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Body composition and physiological demands of female soccer players

Comparison between junior and senior levels

Dissertation for the degree of Master of Science (MSc) in Youth Sports Training, supervised by PhD Manuel João Coelho e Silva and PhD André Teixeira Seabra and submitted to the Faculty of Sport Sciences and Physical Education of the University of Coimbra.

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ABSTRACT

Female soccer's participation and development have grown exponentially at all levels in recent years. The *Federação Portuguesa de Futebol*, placed 31st in the Women's International Ranking, registered 13,951 female players participating in organised soccer. The purpose of this study was to obtain a descriptive profile overview of Portuguese female soccer players, comparing junior (under-19) and senior levels. The sample included fifty Portuguese female soccer players (n=50) from the highest senior and junior competitive levels in the country (aged 20.66±4.88 years, stature 161.6±6.3 cm and body mass 58.4±7.7 kg) and completed anthropometry, echocardiography, air displacement plethysmography (ADP), wingate anaerobic fintess, aerobic fitness, dynamometry isokinetic (flexors and extensors of the knee 60, 180 °. s-1) dynamometry manual, task and ego orientation in sport questionnaire (TEOSQ) and food frequency questionnaire (FFQ). Junior participants were heavier (body mass: 60.3±8.5 kg) and had higher levels of fat mass (% fat: 29.4±3.85) than senior players (body mass: 56.8±6.0 kg; % fat: 19.8±5.5). Juniors performed, on average, +41 watt than senior competitive level (t=2.552, $p<0.05$). Substantial inter-variability by age groups in the progressive running treadmill test was apparent in VT_1 in absolute form (juniors: 1.94±0.23 $L.min^{-1}$; seniors: 1.82±0.20 $L.min^{-1}$; t=2.046, $p<0.05$), VT_1 expressed by % of peak oxygen uptake (juniors: 73.6±5.9%; seniors: 69.6±6.7%; t=2.147, $p<0.05$) and in RER at VT_1 (juniors: 0.87±0.07 $L.min^{-1}/L.min^{-1}$; seniors: 0.82±0.08 $L.min^{-1}$, t=2.030, $p<0.05$). Senior players (1.70±0.52) tend to have significant (t=2.637, p <0.01) lower ego orientation compared with juniors (2.24±0.90). Senior players presented significant levels of fat intake indicators in comparison with junior players (fat – juniors: 21.0±6.4 % ; seniors: 29.4±8.9 %; t=-3.881, $p<0.01$; saturated fat – juniors: 6.2±1.8 %; seniors: 7.7±2.6 %; t=-2.427, $p<0.05$; monounsaturated fat – juniors: 8.7±2.8 %; seniors: 13.5±4.8 %; t=-4.354, $p<0.01$), however junior players presented a considerable higher consume of proteins (t=2.300, $p<0.05$) and carbohydrates (t=2.090, $p<0.05$) than seniors. Future studies should consider larger samples, across a more diverse range of age groups, domestic and international soccer demands and between different positions. More attention and resources are required from both clubs and national teams on player nutritional education and awareness of underlying performance and health issues. Increasing soccer physiological demands highlight the importance of periodic performance testing to better prepare players for competition and support physical development towards higher standards of women's soccer.

Keywords: physiological characteristics, muscle strength, goal orientation, nutritional habits.

ABBREVIATIONS LIST

% - Percentage

ADP – Air Displacement Plethysmography

ASE - American Society of Echocardiography

Bpm – beats per minute

CA – Chronological age

CI – Confidence Interval

Cm – Centimetres

CO2 - Carbon dioxide

CV – Coefficients of variation

DXA – Dual energy x-ray absorptiometry

EAE – European Association of Echocardiography

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

FM-ADP – Fat mass by air displacement plethysmography

FPF – Portuguese Football Federation

HR – heart rate

HRmax – maximum heart rate

ISAK – International Society for Advancement in Kinanthropometry

Kcal – calories

Kg – kilogram

Km – kilometres

Km/h – kilometres per hour

LV – Left ventricle

LVM – Left ventricle mass

MHz – Megahertz

O2 – Oxygen

R – Reliability coefficients

RC – Respiratory compensation point

RER – Respiratory exchange ratio

SD – Standard deviation

SE – Standard error

TEOSQ – Task and Ego Orientation in Sport

VE – Ventilation equivalent

VECO2 – Carbon dioxide release

VEVO2 – Respiratory equivalents of oxygen uptake

VO2max – Maximal oxygen uptake

VT1 – First Ventilatory Threshold

VT2 – Second Ventilatory Threshold

WAnT – Wingate Anaerobic Test

TABLES LIST

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

1.1 Female Soccer

The popularity and professionalism of female soccer has increased significantly in recent years and so has the interest amongst the research community, however there still exists a large discrepancy in the number of studies involving male and female players. The most impactful scientific literature on soccer has predominantly focused on physical demands, morphological characteristics, injury reduction and recovery methods, with a majority of descriptive studies on elite populations.

Female soccer's participation and development has grown exponentially at all levels in recent years. The *Federation Internationale de Football Association (FIFA)* has recently released *The Women's Football Survey 2019* which provides a comprehensive picture of the current global overview of female soccer. According to this survey, 73% of FIFA's member associations have an active women's national team (increase of 55% since 2015) and 76% of member associations have developed a women's football strategy. 13.36 million girls and women play organised football worldwide, however the situation varies greatly from country to country with 9.5 million players in the United States of America while most associations only have a few thousand female players. As part of their long-term development strategy for female soccer worldwide, FIFA expect to increase the number of female players to 60 million, develop comprehensive women's football strategies amongst all their member associations and double the organised youth leagues by 2026 (to name a few), in order to address the dropout rate and female participation in soccer.

The *Federação Portuguesa de Futebol (FPF* – Portuguese Football Federation), placed 31st in the Women's International Ranking (FIFA – last updated 13th December 2019), registered 13,951 female players participating in organised soccer. At national level, FPF subdivides female players into under-15, under-16, under-17, under-19 and senior age groups. Portugal's senior female domestic competition is divided into 2 leagues: Liga BPI Women's Soccer League (first tier, 12 teams) and Women's National League (second tier, initially 61 teams organized geographically in 8 divisions of 7-8 teams), whilst the junior (under-19) age group competes domestically at national level (national league, 59 teams; national cup, 47 teams) under the 9-a-side game rules and laws.

Soccer is classified as an intermittent sport, primarily associated with aerobic capacity (Mohr, Krustrup & Bangsbo, 2003) combined with bounds of decisive high intensity efforts. The performance of such anaerobic actions such as sprinting and jumping highly impact key moments in a soccer match (Aziz, Chia & The, 2000) and, ultimately, the match outcome itself. Castelo et al. (1996) referred to the importance of biological and physiological characteristics in soccer's training process and competition success.

1.2 Body Composition

Influence of body composition on soccer performance is somewhat unclear and may differ amongst playing positions. Two studies suggested that the forwards had the lowest percentage of body fat and lowest body mass, whilst the goalkeepers had the highest percentage of body fat, highest body mass and highest stature (Ingebrigtsen et al., 2011; Milanovic et al., 2012). Furthermore, there were no significant differences between playing positions (Ingebrigtsen et al., 2011). Elite female soccer players' average body fat ranged between 16 to 23%, body mass between 52 and 65kg and stature 160 to 169cm (Can et al., 2004; Ingebrigtsen et al., 2011; Milanovic et al., 2012). In a comparison between sexes, the female soccer players tend to have a lower ratio of lean mass to body fat than their male counterparts (Matković et al., 2003) which can negatively influence endurance and power capabilities (Milanovic et al., 2011).

1.3 Physiological Demands

Soccer competition exposes the individual player to 250 short high intensity anaerobic bounds, 39 repeated sprints, every 90 seconds for a period of 2 to 4 seconds (Stolen et al., 2005), with players being exposed to sprinting actions up to 3% of match duration (Di Salvo et al., 2007) depending on playing position. Female soccer requires a high aerobic capacity, with an average of 9.1 to 11.9km total distance covered and average heart rates of 84 to 86% of individual maximum heart rate (Andersson et al., 2010) during competition. Several studies have also indicated good VO_{2max} levels (46–57.6 $mL.Kg^{-1}.min^{-1}$), despite the fact of these levels being lower than the male soccer players (58.4–63.4 $mL.Kg^{-1}.min^{-1}$) (Helgerud et al., 2001; McMillan et al., 2005; Wong et al., 2009).

1.4 Aim

The purpose of this study was to obtain a descriptive profile overview of Portuguese female soccer players, comparing junior (under-19) and senior levels in order to understand the key morphological and physiological characteristics influencing the transition between both age groups, from an amateur/semi-professional to professional soccer. This would provide valuable information for international scientific literature and promote the growth and development of female soccer in Portugal.

CHAPTER II

METHODOLOGY

2.1 Participants

The sample included 50 Portuguese female soccer players (n = 50). They were subdivided into 2 age groups: (G1) 23 senior participants in clubs of Liga BPI Women's Soccer League (Portuguese Women's National Championship): aged 23.68 years, training experience 9.1 years, stature 161.3 cm and body mass 56.8 kg; (G2) 27 juniors aged 17.76 years, training experience 6.2 years, stature 162 cm and body mass 60.3 kg.

2.2 Anthropometry

Body mass (kg) and stature (cm) were measured by a single trained observer following the protocol described in Lohman et al. (1988), also referred by Malina (1995) and Malina et al. (2004) and used as guidelines by ISAK (International Society for Advancement in Kinanthropometry). The participants were weighted barefoot, wearing shorts and sports top. Body mass was measured by 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.

2.3 Echocardiography

Cardiac structure and function were assessed using a GE Vivid 3 echocardiograph, with a 1.5-3.6 MHz multifrequency probe (GE Vingmed Ultrasound, Horten, Norway) by the same observer, as per recommendations of the American Society of Echocardiography (ASE) and the European Association of Echocardiography (Lang et al., 2006). Dimensions and thicknesses of the cardiac cavities were evaluated at rest. M-mode two-dimensional images were recorded to best determine the cardiac morphology. Left ventricular mass (LVM) was calculated using the ASE cubic equation modified by Devereux et al. (1986).

2.4 Air Displacement Plethysmography (ADP)

Body volume was obtained via air displacement plethysmography (Bod Pod Composition System, model Bod Pod 2006 Life Measurement, Inc., Concord, CA, USA). The equipment was tested prior each measurement using a two-point calibration method with a 50.225 L cylinder. Participants were evaluated using underwear and a swim cap only whilst sitting in the Bod Pod chamber, until two consecutive measurements within 150 mL were collected. Body density ($kg.L^{-1}$) was estimated through dividing body mass (kg) by body volume (L) and then converted to percentage of fat mass using the equation of Siri (1961).

2.5 Anaerobic Fitness

The Wingate Anaerobic Test (WAnT) was performed to assess the participants' anaerobic capacity during a 30-second cycling effort at maximum speed with a constant pre-determined resistance (0.075kg body mass) using a friction-loaded cycle-ergometer Monark Peak Bike (Monark 824E, Monark AB, Vargerg, Sweden). Following a standardised warm up at minimal resistance, the test was started at "go" command with an increase in resistance and simultaneous computer activation. The participants were instructed to exert maximally in a seated position throughout the test. Peak power (watts) and mean power (watts) values were determined.

2.6 Aerobic Fitness

Maximum oxygen uptake (VO2max) was determined using a progressive running test in a motorised treadmill (Quasar, HP Cosmos, Germany). Expiratory O2 and CO2 concentrations and flow were measured breath-by-breath using an automated metabolic card (Quark CPED, Cosmed, Italy). Flow and volume were calibrated before each individual test using a 3-L capacity syringe (Hans Rudolph, Kansas City, MO). Meantime, CO2 and O2 sensors were calibrated for ambient air and of known gas concentrations (Cosmed, UN1956, 560L, 2200 psig, 70 °F): 12.01% and 5% for O2 and CO2, respectively. The test started at a running speed of 8 km/h and 2% inclination for two minutes, with an increment of 1 km/h every minute thereafter whilst maintaining constant inclination until participant's exhaustion. Following completion of each level, the subjects rated their perception of effort (Borg CR10 Scale). Heart rate (bpm) was monitored throughout the whole test via an HR monitor (model T81 - CODED, Polar Electro, Finland)*. Blood lactate (mmol.L^{-1}) was determined using a portable analyser (Lactate Pro2 Analyzer, Arcay, Inc.) one and three minutes post-test. The maximum rate of oxygen consumption was obtained when at least four of the five measures were observed: (1) plateau in oxygen consumption throughout the incremental running speeds; (2) heart rate higher than 95% predicted maximum heart rate for participant's age; (3) level of blood lactate contraction above 8 mmol.L^{-1}; (4) respiratory exchange ratio (RER) exceeding 1.05; (5) subjective exhaustion (Borg CR10 Scale). Subsequently, VO_2 values (VT_1, VT_2 and $VO_{2\ peak}$), heart rate (bpm), test velocities (km.h^{-1}), RER and blood lactate concentration at the end were considered for this study.

2.7 Isokinetic Dynamometry assessment (knee flexors and extensors)

Isokinetic concentric strength of the knee flexors and extensors were measured at 60.s^{-1} and 180.s^{-1} using a Biodex System 3 dynamometer (Shirley, NY, USA). Following a 5-minute warm up on the cycle ergometer (Monark 814E, Varberg, Sweden) with a resistance of 2% of the body mass at 50 to 60rpm and 2 minutes static stretching of the quadriceps, hamstrings and adductors (20 seconds each), the participants completed a specific three-repetition trial prior their five repetitions on their dominant leg whilst remaining in a seated position with arms crossed (hands on shoulders) using the same protocol and sequence described by Duarte et al. (2018). Highest peak torque values were recorded for both knee flexion and extension during concentric muscular action only and expressed in Newton per meter (N.m).

2.8 Hand grip dynamometer

Hand grip isometric strength was measured by a manual dynamometer Lafayette (model 78010, Lafayette, IN, USA). Participants were tested three times on each hand whilst standing with arms fully extended alongside yet away from the body. Results were expressed in kilograms (kg.f).

2.9 Goal orientation

A Portuguese version (Fonseca & Biddle 1996) of the Task and Ego Orientation in Sport Questionnaire (Duda 1989; Chi & Duda 1992) was completed by all players. Cronbach's alphas (task, 0.76; ego, 0.85) indicated acceptable internal consistency. This questionnaire was already used by the FCDEF research group focused on soccer research (Figueiredo et al. 2009).

2.10 Food frequency questionnaire (FFQ)

A self-administered questionnaire (FFQ) was applied to obtain seasonality, frequency and dose volume for 86 food items (Lopes, 2000). The questionnaire was adapted for the Portuguese and informs about the habitual consumption using a scale of nine options (from "never or less than once a month" to "6 or more times per day"). The final values summarize the amount of calories and macronutrients (Lopes et al. 2007).

2.11 Analyses

Descriptive statistics were determined for all variables (personal, anthropometry, body composition, aerobic fitness, Wingate test outputs, goal orientations, food questionnaire outputs): range, mean (value, standard error, 95% confidence interval) and standard deviation. Afterwards, comparisons between groups (seniors vs juniors) were performed using t-test including a previous verification of homogeneity of variances. All analyses were done using IBM version 24.0 software (SPSS Inc, Company, New York).

CHAPTER III

RESULTS

The descriptive statistic tables featured 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, whilst the statistic of comparison tables highlighted t-test values to consider inter-group significance.

Table 1 summarizes descriptive statistics (range, mean, standard error, 95% confidence limits of the mean and standard deviation) of chronological age (CA), training experience, stature, body mass, air-displacement plethysmography parameters and LVM estimated by echocardiography. CA ranged from 16 to 38 years (range 22.01). Mean values for stature and body mass were 161.6 and 58.4, respectively. Additionally, estimated fat mass was, on average, 25.6%.

Short, intermediate and treadmill laboratory outputs are described in Table 2. Short-maximal output (i.e. absolute peak output) ranged from 443 to 869 watts whilst mean output was, on average, 426 watts and 7.36 watt, after normalising for body mass. Furthermore, oxygen consumption at VT1 and VT2 were 1.87 L.min-1 and 2.38 L.min-1, respectively. VO2peak was, on average, 2.63 L.min-1.

Neuromuscular parameters obtained from isokinetic dynamometer and isometric hand grip are described in Table 3. As expected, mean vales of peak torque in extensors and flexors increased with the velocity. For the knee extensors, mean value at 60.s-1 was 137 N.m and at 180.s-1 was 92 N.m. On the knee flexors, mean value at 60.s-1 was 81 N.m and at 180.s-1 was 63 N.m. Hand grip strength presented higher values in right upper limb (29.3±5.2 N.m-1). Table 4 summarises descriptive statistics for task and ego orientations, with higher mean values for task orientation (1.95±0.74) comparing with ego orientation (4.06±0.43).

Table 5 summarizes food frequency questionnaire outputs. The estimated energy expenditure among soccer female players was, on overage, 2268 kcal. Carbohydrates were the main macronutrient consumed by players (53.3±8.4 %). The percentage of fat (24.5±8.1) tend to be higher than protein (23.0±4.4) intake.

Junior participants were, on average, heavier (body mass: 60.3±8.5 kg) and presented higher mean values of fat mass (% fat: 29.4±3.85) than senior players (body mass: 56.8±6.0 kg; % fat: 19.8±5.5). On the other hand, comparable values of LVM were noted for junior (123.1±13.2 g) and senior players (122.0±19.5 g) – Table 6. Differences between groups were non-significant for overall body size, composition and LVM ($p>0.05$).

Comparable values for peak power output among competitive age groups were observed (juniors: 625±87 watt; seniors: 592±100 watt). However, junior players performed, on average, +41 watt than senior competitive level ($t=2.552$, $p<0.05$). Additionally, substantial inter-variability by age groups in the progressive running treadmill test was apparent in VT1 in absolute form (juniors: 1.94±0.23 L.min-1; seniors: 1.82±0.20 L.min-1; $t=2.046$, $p<0.05$), VT1 expressed by % of peak oxygen uptake (juniors: 73.6±5.9%; seniors: 69.6±6.7%; $t=2.147$, $p<0.05$) and in RER at VT1 (juniors: 0.87±0.07 L.min-1/L.min-1; seniors: 0.82±0.08 L.min-1, $t=2.030$, $p<0.05$).

Descriptive statistics and comparisons between the two age groups for neuromuscular parameters are demonstrated in Table 10 and Table 11, respectively. Mean values for isokinetic outputs and hand-grip test were similar in juniors and seniors and consequently, mean differences between groups were trivial.

Principal components extracted from task and ego orientations indicate that senior players (1.70±0.52) tend to have significant ($t=2.637$, $p<0.01$) lower ego orientation compared with juniors (2.24±0.90), however task orientation is equivalent in junior and senior players ($t=1.217$, $p=0.23$) – Table 12 e 13.

Inter-individual variation in the food frequency questionnaire and mean comparisons are summarized in Table 14 and Table 15. Estimated energy intake was +345 kcal in seniors than junior players. Senior players presented substantial levels of fat intake indicators in comparison with junior players (fat – juniors: 21.0±6.4 % ; seniors: 29.4±8.9 %; $t=-3.881$, $p<0.01$; saturated fat – juniors: 6.2±1.8 %; seniors: 7.7±2.6 %; $t=-2.427$,

$p<0.05$; monounsaturated fat – juniors: 8.7±2.8 %; seniors: 13.5±4.8 %; $t=-4.354$, $p<0.01$). Contrarily, junior players presented a considerable higher consume of proteins ($t=2.300$, $p<0.05$) and carbohydrates ($t=2.090$, $p<0.05$) than seniors.

Table 1. Descriptive statistics for chronological age, training experience, body size, body composition and heart size among female soccer players.

		units	range		mean				standard deviation
			minimum	maximum	value	standard error	95% confidence limits		
							lower limit	upper limit	
Personal	Chronological age	years	15.68	37.79	20.66	0.74	19.16	22.16	4.88
	Training experience	years	2.00	20.00	7.53	0.70	6.13	8.94	4.56
Anthropometry	Stature	cm	148.9	176.0	161.6	1.0	159.7	163.5	6.3
	Body mass	kg	42.048	79.040	58.358	1.180	55.976	60.739	7.738
ADP	Thoracic gas volume	L	2.180	3.587	2.931	0.044	2.841	3.020	0.291
	Body volume	L	39.325	75.955	55.672	1.219	53.212	58.132	7.993
	Body density	$kg.L^{-1}$	1.019	2.045	1.073	0.023	1.026	1.120	0.152
	Fat mass	kg	3.9	88.1	34.0	4.3	25.3	42.6	28.2
	Fat mass	%	7.8	28.4	25.6	4.7	16.1	35.1	30.8
	Fat free mass	kg	36.6	60.6	45.8	0.7	44.4	47.1	4.4
	Fat free mass	%	5.7	92.2	64.2	4.4	55.3	73.0	28.7
Echocardiography	Left ventricular mass	g	78.0	156.0	121.7	2.6	116.4	126.9	17.1

ADP (air displacement plethysmography).

Table 2. Descriptive statistics for metabolic parameters obtained from Wingate test (anaerobic test) and progressive maximal running treadmill test (aerobic fitness) among female soccer players.

		units	range		mean				standard deviation
			minimum	maximum	value	standard error	95% confidence limits lower limit	95% confidence limits upper limit	
WAnT	Absolute peak output	watt	443	869	622	13	595	649	88
	Relative peak output by body mass	$watt.kg^{-1}$	8.70	14.20	10.73	0.19	10.34	11.12	1.26
	Absolute mean output	watt	341	639	426	9	408	445	60
	Relative mean output by body mass	$watt.kg^{-1}$	5.80	9.60	7.36	0.13	7.10	7.61	0.83
Treadmill	Absolute VT_1	$L.min^{-1}$	1.47	2.71	1.87	0.04	1.80	1.95	0.23
	Relative VT_1 by body mass	$mL.kg^{-1}.min^{-1}$	21.15	41.10	31.85	0.61	30.63	33.07	3.97
	VT_1 (% peak VO_2)	%	56.07	90.22	71.58	1.01	69.54	73.62	6.61
	Heart rate at VT_1	bpm	122	187	154	2	150	158	13
	Velocity at VT_1	$km.h^{-1}$	8.0	11.0	8.5	0.1	8.3	8.7	0.7
	Respiratory exchange ratio at VT_1	$L.min^{-1}/L.min^{-1}$	0.65	1.03	0.85	0.01	0.83	0.87	0.08
	Absolute VT_2	$L.min^{-1}$	1.93	3.15	2.38	0.04	2.29	2.46	0.28
	Relative VT_2 by body mass	$mL.kg^{-1}.min^{-1}$	27.33	49.40	40.43	0.69	39.04	41.83	4.54
	VT_2 (% peak VO_2)	%	82.0	100.0	90.5	0.7	89.2	91.8	4.3
	Heart rate at VT_2	bpm	158	199	175	1	173	178	9
	Velocity at VT_2	$km.h^{-1}$	9.0	15.0	11.7	0.2	11.3	12.0	1.1
	Respiratory exchange ratio at VT_2	$L.min^{-1}/L.min^{-1}$	0.87	1.12	1.01	0.01	0.99	1.02	0.06
	Absolute VO_2 peak	$L.min^{-1}$	2.13	3.41	2.63	0.04	2.54	2.71	0.29
	Relative VO_2 peak by body mass	$mL.kg^{-1}.min^{-1}$	30.30	55.30	44.67	0.76	43.14	46.21	5.00
	Heart rate at VO_2 peak	bpm	172	204	185	1	183	187	7
	Velocity at VO_2 peak	$km.h^{-1}$	11.0	17.0	13.8	0.2	13.4	14.2	1.4
	Respiratory exchange ratio at VO_2 peak	$L.min^{-1}/L.min^{-1}$	0.99	1.30	1.15	0.01	1.13	1.17	0.07

WAnT (Wingate anaerobic test); VO_{2peak} (peak oxygen uptake); VT_1 (first ventilatory threshold); VT_2 (second ventilatory threshold).

Table 3. Descriptive statistics for neuromuscular parameters obtained from isokinetic strength test of knee muscle actions and isometric hand grip strength test among female soccer players.

Type	velocity / muscle group / contraction [protocol / laterality]			units	range		mean				standard deviation
					minimum	maximum	value	standard error	95% confidence limits		
									lower limit	upper limit	
Isokinetic	60º.s^{-1}	Knee extensors	concentric	N.m	96	225	137	4	130	145	23
		Knee flexors	concentric	N.m	53	114	81	2	76	85	15
	180º.s^{-1}	Knee extensors	concentric	N.m	50	129	92	2	88	97	15
		Knee flexors	concentric	N.m	37	94	63	2	60	67	12
Isometric	Hand grip strength		left	kg.f	14.0	37.0	26.3	0.7	24.8	27.8	4.7
			right	kg.f	20.0	42.0	29.3	0.8	27.8	30.9	5.2

Table 4. Descriptive statistics for principal components extracted from task and ego orientations sports questionnaire (TEOSQ) among female soccer players.

Goal orientations	units	range		mean				standard deviation
		minimum	maximum	value	standard error	95% confidence limits		
						lower limit	upper limit	
Ego orientations	#	1.00	3.50	1.95	0.11	1.72	2.18	0.74
Task orientations	#	3.14	4.86	4.06	0.07	3.92	4.19	0.43

Table 5. Descriptive statistics for parameters of habitual food intake among female soccer players.

Parameter	units	range		mean				standard deviation
		minimum	maximum	value	standard error	95% confidence limits		
						lower limit	upper limit	
Estimated energy intake	kcal	1096	4898	2268	117	2032	2505	769
Proteins	%	13.0	35.8	23.0	0.7	21.6	24.3	4.4
Carbohydrates	%	32.0	71.9	53.3	1.3	50.7	55.9	8.4
Fat	%	10.0	40.0	24.5	1.2	22.1	27.0	8.1
Saturated fat	%	3.4	12.0	6.9	0.4	6.2	7.6	2.3
Monounsaturated fat	%	3.6	18.2	10.6	0.6	9.5	11.8	3.8
Cholesterol	mg	116	813	397	24	348	446	158
Fiber	g	8.0	79.0	28.0	2.2	23.5	32.5	14.7
Ethanol	g	0.00	44.00	3.73	1.17	1.36	6.09	7.69
Calcium	mg	294	2769	923	76	770	1076	498

Table 6. Descriptive statistics for chronological age, training experience, body size, body composition and heart size by competitive age group among female soccer players.

Domain	Variable	units	junior			senior		
			n	mean	standard deviation	n	mean	standard deviation
Personal	Chronological age	years	27	17.76	1.20	23	23.68	5.16
	Training experience	years	27	6.2	3.4	23	9.1	4.8
Anthropometry	Stature	cm	27	162.0	6.1	23	161.3	6.2
	Body mass	kg	27	60.3	8.5	23	56.8	6.0
ADP	Thoracic gas volume	L	27	2.741	0.592	23	2.958	0.473
	Body volume	L	27	57.840	8.820	23	54.078	6.266
	Body density	$kg.L^{-1}$	27	1.083	0.193	23	1.144	0.429
	Fat mass	kg	27	34.7	24.6	23	33.6	31.5
	Fat mass	%	27	29.4	3.85	23	19.8	5.5
	Fat free mass	kg	27	46.7	4.7	23	45.5	4.1
	Fat free mass	%	27	67.9	25.0	23	60.9	31.8
Echocardiography	Left ventricular mass	g	27	123.1	13.2	23	122.0	19.5

ADP (air displacement plethysmography).

Table 7. Statistics of comparisons between competitive age groups on chronological age, training experience, body size, body composition and heart size among female soccer players.

Domain	Variable	units	Homogeneity of variances		mean differences			t-test	
			F	p	value	95% confidence limits		t-value	p
						lower	upper		
Personal	Chronological age	years	14.216	0.000	-5.916	-8.187	-3.645	-5.377*	0.001*
	Training experience	years	1.104	0.299	-2.945	-5.284	-0.606	-2.532*	0.015*
Anthropometry	Stature	cm	0.014	0.907	0.735	-2.751	4.222	0.424	0.673
	Body mass	kg	2.625	0.112	3.567	-0.698	7.832	1.682	0.099
ADP	Thoracic gas volume	L	0.755	0.389	-0.217	-0.526	0.091	-1.416	0.163
	Body volume	L	2.469	0.123	3.762	-0.663	8.186	1.710	0.094
	Body density	$kg.L^{-1}$	1.415	0.240	-0.060	-0.245	0.124	-0.657	0.514
	Fat mass	kg	3.019	0.089	1.085	-14.892	17.062	0.137	0.892
	Fat mass	%	2.004	0.163	9.651	-6.636	25.938	1.191	0.239
	Fat free mass	kg	0.002	0.968	1.186	-1.340	3.712	0.944	0.350
	Fat free mass	%	4.244	0.045	6.993	-9.529	23.515	0.854	0.398
Echocardiography	Left ventricular mass	g	2.061	0.158	1.068	-8.267	10.402	0.230	0.819

ADP (air displacement plethysmography); * (p<0.05).

Table 8. Descriptive statistics for metabolic parameters obtained from Wingate test (anaerobic test) and progressive maximal running treadmill test (aerobic fitness) by competitive age group among female soccer players.

		units	junior			senior		
			n	mean	standard deviation	n	mean	standard deviation
WAnT	Absolute peak output	watt	27	625	87	22	592	100
	Relative peak output by body mass	$watt.kg^{-1}$	27	10.44	1.35	22	10.51	1.60
	Absolute mean output	watt	27	442	58	22	401	53
	Relative mean output by body mass	$watt.kg^{-1}$	27	7.40	0.89	22	7.13	0.79
Treadmill	Absolute VT_1	$L.min^{-1}$	26	1.94	0.23	23	1.82	0.20
	Relative VT_1 by body mass	$mL.kg^{-1}.min^{-1}$	26	32.24	4.05	23	31.41	3.88
	VT_1 (% peak VO_2)	%	24	73.6	5.9	23	69.6	6.7
	Heart rate at VT_1	bpm	24	150	35	22	143	34
	Velocity at VT_1	$km.h^{-1}$	24	8.5	0.7	23	8.6	0.6
	Respiratory exchange ratio at VT_1	$L.min^{-1}/L.min^{-1}$	24	0.87	0.07	23	0.82	0.08
	Absolute VT_2	$L.min^{-1}$	24	2.40	0.28	23	2.37	0.30
	Relative VT2 by body mass	$mL.kg^{-1}.min^{-1}$	24	40.30	4.41	23	40.91	4.46
	VT_2 (% peak VO_2)	%	24	90.8	4.3	23	90.6	4.4
	Heart rate at VT_2	bpm	23	177	9	21	173	9
	Velocity at VT_2	$km.h^{-1}$	24	11.5	1.3	23	11.87	0.69
	Respiratory exchange ratio at VT_2	$L.min^{-1}/L.min^{-1}$	24	1.02	0.05	23	0.99	0.06
	Absolute VO_2 peak	$L.min^{-1}$	24	2.65	0.28	23	2.62	0.32
	Relative VO_2 peak by body mass	$mL.kg^{-1}.min^{-1}$	24	44.35	5.01	23	45.23	4.64
	Heart rate at VO_2 peak	bpm	23	186	6	21	184	8
	Velocity at VO_2 peak	$km.h^{-1}$	24	13.5	1.6	23	14.1	1.1
	Respiratory exchange ratio at VO_2 peak	$L.min^{-1}/L.min^{-1}$	23	1.16	0.06	23	1.14	0.07

WAnT (Wingate anaerobic test); VO_{2peak} (peak oxygen uptake); VT_1 (first ventilatory threshold); VT_2 (second ventilatory threshold).

Table 9. Statistics of comparisons between competitive age groups on metabolic parameters obtained from Wingate test (anaerobic test) and progressive maximal running treadmill test (aerobic fitness) among female soccer players.

Domain	Variable	units	Homogeneity of variances		mean differences			t-test	
			F	p	Value	95% confidence limits lower	95% confidence limits upper	t-value	p
WAnT	Absolute peak output	watt	0.421	0.520	33.022	-20.798	86.842	1.234	0.223
	Relative peak output by body mass	$watt.kg^{-1}$	0.553	0.461	-0.069	-0.918	0.779	-0.164	0.870
	Absolute mean output	watt	0.079	0.780	40.998	8.683	73.314	2.552*	0.014*
	Relative mean output by body mass	$watt.kg^{-1}$	0.050	0.824	0.272	-0.216	0.760	1.121	0.268
Treadmill	Absolute VT_1	$L.min^{-1}$	0.125	0.725	0.128	0.002	0.254	2.046*	0.046*
	Relative VT1 by body mass	$mL.kg^{-1}.min^{-1}$	0.081	0.778	0.828	-1.461	3.117	0.728	0.470
	VT_1 (% peak VO_2)	%	1.202	0.279	3.935	0.243	7.627	2.147*	0.037*
	Heart rate at VT_1	bpm	0.000	0.988	6.977	-13.569	27.524	0.684	0.497
	Velocity at VT_1	$km.h^{-1}$	0.202	0.655	-0.065	-0.454	0.323	-0.338	0.737
	Respiratory exchange ratio at VT_1	$L.min^{-1}/L.min^{-1}$	0.509	0.479	0.043	0.000	0.085	2.030*	0.048*
	Absolute VT_2	$L.min^{-1}$	0.028	0.868	0.033	-0.136	0.202	0.394	0.695
	Relative VT2 by body mass	$mL.kg^{-1}.min^{-1}$	0.069	0.795	-0.608	-3.214	1.998	-0.470	0.641
	VT_2 (% peak VO_2)	%	0.214	0.646	0.232	-2.350	2.814	0.181	0.857
	Heart rate at VT_2	bpm	0.001	0.977	3.741	-1.713	9.195	1.384	0.174
	Velocity at VT_2	$km.h^{-1}$	5.686	0.021	-0.328	-0.948	0.292	-1.073	0.290
	Respiratory exchange ratio at VT_2	$L.min^{-1}/L.min^{-1}$	0.683	0.413	0.031	-0.001	0.063	1.967	0.055
	Absolute VO_2 peak	$L.min^{-1}$	0.000	0.985	0.028	-0.148	0.203	0.319	0.751
	Relative VO_2 peak by body mass	$mL.kg^{-1}.min^{-1}$	0.037	0.848	-0.881	-3.721	1.959	-0.625	0.535
	Heart rate at VO_2 peak	bpm	0.631	0.432	1.758	-2.569	6.084	0.820	0.417
	Velocity at VO_2 peak	$km.h^{-1}$	3.228	0.079	-0.589	-1.375	0.198	-1.508	0.139
	Respiratory exchange ratio at VO_2 peak	$L.min^{-1}/L.min^{-1}$	0.927	0.341	0.018	-0.023	0.059	0.881	0.383

WAnT (Wingate anaerobic test); VO_{2peak} (peak oxygen uptake); VT_1 (first ventilatory threshold); VT_2 (second ventilatory threshold);* ($p<0.05$).

Table 10. Descriptive statistics for neuromuscular parameters obtained from isokinetic strength test of knee muscle actions and isometric hand grip strength test by competitive age group among female soccer players.

Type	velocity / muscle group / contraction [protocol / laterality]			units	junior			senior		
					n	mean	standard deviation	n	mean	standard deviation
Isokinetic	$60^{o}.s^{-1}$	Knee extensors	concentric	N.m	27	137	26	23	139	18
		Knee flexors	concentric	N.m	27	79	16	23	82	12
	$180^{o}.s^{-1}$	Knee extensors	concentric	N.m	27	91	18	23	93	12
		Knee flexors	concentric	N.m	27	62	15	23	64	10
Isometric	Hand grip strength		left	kg.f	27	26.4	4.7	23	26.7	4.8
			right	kg.f	27	29.1	4.8	23	29.7	5.4

Table 11. Statistics of comparisons between competitive age groups on neuromuscular parameters obtained from isokinetic strength test of knee muscle actions and isometric hand grip strength test among female soccer players.

Type	velocity / muscle group / contraction [protocol / laterality]			units	Homogeneity of variances		mean differences			t-test	
					F	p	value	95% confidence limits lower	95% confidence limits upper	t-value	p
Isokinetic	$60^o.s^{-1}$	Knee extensors	concentric	N.m	0.750	0.391	-1.950	6.382	-14.782	-0.306	0.761
		Knee flexors	concentric	N.m	2.809	0.100	-3.113	-11.236	5.010	-0.770	0.445
	$180^o.s^{-1}$	Knee extensors	concentric	N.m	2.425	0.126	-2.588	-11.324	6.149	-0.596	0.554
		Knee flexors	concentric	N.m	1.680	0.201	-2.638	-9.919	4.644	-0.728	0.470
Isometric	Hand grip strength		left	kg.f	0.237	0.628	-0.369	-3.051	2.313	-0.276	0.783
			right	kg.f	1.195	0.280	-0.585	-3.477	2.308	-0.406	0.686

* (p<0.05).

Table 12. Descriptive statistics for principal components extracted from task and ego orientations sports questionnaire (TEOSQ) by competitive age group among female soccer players.

Goal orientations	units	junior			senior		
		n	mean	standard deviation	n	mean	standard deviation
Ego orientations	#	27	2.24	0.90	23	1.70	0.52
Task orientations	#	27	4.16	0.42	23	4.01	0.47

Table 13. Statistics of comparisons between competitive age groups on principal components extracted from task and ego orientations sports questionnaire (TEOSQ) among female soccer players.

Goal orientations	units	Homogeneity of variances		mean differences			t-test	
		F	p	value	95% confidence limits		t-value	p
					lower	upper		
Ego orientations	#	11.745	0.001	0.540	0.127	0.953	2.637*	0.012*
Task orientations	#	0.583	0.449	0.152	-0.099	0.403	1.217	0.230

* (p<0.05).

Table 14. Descriptive statistics for parameters of habitual food intake among female soccer players.

Parameter	units	junior			senior		
		n	mean	standard deviation	n	mean	standard deviation
Estimated energy intake	kcal	27	2208	825	23	2553	833
Proteins	%	27	24.7	4.5	23	21.8	4.5
Carbohydrates	%	27	54.7	8.0	23	49.9	8.4
Fat	%	27	21.0	6.4	23	29.4	8.9
Saturated fat	%	27	6.2	1.8	23	7.7	2.6
Monounsaturated fat	%	27	8.7	2.8	23	13.5	4.8
Cholesterol	mg	27	423	229	23	415	157
Fiber	g	27	26.3	14.6	23	30.9	15.5
Ethanol	g	27	3.6	13.5	23	6.2	9.8
Calcium	mg	27	919	498	23	1061	688

Table 15. Statistics of comparisons between competitive age groups on parameters of habitual food intake among female soccer players.

Parameter	units	Homogeneity of variances		mean differences			t-test	
		F	p	value	95% confidence limits		t-value	p
					lower	upper		
Estimated energy intake	kcal	0.073	0.789	-344.680	-817.367	128.008	-1.466	0.149
Proteins	%	0.074	0.787	2.927	0.368	5.486	2.300*	0.026*
Carbohydrates	%	0.002	0.967	4.850	0.184	9.515	2.090*	0.042*
Fat	%	2.451	0.124	-8.408	-12.764	-4.052	-3.881*	0.001*
Saturated fat	%	6.778	0.012	-1.559	-2.858	-0.260	-2.427*	0.020*
Monounsaturated fat	%	2.878	0.096	-4.780	-6.988	-2.572	-4.354*	0.000*
Cholesterol	mg	0.671	0.417	8.005	-105.483	121.492	0.142	0.888
Fiber	g	0.014	0.906	-4.654	-13.225	3.917	-1.092	0.280
Ethanol	g	0.050	0.824	-2.516	-9.344	4.313	-0.741	0.462
Calcium	mg	0.737	0.395	-141.953	-480.055	196.149	-0.844	0.403

* (p<0.05).

CHAPTER IV

DISCUSSION

This study profiled Portuguese female soccer players and compared them by competitive age group (juniors vs seniors) on a multivariable approach, with a clear focus on body composition and physiological demands. The participants had more than two years of training experience, played in different positions and some were involved with the Portuguese national teams at youth and senior levels. Although, it is important to note that this study only considered a small portion of the current number of female soccer players registered in organised soccer in Portugal, with a limited sample of 0.52% and 0.60% of the total amount of adult players (over 18 years old) and youth players (under 18 years old), respectively (data obtained from FIFA Women's Football Survey, 2019). Therefore, the present study gives us a representation of the Portuguese female soccer players on body size and composition, aerobic and anaerobic capacity, muscle strength, goal orientation and eating habits.

The main findings suggested that junior participants were heavier and presented higher fat mass than seniors, although inter-group relationship was trivial. Additionally, juniors attained significantly better results for mean output (figure 1), oxygen consumption at VT_1 (both absolute and percentage of peak oxygen uptake) and respiratory exchange ratio at VT_1 in comparison with the senior participants (figure 2). Seniors demonstrated considerably lower ego orientation (figure 3) and presented substantial levels of fat intake (fat, saturated fat and monounsaturated fat) than the juniors, however the latter group expressed a significant higher consume of proteins and carbohydrates (figure 4). Analyses failed to confirm differences in muscle strength between the two groups.

Body size and composition

Observations on the overall body size dimensions (i.e. stature and body mass) of the current sample are comparable with other studies involving female soccer players from Spain (Mujika et al., 2009; Sedano et al., 2009) and Turkey (Can et al., 2004). Among 190 female soccer players from two different competitive levels (regional vs national) mean stature and body mass were, approximately, ~161 cm and ~81 kg, respectively. In contrast, comparisons by competitive age group among 34 females professional Spanish players (Mujika et al., 2009) are not consistent with the description of the present sample. In the current study, trivial differences were noted between juniors and seniors in stature. Meanwhile, junior players were +3.5 kg heavier than seniors. Junior and senior Spanish female soccer players tended to present comparable mean values for stature and body mass (Mujika et al., 2009). The hypothesis that overall body size descriptors are not meaningful parameters to reach the senior age group was suggested. Additionally, fat mass of the present sample is, on average, greater than previous studies with Spanish (Gravina et al., 2011), Danish (Krustrup et al., 2010), Turkish (Can et al., 2004) and Czech (Bunc et al., 2004) players. Among 40 senior elite Danish players fat mass percentage was 14% (ranged 9.3-21.6%). However, methodologic assumptions to estimate fat mass percentage were not detailed. Furthermore, junior players of the present sample appeared to present a higher fat mass compared with seniors which may explain inter-individual variation in body mass. Other considerations that may influence higher body mass and fat mass in the juniors are their potential reduced training volume exposure and limited contact with specialized support staff such as nutritionists, in order to improve their education and enhance performance.

In the present study, overall body size did not discriminate players by competitive age groups. Nevertheless, an excessive of fatness tends to create a negative influence in soccer as the sport require the displacement and projection of gravity centre (Malina & Geithner, 2011). Sport scientists/strength and conditioning coaches should optimise metabolic active tissues and consequently, reducing fat mass percentage in order to overcome soccer metabolic demands.

Body composition and Nutritional habits

There is a paucity of nutrition assessment data in elite female athletes. Mean values for energy intake among juniors were similar those were reported among Canadian young adult soccer players. As expected, senior group consumed +345 kcal than young age-group. Carbohydrates are the principal fuel consumed during soccer patters (Burke et al., 2004). The percentage of total intake recommended for carbohydrates and proteins ranged from 45-65% and 10-30%, respectively (Otten et al., 2006) which was verified in junior and senior competitive age groups. On the other hand, total fat intake guidelines ranged from 25-35% (Otten et al., 2006). Junior players tended to present lower values according to the recommendations for soccer players. Nutritional guidelines did not differ from senior to younger age groups, therefore further studies should define age-group specific nutritional guidelines for adolescent athletes.

Physiological characteristics

Datson et al (2014) have completed a comprehensive review, highlighting a considerable number of elite female soccer studies on physiological demands. Specifically, the relationship of heart rate and maximal oxygen uptake (VO_{2max}) was used to estimate aerobic capacity. During competition, female soccer players work at an average of 77-80% of VO_{2max} and 86±3% of maximum heart rate (HR_{max}) with peak values of 96% and 98±1%, respectively. VO_{2max} for elite players has been reported at 49.4-57.6 $mL.kg^{-1}.min^{-1}$, with some studies using an estimation from the multistage fitness test. Similarly, Martinez-Lagunas et al. (2014) have also reviewed several female soccer investigations from diverse nationalities and competition levels. VO_{2max} ranged from 45.1-55.5 $mL.kg^{-1}.min^{-1}$ and HR_{max} ranged from 189-202 bpm, however the measurement methods were not detailed. Additionally, Krustrup et al. (2005) studied 14 Danish elite female soccer players and monitored their heart rate (HR) with chest straps during 4 competitive matches. Mean HR was recorded at 167 bpm (87% HRmax) and peak HR in competition was 186 bpm (97% HR_{max}). Based on outcomes from a laboratory incremental treadmill test, HR- VO_2 relationship were calculated. VO_2 in competition was estimated at 2.2 L. min^{-1} (77% VO_{2max}) and VO_2 peak estimated at 96%. All these values reinforce the importance of the aerobic energy system during soccer competition.

In this study, mean VO_2 peak was 2.63±0.29 L. min^{-1} and relative VO_2 peak was 44.67±5.00 $mL.kg^{-1}.min^{-1}$ across both competitive groups, with no significant differences found between groups. Likewise, mean HR at VO_2 peak was 185±7 bpm and trivial differences between groups. These values were similar to the available literature on female soccer for both VO_2 peak and HR, however Datson et al. (2014) reported slightly higher values for elite national team players than the other investigations. This difference may be a result of the standards of competition (part-time amateur/semi-professional vs full-time professional) at the time of the studies and, therefore, international level players could have been involved in greater training loads with regular access to specialised support staff (i.e. full-time sport scientists/strength and conditioning coaches).

Highly developed anaerobic capacity is also critical in soccer to support performance of high-intensity actions such as accelerations, decelerations and changes in direction throughout the game (Turner et al, 2013), yet limited information is available in the literature. Particularly using the Wingate test, Fallon et al. (2015) studied a small sample of collegiate athletes and reported peak power output of 533±90 watt and mean power output of 465±70 watt. When compared to the present study, the participants achieved higher peak power (622±88 watt) but lower mean outputs (426±60 watt). Additionally, juniors produced significantly higher mean power outputs than the seniors, however the difference was trivial when normalised to body mass (relative mean output) as the juniors were heavier and had higher fat mass. Therefore, further considerations must be given to body composition characteristics in the attempt to improve the test outcomes. Future studies should acknowledge force-velocity relationship and optimize the test for metabolic active tissues.

Goal orientation

Little information exists on the ego and task orientation of female soccer players. One study comparing female and male sport behaviors (Kavussanu et al., 2009) reported less empathy and more antisocial nature amongst male athletes. Another study (Eubank and Gilbourne, 2003) stated that perceived self-confidence in goal achievement is directly linked with task succession.

This study observed a higher task (4.06±0.43) than ego orientation (1.95±0.74) amongst all participants, where enjoyment seems to support goal achievement.

Limitations and Future Research

Although the present study considers a multidimensional profile of junior and senior female players, including body composition, laboratory protocols, nutritional habits and physiological parameters, limitations of the present research should be noted. The cross-sectional sample was limited to 50 players. Future studies should consider larger samples, across a more diverse range of age groups, domestic and international soccer demands, and, even, between different positions.

Additionally, air-displacement plethysmography divides body mass in a bi-compartmental model (i.e. fat mass and fat-free mass). Future studies should adopt multiple techniques to fractionate body mass such as dual-x-ray absorptiometry (DXA) and bioimpedance. LVM was estimated by echocardiography, using cardiac linear measures, which has been done in studies with male adolescent athletes (Castanheira et al., 2017) and non-sports practitioners (Valente dos Santos et al., 2014). Nevertheless, cardiac magnetic resonance imaging is considered the standard technique for determining LVM. Finally, future research also needs to approach the diet using a multi-protocol approach (questionnaire, interview and food diary reports).

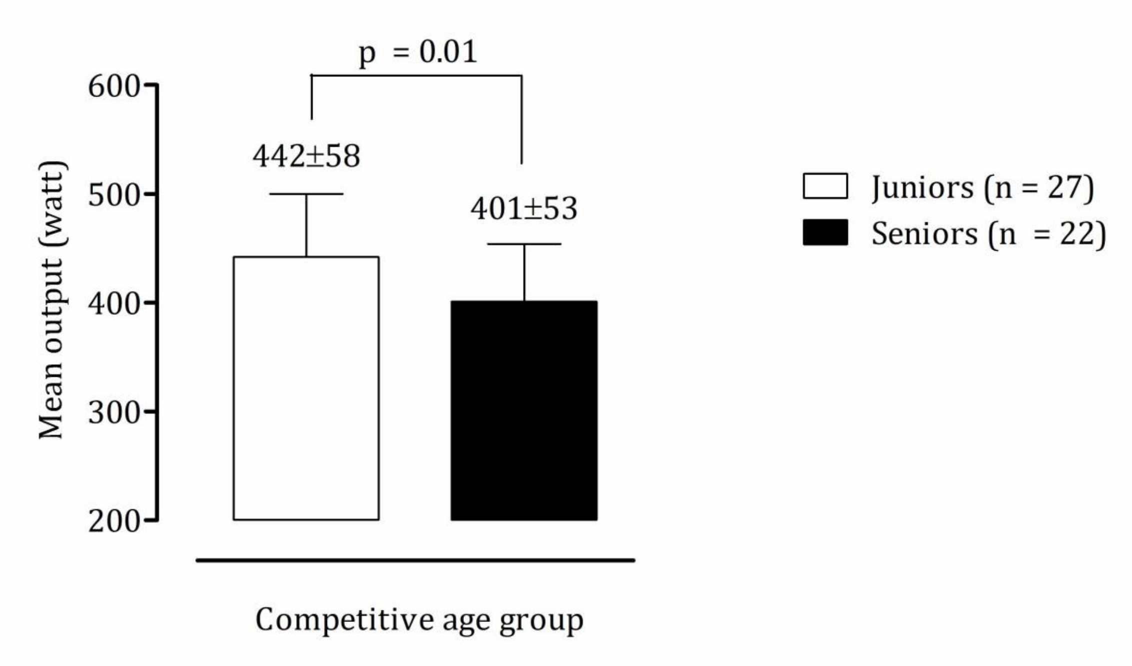

Figure 1. Mean values for anaerobic outputs obtained from the Wingate test by competitive age group.

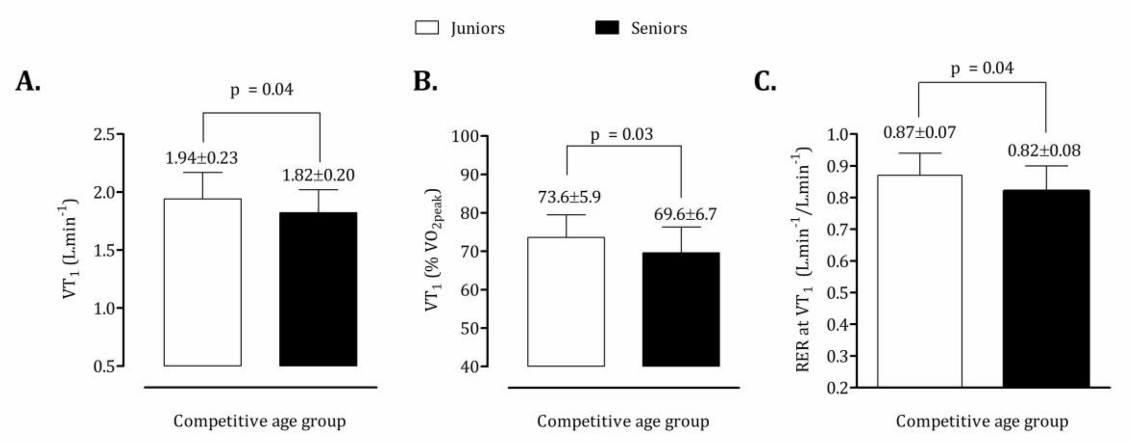

Figure 2. Means for parameters obtained from treadmill test expressed in absolute values (A.), percentage of peak oxygen uptake (B.) and respiratory exchange ratio (C.) at VT_1 by competitive age group.

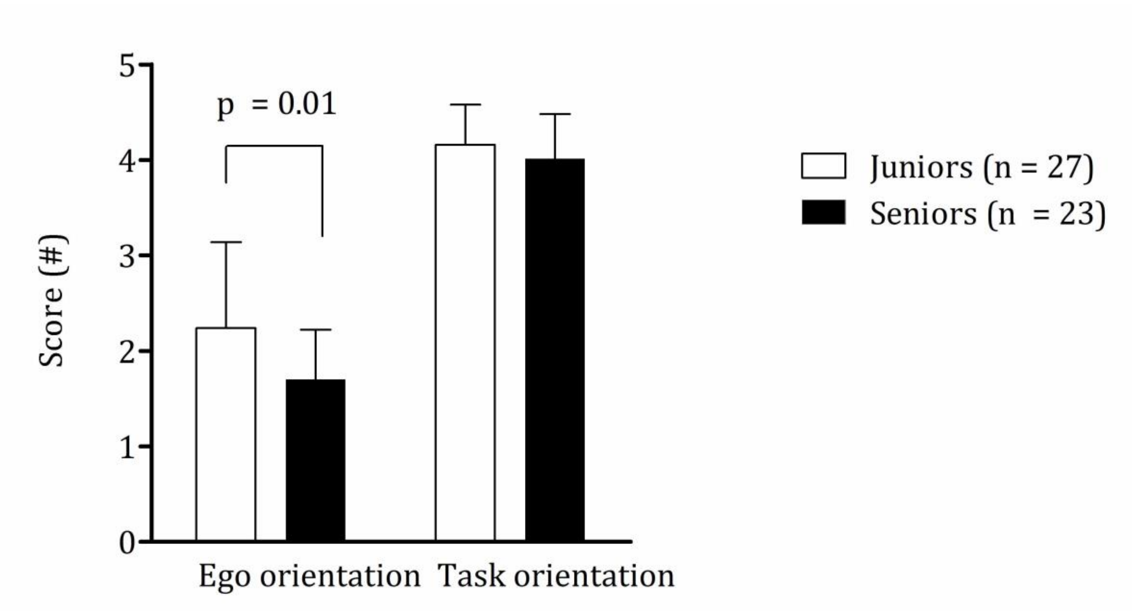

Figure 3. Mean values for ego and task orientation by competitive age group.

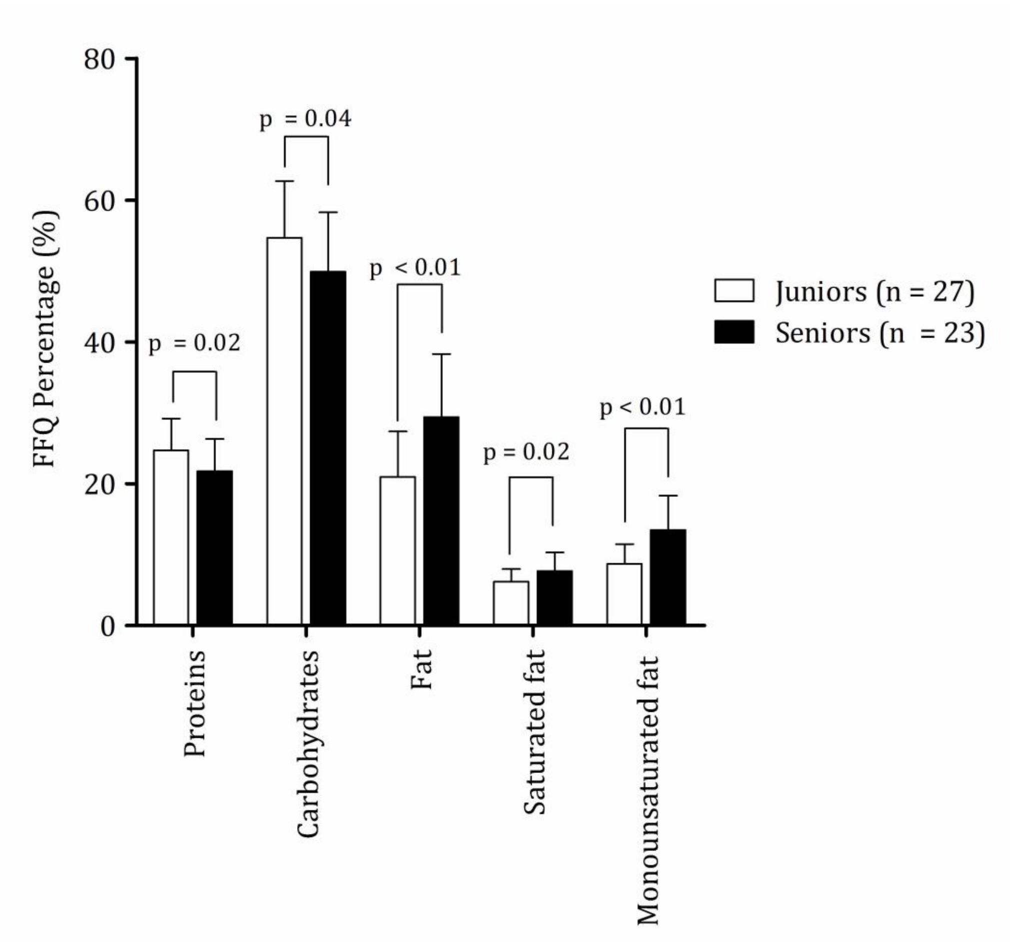

Figure 4. Mean values for food intake parameters by competitive age group.

CHAPTER V

CONCLUSION AND PRATICAL RECOMMENDATIONS

The present study aimed to provide a descriptive overview of Portuguese female soccer players, focusing on the juniors' (under-19) readiness to transition into senior competition.

The ranges reported across multiple variables were considerable. Particularly, juniors were heavier and had higher levels of fat mass which may lead to decrease in performance and, ultimately, be a critical factor for selection at senior level. Clubs and national teams should invest in nutritional education for youth players, in order to change eating habits and enhance performance throughout childhood and adolescence. Other female specific considerations underlying nutritional habits are the menstrual cycle, female athlete triad, iron deficiency and anemia, to name a few. All these may affect performance, health and player availability, therefore it should be considered and acted upon.

Soccer is becoming a faster sport, with increasing physiological demands and more high-intensity efforts. Coaches and support staff should take current literature into consideration to better prepare their athletes. Further consideration should be given to performance testing in order to schedule it periodically across the competitive season (start of pre-season, end of pre-season, mid-season and end of season). Doing so will provide all relevant staff with individual multidimensional profiles regularly, supporting players physical development and screening for the risk on injuries, whilst providing a great tool for coaches review and reflection of training methodologies.

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