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BODY COMPOSITION, NUTRITIONAL INTAKE, AND PHYSICAL ACTIVITY IN FEMALE FUTSAL PLAYERS - INSIGHTS FROM A PORTUGUESE CASE-STUDY

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ABSTRACT

Futsal is a high-intensity, intermittent sport that places significant physical and physiological demands on athletes, making the intersection of nutrition and physical activity pivotal for performance, recovery, and health. Despite the growing participation of women in futsal, data on their nutritional status and body composition remain scarce, particularly in Portugal. This study aimed to assess dietary intake from food diaries, body composition, and physical activity levels in senior female futsal players. Eighteen semi-professional female futsal players were evaluated for anthropometric and body composition (Body Mass Index, muscle mass, body fat), physical activity levels (from IPAQ questionnaire), and dietary intake (from three-day food diaries). Nutrient intake was compared to current sports nutrition guidelines, and low energy availability (LEA) was also assessed. The findings revealed suboptimal intake of carbohydrates, fiber, and critical micronutrients, including calcium, iron, magnesium, and vitamin D. LEA was identified in 16.7% of participants, suggesting potential health risks. Despite high physical activity levels, nutritional intake frequently fell short of sport-specific recommendations, underscoring the importance of tailored nutritional strategies to support the unique demands of female futsal players, address dietary deficiencies, optimize body composition, and mitigate health risks associated with inadequate nutrient intake and LEA. These findings provide a foundation for developing evidence-based guidelines aimed at enhancing health, performance, and long-term fitness in female futsal athletes.

Key words: Female players. Futsal. Sports nutrition. Nutritional status.

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RESUMO

Composição corporal, ingestão nutricional e atividade física em jogadoras de futsal - perspetivas de um estudo de caso em Portugal

O futsal é um desporto de alta intensidade e natureza intermitente que impõe exigências físicas e fisiológicas significativas aos atletas, tornando a interação entre nutrição e atividade física crucial para o desempenho, recuperação e saúde. Apesar da crescente participação das mulheres no futsal, os dados sobre o seu estado nutricional e composição corporal permanecem escassos, particularmente em Portugal. Este estudo teve como objetivo avaliar a ingestão alimentar a partir de registos alimentares, a composição corporal e os níveis de atividade física em jogadoras seniores de futsal. Dezoito jogadoras semi-profissionais de futsal foram avaliadas quanto a parâmetros antropométricos e de composição corporal (Índice de Massa Corporal, massa muscular, gordura corporal), níveis de atividade física (questionário IPAQ) e ingestão alimentar (três dias). A ingestão de nutrientes foi comparada com as recomendações atuais de nutrição desportiva, e também foi avaliada a baixa disponibilidade energética (LEA). Os resultados revelaram uma ingestão subótima de hidratos de carbono, fibra e micronutrientes críticos, incluindo cálcio, ferro, magnésio e vitamina D. A LEA foi identificada em 16,7% das participantes, sugerindo potenciais riscos para a saúde. Apesar dos elevados níveis de atividade física, a ingestão nutricional revelou-se frequentemente inferior às recomendações específicas para o desporto, sublinhando a importância de estratégias nutricionais personalizadas para apoiar as exigências únicas das jogadoras de futsal, colmatar deficiências alimentares, otimizar a composição corporal e mitigar riscos de saúde associados à ingestão inadequada de nutrientes e à LEA. Os resultados sustentam a criação de diretrizes baseadas em evidências para aprimorar a saúde, o desempenho e a condição física das atletas de futsal.

Palavras-chave: Jogadoras. Futsal. Nutrição desportiva. Estado nutricional.

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INTRODUCTION

Futsal is an indoor variation of football that has been FIFA-sanctioned since 1988, characterized by its dynamic, high-intensity, and intermittent nature, placing significant physical demands on athletes (Naser et al., 2017).

The small playing area, frequent sprinting, and rapid transitions between offensive and defensive play require a combination of technical proficiency, tactical awareness, and superior aerobic and anaerobic conditioning (Barbero-Alvarez et al., 2008).

As a result, futsal athletes must develop specific physical and physiological traits to meet these demands (e.g., necessitate tailored nutritional strategies to optimize glycogen replenishment, muscle repair, and overall recovery (Rodrigues et al., 2011)).

Proper nutrition plays a fundamental role in supporting the energy expenditure required in futsal, maintaining hydration, and optimizing recovery between training sessions and matches.

Nutritional strategies tailored to the sport are essential to prevent performance declines, facilitating muscle repair, and adapting to fatigue-related mechanisms (Burke et al., 2011).

However, existing literature suggests that female futsal players often exhibit suboptimal dietary patterns, including excessive intake of sodium and potassium, while being deficient in essential vitamins such as D and E (Gogojewicz et al., 2023). Such imbalances may have implications for performance, recovery, and overall health.

In addition to nutrition, body composition is a fundamental component of athlete assessment, as it directly influences health and performance. Research has highlighted the significant relationship between body composition and performance metrics, with variations in body fat percentage and muscle mass impacting anaerobic capacity, agility, and overall effectiveness on the court (Castillo et al., 2022).

While optimal body composition varies across sports and playing positions (Ramos-Campo et al., 2014), establishing reference data for futsal athletes remains an area requiring further investigation.

In Portugal, futsal has gained considerable popularity, particularly among female athletes, reflecting broader global trends in women's sports development (Federação_Portuguesa_de_Futebol, 2019).

However, data on the physical activity levels, body composition, and nutritional intake of Portuguese female futsal players remain scarce, underscoring the importance of region-specific research.

Although studies have explored these factors individually in team sports, few have provided descriptive data specifically for female futsal players. Addressing these gaps is essential to establish a comprehensive understanding of the physical and nutritional profiles of Portuguese female futsal athletes.

This study aims to describe the body composition, physical activity levels, and nutritional intake among senior female futsal players in Portugal.

By providing a detailed characterization of these variables, this research seeks to contribute to evidence-based recommendations that can enhance training strategies, dietary planning, and overall support for female futsal players.

MATERIAL AND METHODS

Participants

The study group consisted of 18 women, who were members of a semi-professional Portuguese futsal team from Northern region.

The mean age of athletes was 22.7±8.8 years, and the average training experience was 4.2±4.4 years.

All subjects were free from injury and illness, and declared that they had not introduced any changes in their lifestyles, training elements, nutrition, and/or supplementation.

Sociodemographic variables, including chronological age, level of education, years of futsal practice, number of household members, and area of residence, were collected by questionnaire.

Anthropometric and Body Composition Measurements

For data collection on body composition, body mass (kg) was measured using a digital scale (Medisana® BS 444 - maximum capacity 180kg), and height was assessed using a portable stadiometer (Seca 213®).

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The Body Mass Index (BMI) was calculated using the equation: BMI = weight/height^2. For athletes over 18 years old, the World Health Organization (WHO) reference points were used for nutritional status classification (World Health, 2010). In the case of athletes aged between 15 and 18 years (n=7), the BMI percentile was considered according to age and appropriate for gender (World Health, 2007).

Perimeters (brachial, abdominal, thigh, and calf) were measured using an anthropometric tape (Seca 203®). For the collection of skinfolds (triceps, abdominal, thigh, and calf), the Harpenden skinfolder caliper® was used. All procedures performed in this study were based on th methodology of the International Society for the Advancement of Kinanthropometry (ISAK (International Society for Advancement of et al., 2011)).

To estimate the amount of muscle mass in kilograms, two formulas were used: Poortmans' formula for youth athletes and Lee's formula for senior athletes:

Poortmans' Formula (Poortmans et al., 2005)

$$\text{MMS (kg)} = \text{Ht} - [(0{,}0064 - \text{CAG}^2)(0{,}0032 - \text{CTG}^2)(0{,}0015 - \text{CCG}^2](2{,}56 - \text{sexo})(0{,}0{,}136 - \text{idade})$$

Legend: MMS – Muscle Mass; Ht – Height; CAG – Corrected abdominal circumference; CTG – Corrected triceps circumference; CCG – Corrected calf circumference.

Lee's Formula (Lee et al., 2000)

$$\text{SM (kg)} = \text{Ht} - (0{,}00744 - \text{CAG}^2 + 0{,}00088 - \text{CTG}^2 + 0{,}00441 - \text{CCG}^2) + 2{,}4 - \text{sexo} - 0{,}048 - \text{idade} + \text{etnia} + 7{,}8$$

Legend: SM – Lean Mass; Ht – Height; CAG – Corrected abdominal circumference; CTG – Corrected triceps circumference; CCG – Corrected calf circumference

The body fat percentage was calculated for both categories using Evans' formula:

Evans' Formula (Evans et al., 2005)

$$\%\text{BF} = 8{,}997 + 0{,}24658 * (3\text{SKF}) - 6{,}343 * (\text{sex}) + 1{,}998 * (\text{ethnicity})$$

Legend: %BF – Body fat percentage; 3SKF – Abdominal, triceps, and thigh skinfolds.

Exercise Energy Expenditure

Physical activity was assessed using the short form of the International Physical Activity Questionnaire (IPAQ-SF), a validated and widely adopted self-report instrument for estimating physical activity levels across diverse populations, including athletes (Craig et al., 2003).

The questionnaire, available online (https://sites.google.com/view/ipaq/download?authuser=0), collects information on the duration (in minutes per day) and frequency (in days per week) of walking, moderate-intensity, and vigorous-intensity activities, considering only bouts lasting at least 10 consecutive minutes. It also includes items related to sedentary behaviors, such as time spent sitting or lying down during the previous seven days.

To estimate exercise energy expenditure, the total time spent per week in each activity domain was first calculated by multiplying the reported duration by the weekly frequency.

This value was then multiplied by a corresponding average Metabolic Equivalent of Task (MET) value, as established by IPAQ conventions, to obtain energy expenditure expressed in MET-minutes per week. The MET values used in the present study followed the standardized values provided by IPAQ: 3.3 METs for walking, 4.0 METs for moderate-intensity activity, and 8.0 METs for vigorous-intensity activity. These values represent the energy cost of each activity relative to resting metabolic rate, with 1 MET defined as the energy expenditure at rest (equivalent to 3.5 ml O_2/kg/min).

Exercise energy expenditure was computed by applying the following formula for each activity type: MET-min/week = minutes/day × days/week × MET value. The total weekly energy expenditure was derived by summing the MET-min/week values for walking, moderate, and vigorous activities. Based on the resulting total, participants were classified into one of three physical activity levels according to IPAQ guidelines: low (less than 600 MET-min/week), moderate (between 600 and 1500 MET-min/week), or high (greater than 1500 MET-min/week).

This methodological approach allowed both quantification of weekly energy expenditure related to physical activity and categorical classification of participants' overall activity levels.

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Nutritional intake assessment

Data collection on dietary intake was carried out through the food diary (FD), a prospective method aimed at recording all foods and beverages consumed over three days representative of the athletes' usual diet. The completion of the FD over three days of one week included: one game day, one training day, and one rest day.

To ensure a better understanding of the study and clarify any doubts, an informative session was held beforehand on the proper completion of the food diary, emphasizing the detailed description of food intake and portion sizes.

This guidance was reinforced with each athlete when handing over the record.

Additionally, the diary included a household measures guide to help estimate portion sizes.

All data were entered into Nutrium® software (https://nutrium.com/pt/), where the nutritional intake values for each nutrient were extracted. The data were then exported to Microsoft® Excel for processing. For habitual intake, the average values from the three reported days were considered.

Energy availability (EA) was calculated as: EA = (Energy Intake − Exercise Energy Expenditure) / Fat-Free Mass (FFM), expressed in kcal/kg FFM/day (Loucks, 2004). Energy intake was assessed using 3-day food records, and exercise energy expenditure was estimated from the IPAQ questionnaire, considering only moderate to vigorous physical activity. EA values <30 kcal/kg FFM/day were classified as low energy availability (LEA) (Burke et al., 2018).

Ethics

The study was approved by the Ethics Committee of the University of Trás-os-Montes e Alto Douro (Doc23-CE-UTAD-2022).

Statistical Analyses

All data were analysed using the Statistical Package for the Social Sciences for Windows (version 27, IBM SPSS). Means (± standard deviation) and frequencies were calculated for all variables.

RESULTS

Characteristics of the female futsal players are summarized in Table 1.

All field positions were represented (Goalkeeper, Fixo, Winger, and Pivot) in this study. The sample consisted of 18 female futsal players. Regarding educational background, 33.3% had superior education, while 61.1% had completed middle or high school.

This distribution suggests a relatively balanced academic profile, with nearly one third of players having attained higher education degrees. The majority of players are from rural and semi-rural residence areas.

Table 1 - Characterization of the sample of female futsal players.

		Mean ± SD
Chronological age		22.7 ± 8.8
Education level n (%)		
	Upper Primary	5.6
	Middle School	33.3
	High School	27.8
	Bachelor's Degree	22.2
	Master's Degree	11.1
Years of futsal		4.2 ± 4.4
Household size (number persons)		3.7 ± 1.8
Residence area n (%)		
	Urban	29.4
	Semi-urban	29.4
	Rural	41.2

SD: standard deviation.

Anthropometry and Body Compositions

The Table 2 present the anthropometric and body composition data of the futsal players. The participants had a mean body weight of 60.5 ± 8.8 kg and a mean height of 1.64 ± 0.1 m. The average Body Mass Index (BMI) was 22.6 ± 2.9 kg/m^2. Based on BMI classifications, 77.8% of the players fell within the normal weight category, 16.7% were classified as overweight, and 5.6% as obese, while no participants were underweight.

Skinfold measurements revealed a mean triceps skinfold thickness of 15.7 ± 6.0 mm, an abdominal skinfold of 17.7 ± 6.3 mm, crural skinfold of 20.7 ± 8.8 mm, and calf skinfold of 26.1 ± 7.0 mm. Regarding body composition, the players had an average

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muscle mass of 20.2 ± 4.6 kg, corresponding to 33.1 ± 5.3% of total body weight, and a mean body fat percentage of 23.7 ± 4.7%.

Physical Activity

The mean weekly energy expenditure in walking activities was 1568.5 ± 1580.0 MET-min/week (Table 3). For moderate-intensity physical activity (MPA), the average was 720.0 ± 613.4 MET-min/week, and for vigorous-intensity physical activity (VPA), the mean value reached 2618.8 ± 1054.9 MET-min/week. The total weekly physical activity amounted to 4907.3 ± 1925.8 MET-min/week.

When expressed in terms of estimated caloric expenditure, the participants expended an average of 1724.4 ± 1783.2 kcal/week through walking, 757.4 ± 657.0 kcal/week during moderate activities, and 2787.1 ± 1061.1 kcal/week through vigorous activities. The total energy expenditure associated with physical activity reached a mean of 5268.9 ± 2116.4 kcal/week.

Table 2 - Anthropometric assessment and body composition of female futsal players.

		Mean ± SD
Weight (kg)		60.5 ± 8.8
Height (m)		1.64 ± 0.1
BMI (kg/m^2)		22.6 ± 2.9
BMI Categories (%)		
	Underweight	0
	Normal	77.8
	Overweight	16.7
	Obesity	5.6
Skinfolds (mm)		
	Triceps	15.7 ± 6.0
	Abdominal	17.7 ± 6.3
	Crural	20.7 ± 8.8
	Calf	26.1 ±7.0
Body composition		
	Muscle mass (kg)	20.2 ± 4.6
	Muscle mass (%)	33.1 ± 5.3
	Body fat (%)	23.7 ± 4.7

SD: standard deviation; BMI: Body Mass Index.

According to IPAQ categorical scoring, all participants were classified as having a high level of physical activity, with 100% of the sample meeting or exceeding the criteria for this category. No participants fell into the moderate or low physical activity categories.

Nutritional Intake Evaluation

Table 4 outlines the mean daily intake (± SD) of macronutrients among female futsal players, alongside current sports nutrition recommendations based on the ISSN/ACSM guidelines (Kerksick et al., 2018; Thomas et al., 2016).

Mean energy intake was 1591.1 ± 361.1 kcal/day (26.3 ± 6.0 kcal/kg/day). Among athletes, 16.7% (n=3) had low energy availability (<30 kcal/kg FFM/day), 22.2% (n=4) had subclinical energy availability (30 - 45 kcal/kg FFM/day).

Table 3 - Physical activity of female futsal players.

		Mean ± SD
MET min/week walking		1568.5 ± 1580.0
MET min/week MPA		720.0 ± 613.4
MET min/week VPA		2618.8 ± 1054.9
MET min/week total		4907.3 ± 1925.8
Kcal/week walking		1724.4 ± 1783.2
Kcal/week MPA		757.4 ± 657.0
Kcal/week VPA		2787.1 ± 1061.1
Kcal/week total		5268.9 ± 2116.4
Physical Activity Level (%)		
	Low	0
	Moderate	0
	High	100

SD: standard deviation; MET: metabolic equivalent of task; MPA: moderate-intensity physical activity; VPA: vigorous-intensity physical activity.

Protein intake was generally adequate, with an average of 1.5 ± 0.4 g/kg/day, aligning with the ISSN/ACSM recommendation of 1.2–2.0 g/kg/day. Accordingly, 61.1% of participants met the minimum protein recommendation.

Conversely, carbohydrate intake was notably below recommended levels. The mean intake was 3.1 ± 1.2 g/kg/day, far below the suggested 5-10 g/kg/day for active individuals, with only 11.1% meeting the minimum recommendation. Similarly, dietary fiber intake averaged 15.5 ± 6.9 g/day, falling short of the recommended 25 g/day, with only 11.1% of players achieving the target.

Total fat intake represented 31.1 ± 5.6% of total energy intake, remaining within the recommended range of 20–35%, with 77.8% of participants meeting this recommendation.

However, saturated fat intake accounted for 9.9 ± 2.1% of total energy, slightly above the recommended upper limit of <10%, with only half of the athletes (50%) remaining within this threshold

Table 4 - Macronutrient intake of female futsal players (mean ± SD) and current recommendations.

Nutrient Intake	Mean ± SD	Recommendation	Percent Meeting Minimum Recommendations
Energy (kcal)	1591.1 ± 361.1	NA	NA
Energy (kcal/kg/d)	26.3 ± 6.0		
Energy Availability (kcal/kg FFM/day)	56.5±34.0	>45[a]	61.1%
Protein (g)	86.2 ± 18.3	NA	NA
Protein (g/kg/d)	1.5 ± 0.4	1.2–2.0[b]	61.1%
Carbohydrates (g)	179.4 ± 55.4	NA	NA
Carbohydrates (g/kg/d)	3.1 ± 1.2	5–10[b]	11.1%
Sugars (g)	52.3 ± 25.2	NA	NA
Fiber (g)	15.5 ± 6.9	25[b]	11.1%
Fat (g)	55.1 ± 16.7	NA	NA
Fat (%E)	31.1 ± 5.6	20–35%[b]	77.8%
Saturated fat (g)	17.7 ± 6.3	NA	NA
Saturated fat (%E)	9.9 ± 2.1	<10%[b]	50%

% E: percentage of total energy intake; NA: Not Applicable; [a] source: reference (Burke et al., 2018); [b]: ISSN/ACSM recommendation.

Table 5 presents the mean daily intake (± SD) of selected micronutrients among the female futsal players, compared to current dietary recommendations of European Food Safety Authority (EFSA, 2024). The results indicate suboptimal intake across several key nutrients.

The mean calcium intake was 479.9 ± 136.1 mg/day, considerably below the recommended 1000 mg/day, with none of the participants meeting the minimum requirement. Similarly, iron intake averaged 7.7 ± 1.9 mg/day, less than half of the 16 mg/day recommendation, with 0% of participants reaching the target. Magnesium intake was also inadequate, with a mean of 182.2 ± 47.3 mg/day against a recommendation of 300 mg/day, again with no athletes meeting the minimum intake.

Sodium intake, on the other hand, exceeded the recommended upper limit (<2000 mg/day), averaging 2578.7 ± 826.6 mg/day. Despite this, only 22.2% of participants remained within the recommended range.

For vitamins, the mean intake of vitamin B12 was 2.9 ± 1.4 µg/day, below the 4 µg/day recommendation, with just 27.8% of players meeting the requirement. Vitamin D intake was particularly low, with a mean of 2.5 ± 2.0 µg/day compared to a recommended 15 µg/day, and none of the participants met the recommended intake.

Table 5 - Micronutrient intake of female futsal players (mean ± SD) and current recommendations.

Nutrient Intake	Mean ± SD	Recommended Dietary Intake or Adequate Intake[a]	Percent Meeting Minimum Recommendation
Calcium (mg)	479.9 ± 136.1	1000	0%
Iron (mg)	7.7 ± 1.9	16	0%
Magnesium (mg)	182.2 ± 47.3	300	0%
Sodium (mg)	2578.7 ± 826.6	<2000	22.2%
Vitamin B12 (µg)	2.9 ± 1.4	4	27.8%
Vitamin D (µg)	2.5 ± 2.0	15	0%

[a] source: reference (EFSA, 2024).

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DISCUSSION

The present study provides a comprehensive assessment of semi-professional female futsal players by analysing their anthropometric characteristics, physical activity patterns, and dietary intake.

The key findings from this study highlight the nutritional imbalance observed among female players in relation to the physical demands, as has also been reported in other studies on futsal (Rodrigues et al., 2024; Soares et al., 2016), football (Dasa et al., 2023), and other sports (Condo et al., 2019).

Most players exhibited a normal BMI (mean: 22.6 ± 2.9 kg/m^2). The body fat percentage of 23.7 ± 4.7% is consistent with the findings of Hoffmann et al., (2021). Muscle mass represented approximately one-third of body weight (33.1 ± 5.3%), suggesting an advantageous lean-to-fat ratio conductive to performance.

Nonetheless, a small proportion of athletes were classified as overweight or obese, suggesting space for targeted body composition optimization.

Maintaining appropriate proportions of lean and fat mass is essential in futsal, where agility, power, and speed are critical performance determinants. Excess body fat may hinder acceleration and increase joint loading, while inadequate muscle mass could compromise stability, force production, and injury resilience.

Regarding physical activity levels, all participants were classified in the "high" category according to the IPAQ scoring protocol, with vigorous-intensity activities contributing most substantially to total energy expenditure.

The mean energy expenditure exceeded the 1500 MET-min/week benchmark commonly used to define high activity levels (Craig et al., 2003), which is consistent with the intense physical demands of futsal. This sport is characterized by repeated bouts of high-intensity efforts, as reflected in the elevated MET and caloric expenditure values. However, individual variations in walking and moderate activity levels highlight possible differences in lifestyle or occupational activity beyond training sessions, as well as limitations inherent to self-reported tools such as the IPAQ (Lee et al., 2011).

Despite the high physical demands observed, dietary intake was inadequate in several key areas such as energy availability, macro- and micro-nutrients.

Our results showed that 16.7% of the athletes had LEA, values aligned with other authors (Burke et al., 2018), and better than a previous study among female gymnasts were LEA was observed in 37.3% of the athletes (Silva, Paiva, 2015). LEA is one of the criteria to Female Athlete Triad, that is a medical condition often observed in physically active girls and women, and involves three components: (1) low energy availability with or without disordered eating, (2) menstrual dysfunction and (3) low bone mineral density (Souza et al., 2014).

LEA can lead to significant health and performance issues, including menstrual dysfunction, impaired bone health, and increased risk of injuries. Even short-term LEA can disrupt hormonal balance and metabolic function, potentially leading to long-term consequences if not addressed (Heikura et al., 2022).

The prevalence of LEA and subclinical energy availability in the present study suggests a need for targeted nutritional strategies and monitoring to ensure athletes maintain adequate energy availability to support both health and performance.

While the average protein intake (1.5 g/kg/day) met the ISSN/ACSM guidelines for athletes (1.2-2.0 g/kg/day) (Thomas et al., 2016), 38.9% of participants fell outside the recommended range, potentially compromising recovery and adaptation. More concerning was the low carbohydrate intake (3.1 ± 1.2 g/kg/day), with 88.9% of athletes falling below the recommended 5-10 g/kg/day for high-intensity intermittent sports such as futsal (Kerksick et al., 2018).

Similar findings have been reported in other studies involving female futsal players (Rodrigues et al., 2024; Soares et al., 2016), further emphasizing a recurring pattern of insufficient carbohydrate consumption in this population. Inadequate carbohydrate availability may hinder glycogen replenishment, impairing both performance and recovery, particularly during congested match periods or high training loads.

Fiber intake was also insufficient, with players consuming a mean of 15.5 g/day, well below the recommended 25 g/day for women (EFSA, 2024; Rodriguez et al., 2009).

This likely reflects limited consumption of whole grains, legumes, fruits, and vegetables

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- key dietary sources of both fiber and essential micronutrients.

Micronutrient analysis revealed widespreadinadequacies. None of the athletes met the recommended intakes for calcium, iron, magnesium, or vitamin D. Particularly concerning is the low intake of calcium and iron, with mean values far below the recommended 1000 mg/day for calcium (especially important in female athletes with menstrual dysfunction) and 16 mg/day for iron (Manore, 1999; Rodriguez et al., 2009).

In female athletes, iron levels and how the body manages iron can be affected by changing ovarian hormones and blood loss during menstruation. Ensuring enough calcium and maintaining healthy vitamin D levels are crucial for strong bones, especially because women have a greater calcium requirement than men.

When oestrogen levels are low, such as in cases of amenorrhea, these nutrients become even more important to help prevent stress fractures. These deficits are associated with increased risk of low bone mineral density, fatigue, and impaired oxygen transport (Beck et al., 2021).

Magnesium intake (182.2 mg/day) also fell short of general recommendations (300 mg/day), which may compromise energy metabolism and neuromuscular function (Volpe, 2015).

Similarly, vitamin D intake was alarmingly low (mean: 2.5 µg/day), with none of the athletes achieving the recommended level of intake. However, it is important to note that vitamin D can also be synthesized endogenously through adequate exposure to sunlight, particularly UVB radiation, which contributes significantly to overall vitamin D status (Holick, 2004; Wacker, Holick, 2013).

A previous study with serum vitamin evaluation concluded that vitamin D deficiency/insufficiency [25(OH)D < 20 ng/ml] is highly prevalent in Portugal, affecting more than 60% of all Portuguese adults, with strong geographical and seasonal variation (Duarte et al., 2020).

Nonetheless, athletes who train predominantly indoors, such as futsal players, may have limited sun exposure, increasing their risk of deficiency despite potential for cutaneous synthesis, supporting concerns raised by Larson-Meyer, Willis (2010), who highlighted widespread vitamin D deficiency in indoor athletes.

Given its role in bone health and immune function, supplementation may be necessary.

Although sodium intake exceeded general dietary recommendations, this could be compensated in athletes due to increased sweat losses during training and competition (Sawka et al., 2007). However, care should be taken to balance rehydration with long-term cardiovascular health.

The interplay between body composition, physical activity, and nutrition underscores the complexity of optimizing performance in female futsal. While high activity levels impose increased nutritional demands, particularly for energy, iron, and bone-related nutrients, dietary intakes in this cohort frequently fell short.

This gap emphasizes the need for targeted nutritional education and support, including practical strategies for improving energy availability and micronutrient density within the constraints of athlete lifestyles. These patterns may reflect an underlying risk of Relative Energy Deficiency in Sport, a syndrome known to impair metabolic rate, menstrual function, bone health, and immune function (Mountjoy et al., 2018).

Importantly, consideration should also be given to sex-specific physiological factors such as the menstrual cycle, which can influence nutrient needs, energy metabolism, and hydration status (McNulty et al., 2020).

Integrating these variables into athlete monitoring may enhance the personalization and effectiveness of nutrition and training plans, in some instances, supplementation may be required.

This study provides valuable insights into the body composition, energy availability and dietary intake of female futsal athletes, a population that remains underrepresented in sports nutrition research. A key strength is the use of validated tools for assessing energy intake and body composition. However, the study has some limitations.

The reliance on self-reported dietary intake and physical activity data may introduce reporting bias or underestimation, particularly in active populations. Additionally, the use of the IPAQ may not fully capture sport-specific energy expenditure compared to objective methods like heart rate monitors or doubly labeled water.

Finally, the sample size was relatively small, which may limit the generalizability of the

findings to broader populations of female team-sport athletes, and no data about reproductive function was collected.

CONCLUSION

This study highlights critical nutritional gaps among semi-professional female futsal players, particularly in carbohydrate, fiber, and micronutrient intake (calcium, iron, magnesium and vitamin D).

The LEA was found in 16.7% of the athletes. The combination of suboptimal dietary patterns and varied body composition profiles reinforces the need for individualized, sport-specific nutritional strategies.

Addressing these deficiencies is essential not only for enhancing performance and recovery but also for promoting long-term health.

These findings provide a foundation for the development of evidence-based dietary guidelines and targeted interventions tailored to the unique demands of female futsal players.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

DATA AVAILABILITY STATEMENT

Raw output data from this research are available upon reasonable request to the corresponding author.

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