valve	mm·Hg	
TAPSE	mm	
LV (left ventricle); SIV (thickness of interventricular septum); TAPSE (tricuspid annular systolic excursion)		

ISOK		
	units	value
PT extension 60 $°{\cdot}s^{-1}$	$N{\cdot}m^{-1}$	
PT flexion 60 $°{\cdot}s^{-1}$	$N{\cdot}m^{-1}$	
Ratio H/Q (60 $°{\cdot}s^{-1}$)		
PT extension 180 $°{\cdot}s^{-1}$	$N{\cdot}m^{-1}$	
PT flexion 180 $°{\cdot}s^{-1}$	$N{\cdot}m^{-1}$	
Ratio H/Q (180 $°{\cdot}s^{-1}$)		
PT (peak torque); H (hamstrings); Q(quadriceps)		

Handgrip dynamometer		
	units	
right	kg·f	
left	kg·f	

Aerobic Fitness		
	units	value
VT1		
O_2 uptake	$L \cdot min^{-1}$	
O_2 uptake	$mL \cdot kg^{-1} \cdot min^{-1}$	
Heart rate	bpm	
Speed	$Km \cdot h^{-1}$	
RER		
RC		
O_2 uptake	$L \cdot min^{-1}$	
O_2 uptake	$mL \cdot kg^{-1} \cdot min^{-1}$	
Heart rate	bpm	
Speed	$Km \cdot h^{-1}$	
RER		
VO_2max		
O_2 uptake	$L \cdot min^{-1}$	
O_2 uptake	$mL \cdot kg^{-1} \cdot min^{-1}$	
Heart rate	bpm	
Speed	$Km \cdot h^{-1}$	
RER		
Final Stage		
Blood lactate	$mmol \cdot L^{-1}$	
VT1 (ventilatory threshold 1); RC (respiratory compensation point); RER (respiratory exchange ratio)		

TEOSQ	
	value
Ego orientation	
Task orientation	
TEOSQ (task and ego orientation in sport questionnaire)	

Wingate test		
	units	value
Absolute maximum mechanical power	watt	
Relative maximum mechanical power	$watt \cdot kg^{-1}$	
Time at maximum mechanical power	ms	
Absolute average mechanical power	watt	
Relative average mechanical power	$watt \cdot kg^{-1}$	
Power drop	watt	
Power drop	$watt \cdot kg^{-1}$	
Maximum speed	rpm	
Power at maximum speed	watt	
Time at maximum speed	ms	
Decline in power	watt	

FFQ		
	units	value
Calories	kcal	
Proteins	%	
Carbohydrates	%	
Total body fat	%	
Saturated fat	%	
Monounsaturated fat	%	
Polyunsaturated fat	%	
Cholesterol	mg	
Fibers	g	
Ethanol	g	
Calcium	mg	