

Body Composition, Dietary Intake and Physical Performance in Young Female and Male Tennis and Padel Players

Avaliação da composição corporal, ingestão alimentar e performance desportiva em jovens jogadores de ténis e padel do sexo feminino e masculino

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Abstract

Introduction: The nutritional needs of young athletes must be specific, as they must focus on sports performance, but also ensure adequate growth.

Objectives: (a) Characterize the energy and macronutrients intake in young tennis and padel players during competition, training, and rest days; (b) Verify if athlete's food intake reaches the nutritional recommendations; (c) Evaluate the impact of body composition on physical performance tests; (d) Correlate the dietary intake with physical performance tests.

Methods: Twelve tennis players and twelve padel players, aged between 14 and 19 years, were invited to participate in this study. Anthropometric characteristics were evaluated, and physical performance tests were performed. Food diaries were assessed on competition, training, and rest days.

Results: No significant differences ($p > 0.05$) were found in dietary intake between the three days. It was found that athletes do not achieve energy, carbohydrates, and fat as per the recommendations. Protein intake is within the recommended values. Only body mass index was significantly associated with carbohydrate consumption ($r = -0.629$; $p = 0.028$). Muscle mass and percentage of body fat were the anthropometric characteristics with the highest correlation with physical performance.

Conclusion: Energy and carbohydrate intake in young tennis and padel players is below the recommendations, which is not the case for protein and fat. Muscle mass and body fat mass seem to be the anthropometric characteristics that most correlate with physical performance. The dietary intake is not associated with physical performance tests. More studies on this specific population and sports are needed.

Keywords

Tennis; Padel; Body Composition; Dietary Intake; Physical Performance.

Resumo

Introdução: As necessidades nutricionais de jovens atletas devem ser específicas e direcionadas para o desempenho desportivo, mas também garantir o crescimento adequado.

Objetivos: (a) Caracterizar a ingestão alimentar de jovens jogadores de ténis e padel durante os dias de competição, treino e descanso; (b) Verificar se a ingestão alimentar atinge as recomendações nutricionais; (c) Avaliar o impacto da composição corporal em testes de performance; (d) Correlacionar a ingestão alimentar com testes de performance.

Métodos: Doze jogadores de ténis e doze jogadores de padel, de 14-19 anos, foram convidados para este estudo. Foi avaliada a composição corporal e realizados testes de performance. Os diários alimentares foram avaliados em dias de competição, treino e descanso.

Resultados: Não existem diferenças significativas ($p > 0,05$) na ingestão alimentar entre os três dias. A ingestão de energia, hidratos de carbono e gordura, não se encontra conforme recomendado. A ingestão proteica encontra-se dentro dos valores recomendados. O índice de massa corporal foi significativamente associado com o consumo de hidratos de carbono ($r = -0,629$; $p = 0,028$). A massa muscular e a percentagem de gordura corporal foram as características antropométricas com maior correlação com a performance.

Conclusão: A ingestão de energia e hidratos de carbono de jovens jogadores de ténis e padel encontra-se abaixo das recomendações, o que não acontece na proteína e gordura. A massa muscular e a massa de gordura corporal parecem ser as características antropométricas com maior correlação na performance. A

ingestão alimentar não apresenta associação com a performance. Mais estudos sobre esta população específica e desportos são necessários.

Palavras-Chave:

Ténis; Padel; Composição Corporal; Ingestão Alimentar; Desempenho Físico.

List of abbreviations

BMI - Body mass index

CMJ - Countermovement jump

MBT - Medicine ball throw

SJ - Squat jump

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1. Introduction

Racquet sports have two distinct game formats to play. Tennis, badminton, padel, and table tennis are examples of sports where the goal is passing the implement over a net on a divided court. Squash and racquetball are examples of sports where the goal is to hit against a wall in a shared court^(1, 2).

Tennis and padel are two examples of racquet sports, that are acyclic disciplines and feature high-intensity workload cycles, broken up by brief breaks, that enables a full recovery. As a result, it is necessary to alternate between anaerobic and aerobic energy sources, in order to fulfil the various metabolic requirements. On the one hand, high intensity, shorter points, changes of direction, and shots require anaerobic energy. On the other hand, the aerobic system persists throughout extended periods of moderate effort, postponing exhaustion as well as indirectly promoting focus, technical proficiency, and workload maintenance throughout a game⁽¹⁾.

In recent years, we have seen padel become one of the most popular sports with an increase of regular participants around the world. The uniqueness of this sport is the existence of walls and fences surrounding the court on which the ball can bounce. This consequently lengthens rallies so the number of actions and shots per player is higher in comparison with similar racket sports like badminton, tennis, or squash^(3, 4).

Tennis is a highly technical sport, which has been evolving and changing. With specific technical skills as predominant factors (for example, skills in handling the racket and control of the ball) to a more dynamic and explosive sport

characterized by a greater hitting power and speed, which is remarkably physically demanding⁽⁵⁾.

In this scenario, tennis and padel players require high performance in most of the components associated with physical fitness, such as speed, agility, strength, and power, among other factors^(3, 5, 6).

Body composition and anthropometric parameters are associated with greater success. In account of the possibility that an excess of body fat mass may impair athletic performance, some writers have looked at the relationship between body composition and athletic performance as well as technical and tactical skills. A high body fat mass makes injuries more likely to occur. Therefore, it is known that anthropometric measurements may have an impact on performance, although no study was found that access the best body composition to optimise performance^(3, 5, 7, 8).

Young athletes need special care, as they are passing by anatomical and physiological changes, resulting from the growth and maturation characteristic of this phase. To compete and train at the highest level, it is important to ensure sufficient energy and macronutrient intake. Therefore, particularly in young players, nutritional needs must be specific, as they must not only be focused on sports performance, but must also ensure adequate growth, maturation, and development⁽⁹⁻¹¹⁾.

Research about tennis and padel nutrition in young players is still very limited. So, it is important to provide a better understanding of eating habits and daily energy and macronutrient intake distribution during training, competition, and rest days in this population⁽⁹⁾.

2. Objectives

The aims of this study are (a) to characterize and analyse the energy and macronutrients intake in young tennis and padel players during competition, training and rest days, (b) to verify if athletes food intake reaches the nutritional recommendations, (c) to evaluate the impact of the body composition on physical performance tests, and (d) to correlate the dietary intake with physical performance tests.

3. Materials and Methods

3.1 Sampling and Eligibility

Twelve tennis players (six female and six male) and twelve padel players (six female and six male) were asked to participate in this cross-sectional study. All tennis players trained and represented Clube de Ténis do Porto and all the padel players trained and represented Top Padel.

Athletes were included in this study if they: 1 - were competitive players aged between 14 and 19 years old; 2- have participated in international tournaments or represented their own country in the national team or have a minimum of 50 national rankings. Athletes were excluded if they: 1 - failed to complete all the procedures; 2 - were physically injured or not capable to perform at the maximum effort.

After being fully informed about the procedures, tennis and padel club's sports directors gave authorization for the athletes to participate in this study by their own free will. All participants gave informed consent, and the players under 18 years old had to give parental/tutor consent. All data collected was in accordance with the declaration of Helsinki.

A methodology scheme of this study is presented in Fig. 1.



Fig.1 - Research methodology scheme.

3.2 Body Composition Evaluation

Anthropometric measurements were performed according to the *International Society for Advancement of Kinanthropometry* (ISAK)⁽¹²⁾ and were taken by the same evaluator before any athlete performed any exercise. Anthropometric variables included height, weight, 8 skinfolds (biceps, triceps, subscapular, suprailiac, supraspinal, abdominal, thigh, and medial calf), and 3 body circumferences (arm, thigh, and medial calf). Height was measured in meters (m) using a stadiometer (SECA® Bodymeter 206), and weight was determined in kilograms (kg) using a portable digital scale (SECA® Robusta 831). Skinfold thickness was assessed using a calliper (Harpenden®) and was expressed in millimetres (mm). To assess the body circumferences, it was used measuring tape (SECA® 201) and was expressed in centimetres (cm).

Body mass index (BMI) was calculated as $\text{weight}/\text{height}^2$ ⁽¹³⁾. The sum of 8 skinfolds was calculated. According to Luna-Villouta et al.⁽⁵⁾ body fat percentage was estimated using three different equations (Slaughter et al⁽¹⁴⁾, Durnin and Rahaman⁽¹⁵⁾, and Sárria et al⁽¹⁶⁾). Muscle mass was calculated in kg, using Poortmans et al equation⁽¹⁷⁾.

3.3 Physical Performance

On the day of the physical test's performance, it was asked to all the athletes to abstain from exercising previously. All participants performed a 15 minutes warm-up with physical and stretching exercises.

Tennis players performed the physical tests on an outside clay court and the padel players on an indoor court with a grass surface and glass walls.

The protocol used for the physical performance tests is described in Fig.2. During all the tests performed, the athletes were verbally motivated to give the maximum effort. There was a 5 minutes recovery break between each test.

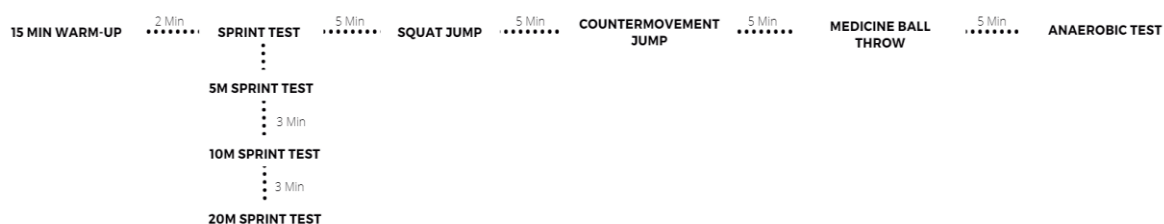


Fig.2 - Physical tests performance protocol

3.3.1 Sprint Test (5m x 10m x 20m)

The athletes initiated the sprint in a standing position, behind the starting line, and must run the stipulated distance (5m, 10m, and 20m), in a straight line, in the shortest possible time. Each athlete performed two attempts in each distance, with a three minutes rest interval between each repetition to prevent fatigue-related performance decrease^(18, 19). The shortest recorded time, with a digital chronometer, was used.

3.3.2 Squat and Countermovement Jump

Each athlete performed two attempts of each jump with 45 seconds apart. Players start the test with their feet shoulder-width apart and their hands on their hips throughout the test. The starting position for the squat jump (SJ) was with the knees bent 90 degrees, keeping this position for three seconds, and then the athlete should jump as high as possible. For the countermovement jump (CMJ), the player must jump as high as possible, bending his knees and without using his

arms to swing. The highest jump of the best two attempts was considered for further analysis and was measured with the *My Jump 2* application^(19, 20).

3.3.3 Medicine Ball Throw

All athletes must throw a 3 kg medicine ball with both hands over the head. The distance was measured between the initial position and the place where the ball landed the first impact with the ground. Each athlete performed the test twice and the longest distance reached was used for analysis^(6, 21).

3.3.4 Anaerobic Test

The athletes performed an anaerobic test which is designed to measure power and fatigue index. This test consists in realizing six sprints over a 35 meters distance, with 20 seconds of recovery between every sprint. The time of every sprint was measured with a stopwatch, and calculated the maximum power, minimum power, average power and fatigue index⁽²²⁾.

3.4 Food Diary

All participants were instructed to take pictures of every food and beverage consumed, for a period of three separate days (competition, training, and rest days), using their smartphones. They were asked to take one picture from an angle of 45 degrees, one before and one after the food or beverage was consumed. The subjects were asked to make sure that all ingredients were visible in the photograph and if they had second servings or snacks those must be included as well. To have more precise information, the researcher encouraged all the participants to write or audiotape a description of the food consumed. Using this method, participants give detailed information about brand labels, cooking methods, and a clear description of the ingredients in each meal.

To ensure and standardized the information, all participants received written instructions on how to take the pictures.

All pictures taken were sent to the researcher in real-time via smartphone through the application WhatsApp®. If the participants didn't send an updated photo for 2h, they received a personalized message to ensure they didn't forget to report any meal consumption. If the information or the picture were unsatisfactory, participants were immediately contacted, asking for clarification.

To estimate the energy and macronutrient intake, the main researcher reviewed all the food pictures. To accurately estimate the portions, it was used two photographic manuals, Manual fotográfico IAN-AF⁽²³⁾ and Manual de quantificação alimentar Latin-America⁽²⁴⁾, and a manual with a mean weight of Portuguese foods and beverages and household measures, Peso e Porções de Alimentos.⁽²⁵⁾ The energy and macronutrient intake was calculated with Nutrium® software 2022.

3.5. Statistical Analysis

Data and statistical analysis were performed with the IBM® SPSS® Statistics software (v27.0 for Windows, SPSS, Inc, an IBM Company, Chicago, IL). The parametric data obtained were expressed as mean, standard variation (SD), 95% confidence interval (CI), and absolute and relative frequency. Shapiro-Wilk test was used to determine the normal distribution of variables. Pearson and Spearman's correlations were used to assess the association between variables, such as body composition, physical performance results, and energy and macronutrient intake. ANOVA test and Friedman's test were used to compare the

three days of food diary. Statistical significances were established at a p-value <0.05.

4. Results

4.1. Participants characteristics

Participant's descriptive characteristics are presented in Table 1. Due to dropouts, this study included 12 athletes, 8 tennis players (5 females and 3 males) and 4 padel players (1 female and 3 males).

Table 1. Characterization of participants (n=12)

	All (n=12)
Age (yr)	15,8 (±1,6)
Training (hours/week)	10,5 (±3,8)
Water ingestion (L/day)	1,9 (± 1,1)
Sleep (hours/day)	7,8 (±0,6)
Sleep Pre-Competition Day (hours/day)	8,7 (±0,6)
Weight (kg)	61,6 (±10,1)
Height (m)	1,73 (±0,1)
BMI (kg/m ²)	20,6 (±1,8)
Body fat (%)	16,4 (±5,2)
Sum skinfolds (mm)	70,7 (±27,2)
Muscle mass (kg)	26,7 (±7,2)

Values are presented as mean (±SD)

yr = years; L = liters; kg = kilograms; m = meters; BMI = Body Mass Index; kg/m² = kilogram per meters squared;

% = percentage; mm = millimetres.

Dietary supplement intake reported is described in Table 2. One-third of the participants reported taking daily dietary supplements, with a higher relative frequency for creatine, magnesium, and multivitamins.

Table 2. Dietary supplements intake (reported values).

	Relative frequency (%)
Creatine	16,7
Vitamin C	8,3
Magnesium	16,7
Multivitamins	16,7

% - Percentage.

4.2. Dietary Intake

As presented in Table 3, no significant differences were found in total energy and macronutrient intakes between competition, training, and rest days.

Table 3. Total energy and macronutrient intake on competition, training, and rest days, expressed as absolute values.

	Competition Day	Training Day	Rest Day	<i>p</i> -value
Absolute Energy ^a (kcal)	2298,8 (±628,6)	2082,2 (±492,3)	2154,3 (±749,4)	0,608
Energy ^a (kcal.FFM ⁻¹)	45,3 (±3,3)	41,7 (±3,5)	41,8 (±3,3)	0,599
Total CHO ^a (g)	217,75 (±66,1)	218,9 (±58,7)	218,3 (±60,7)	0,998
Total Protein ^b (g)	122,9 (±40,8)	101,5 (±17,7)	121,4 (±62,0)	0,203
Total Fat ^a (g)	97,7 (±36,7)	83,6 (±30,8)	77,1 (±27,2)	0,139

Values are presented as mean (±SD).

a - ANOVA for repeated measures; b - Friedman test.

kcal = calories; kcal.FFM⁻¹ = calories per free fat mass; g = grams.

* Significant *p*-value < 0,05

It was possible to notice that athletes fail to reach carbohydrates consumption, according to the sports nutrition recommendations (5-7g.kg⁻¹). On average, protein intake is within the recommended values, however, is close to the upper limit of the recommendations (1.4-2g.kg⁻¹). Athletes fat intake is slightly higher than the guidelines suggested for this macronutrient (~25-35% of total energy intake). Accordingly, with the sports nutrition recommendations for young athletes, the studied populations showed a lower energy availability, as the energetic intake is lower than 45 kcal.kg FFM⁻¹ (10, 11) (Table 4).

Table 4. Mean daily energy and macronutrient intake comparison to sports nutrition recommendations.

	Dietary intake	Sports Nutrition Recommendations
Carbohydrates (g.kg ⁻¹)	3,6 (±0,6)	5,0 - 7,0 g.kg ⁻¹ per day
Carbohydrates (%TEI)	40,4 (±3,1)	
Protein (g.kg ⁻¹)	1,9 (±0,4)	1,4 - 2,0 g.kg ⁻¹ per day
Protein (%TEI)	21,1 (±3,5)	
Fat (g.kg ⁻¹)	1,4 (±0,4)	25 - 35% TEI
Fat (%TEI)	35,3 (±6,2)	
Energy (kcal.Kg FFM ⁻¹)	42,9 (±2,25)	≥45 kcal.kg FFM ⁻¹ per day

Values are presented as mean (±SD).

Recommendations based on the Energy and Macronutrient Considerations for Young Athletes review paper (Hannon et al. 2020) and Sport Nutrition For Young Athletes (Purcell, L. et al 2013).

g.kg⁻¹ = grams per kilograms; kcal.FFM⁻¹ = calories per kilograms of Free Fat Mass; %TEI = percentage of Total Energy Intake.

4.3. Physical Performance

Participant's descriptive physical performance results are presented in

Table 5.

Table 5. Physical performance results.

	Test Performance	95%CI
Sprint 5m (s)	1,3 (\pm 0,2)	1,2 - 1,5
Sprint 10m (s)	2,1 (\pm 0,3)	2,0 - 2,3
Sprint 20m (s)	3,7 (\pm 0,3)	3,5 - 3,9
Squat Jump (cm)	30,9 (\pm 7,8)	25,9 - 35,9
Countermovement Jump (cm)	33,2 (\pm 8,8)	27,7 - 38,8
Medicine ball throw (m)	5,7 (\pm 1,3)	4,9 - 6,6
AnaerobicTest		
Maximum_Power (w)	685,2 (\pm 256,5)	522,2 - 848,1
Minimum_Power (w)	497,4 (\pm 210,3)	363,8 - 631,0
Average_Power (w)	589,8 (\pm 234,5)	440,8 - 738,8
Fatigue_Index (w/sec)	6,2 (\pm 3,4)	4,1 - 8,4

Values are presented as mean (\pm SD); 95%CI = 95% confidence intervals.

s = seconds; cm = centimetres; m = meters; w = watts; w/sec = watts per seconds.

4.4. Body Composition and Dietary Intake

Carbohydrate consumption was moderately negatively significantly associated with BMI ($r=-0,629$; $p=0,028$). No other significant association was observed between body composition and energy and macronutrient intake.

Table 6. Association between energy and macronutrient intake and body composition.

	Carbohydrates (g.kg ⁻¹ per day)		Protein (g.kg ⁻¹ per day)		Fat (g.kg ⁻¹ per day)		Energy (kcal.FFM ⁻¹ per day)	
	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value
BMI (kg/m ²)	-0,629 ^a	0,028*	-0,537 ^a	0,072	-0,213 ^a	0,507	-0,462 ^a	0,131
Muscle mass (kg)	-0,511 ^a	0,090	-0,116 ^a	0,719	-0,256 ^a	0,421	-0,532 ^a	0,075
Sum skinfolds (mm)	-0,161 ^b	0,618	-0,434 ^b	0,159	-0,336 ^b	0,286	-0,217 ^b	0,499
Body fat (%)	0,126 ^b	0,697	-0,245 ^b	0,443	-0,063 ^b	0,846	0,077 ^b	0,812

a – Pearson correlation coefficient; b -Spearman correlation coefficient.

BMI = Body Mass Index; kg = kilograms; kg/m² = kilogram per meters squared; % = percentage; mm = millimetres.

* Significant p-value < 0,05

4.5. Body Composition and Physical Performance

In Table 7, the correlations between all physical performance results and body composition are shown for all participants. For BMI, there was a positive significant correlation with MBT ($r=0,660$; $p=0,019$). The association between muscle mass and physical performance results was moderate to very strong significant positively with the SJ ($r=0,697$; $p=0,012$), CMJ, ($r=0,773$; $p=0,003$), MBT ($r=0,827$; $p<0,001$), maximum power ($p=0,853$; $p<0,001$), minimum power ($p=0,909$; $p<0,001$), and average power ($p=0,864$; $p<0,001$). Muscle mass was also significantly negatively associated with the 10 metres sprint ($r=-0,746$; $p=0,005$). As for the sum skinfolds and body fat percentage there was a moderate to strong positive significant association with 5 metres sprint ($p=0,760$; $p=0,004$ and $p=0,616$; $p=0,033$, respectively) and 10 metres sprint ($p=0,657$; $p=0,020$ and $p=0,797$; $p=0,002$, respectively). Body fat percentage was also moderate to strong significant negatively associated with CMJ ($p=-0,589$; $p=0,044$), MBT ($p=-0,629$; $p=0,028$), maximum power ($p=-0,706$; $p=0,010$), minimum power ($p=-0,825$; $p<0,001$) and average power ($p=-0,769$; $p=0,003$).

Table 7. Association between body composition and physical performance results.

	BMI (kg/m ²)		Muscle mass (kg)		Sum skinfolds (mm)		Body fat (%)	
	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value
Sprint 5m (s)	0,011 ^a	0,974	-0,344 ^a	0,273	0,760 ^b	0,004*	0,616 ^b	0,033*
Sprint 10m (s)	-0,550 ^a	0,064	-0,746 ^a	0,005*	0,657 ^b	0,020*	0,797 ^b	0,002*
Sprint 20m (s)	-0,406 ^a	0,190	-0,517 ^a	0,085	0,293 ^b	0,356	0,384 ^b	0,217
Squat Jump (cm)	0,341 ^a	0,320	0,697 ^a	0,012*	-0,378 ^b	0,226	-0,531 ^b	0,075
Countermovement Jump (cm)	0,389 ^a	0,212	0,773 ^a	0,003*	-0,349 ^b	0,266	-0,589 ^b	0,044*
Medicine ball throw (m)	0,660 ^a	0,019*	0,827 ^a	<0,001*	-0,399 ^b	0,199	-0,629 ^b	0,028*
AnaerobicTest								
Maximum_Power (w)	0,467 ^a	0,126	0,853 ^a	<0,001*	-0,399 ^b	0,199	-0,706 ^b	0,010*
Minimum_Power (w)	0,434 ^b	0,159	0,909 ^b	<0,001*	-0,524 ^b	0,080	-0,825 ^b	<0,001*
Average_Power (w)	0,402 ^a	0,196	0,864 ^a	<0,001*	-0,434 ^b	0,159	-0,769 ^b	0,003*
Fatigue_Index (w/sec)	0,517 ^b	0,085	0,455 ^b	0,138	-0,007 ^b	0,983	-0,210 ^b	0,513

a - Pearson correlation coefficient; b - Spearman correlation coefficient.

s = seconds; cm = centimetres; m = meters; w = watts; w/sec = watts per seconds.

* Significant p value < 0,05.

4.6. Physical Performance and Dietary Intake

No performance test showed a significant correlation with energy and macronutrient intake, as presented in Table 8.

Table 8. Association between energy and macronutrient intake and physical performance results.

	Carbohydrates (g.kg ⁻¹ per day)		Protein (g.kg ⁻¹ per day)		Fat (g.kg ⁻¹ per day)		Energy (kcal.FFM ⁻¹ per day)	
	Correlation	p-value	Correlation	p-value	Correlation	p-value	Correlation	p-value
Sprint 5m (s)	-0,045 ^a	0,889	-0,356 ^a	0,256	-0,063 ^a	0,846	0,029 ^a	0,929
Sprint 10m (s)	0,283 ^a	0,374	-0,077 ^a	0,813	-0,104 ^a	0,748	0,165 ^a	0,608
Sprint 20m (s)	0,062 ^a	0,848	-0,065 ^a	0,840	-0,375 ^a	0,229	-0,019 ^a	0,953
Squat Jump (cm)	-0,030 ^a	0,926	0,156 ^a	0,628	0,257 ^a	0,420	-0,012 ^a	0,971
Countermovement Jump (cm)	-0,082 ^a	0,800	0,085 ^a	0,793	0,194 ^a	0,546	-0,080 ^a	0,805
Medicine ball throw (m)	-0,263 ^a	0,409	-0,149 ^a	0,645	0,043 ^a	0,895	-0,276 ^a	0,385
AnaerobicTest								
Maximum_Power (w)	-0,294 ^a	0,354	-0,189 ^a	0,556	-0,065 ^a	0,841	-0,388 ^a	0,212
Minimum_Power (w)	-0,336 ^b	0,286	0,014 ^b	0,966	-0,175 ^b	0,587	-0,252 ^b	0,430
Average_Power (w)	-0,265 ^a	0,405	-0,076 ^a	0,815	-0,043 ^a	0,893	-0,345 ^a	0,273
Fatigue_Index (w/sec)	-0,133 ^b	0,681	-0,364 ^b	0,245	-0,119 ^b	0,713	-0,147 ^b	0,649

a - Pearson correlation coefficient; b - Spearman correlation coefficient.

s = seconds; cm = centimetres; m = meters; w = watts; w/sec = watts per seconds.

* Significant p value < 0,05.

5. Discussion

As mentioned before, energy is essential during growth, development, and maturation stage. In young athletes, activity energy expenditure is often the greatest contributor to total energy expenditure. As a result, activity energy expenditure is influenced by the type, duration, and intensity of exercise. Due to this, young athletes overall energy consumption varies greatly among individuals, even within the same activity. Although it can be challenging to determine a young athlete's precise energy needs, it is strongly advised that they do not have a negative energy balance since this can have an adverse effect on both their performance and their long-term physical and mental health. Previous research suggests that younger athletes frequently have energy intake lower than recommendations (≥ 45 kcal.kg FFM⁻¹), as shown in our study^(9-11, 26).

It is clear that there is a carbohydrate deficiency when we compare this population's specific recommendations with adult tennis players, especially when we compare to guidelines for competition days (8 - 10g/kg.day)^(10, 11), as observed in other studies^(9, 27, 28). Reduced glycogen levels brought on by a low carbohydrate intake might promote the onset of muscular fatigue^(10, 28). Early muscular fatigue can compromise recovery and result in lower training and competition performance⁽¹⁰⁾. Although our study didn't find any association, may be due to the small sample size and the specificity of the performance tests.

Protein is an essential macronutrient with many different roles in the body. Young athletes need it to maintain tissue turnover and help with tissue development⁽¹⁰⁾. Our study suggests that this population of young tennis and padel athletes meet the protein intake recommendations, as reported in other previous studies⁽⁹⁾. Nonetheless, for elite-standard tennis player's recommendations for protein intake are ~1,8g/kg.day, which indicates that this study population consumed higher protein than what is advised⁽²⁷⁾. In this regard, some young athletes may possibly be consuming an excessive amount of protein, according to the guidelines^(10, 27).

Dietary fat is required to support healthy cell membrane function, supply essential fatty acids, and synthesise hormones^(10, 11, 27). Fat also plays a role in energy production during exercise, especially when the duration overcome 60 to 90 minutes^(10, 27). The population of this study showed consumption of fat similar to that reported in other studies, which is slightly higher than recommended for both adults and young players^(9, 10, 27).

Excessive protein consumption has been linked to lower carbohydrate and total calorie intake, which may have contributed to the insufficient energy and carbohydrate intake shown in this study^(9, 28). Also, athletes who took significantly more protein than recommended seemed to have a more fat intake than advised, which may explain our study results⁽²⁸⁾. Another reason for athletes having a protein intake close to the upper recommended value may be explained by the overvaluing of this macronutrient among coaches and players^(26, 29).

Players should periodize their energy and macronutrient consumption to optimize performance, recovery, and health^(9, 30, 31). In this study, there were no significant changes concerning dietary intake throughout the 3 days (competition, training and rest days). Because there are so many unpredictable variables during competitions, fuelling to maximise performance is exceptionally challenging in both of these sports^(9, 27). Particularly young players, who are commonly exposed to multiple matches per day, are frequently susceptible to inadequate recovery between matches⁽⁹⁾. Players also do not know how long matches may last or whether their starting time will be delayed or changed^(9, 27). In this sense, it is important to prioritize and adapt food intake to the day and competitive moment, which was not observed in this study.

The physical attribute values of the competitive tennis and padel players tested in this study are comparable to those seen in players of a similar age, but notably lower than those of adults which is coincident with others sports^(4, 6, 21, 32-34). In previous research, the majority of these performance assessments were determined to be reliable indicators of tennis and padel performance^(18, 19, 32). Other studies support the associations reported in this study, although they have been observed in other sports^(35, 36, 37). As observed in this study, anthropometric

characteristics have a significant impact on the performance of the tests. To our knowledge, this is the first research to compare anthropometric measures and indicators of physical performance in young tennis and padel players. Therefore, more studies are required to access the best body composition to optimise performance.

This study presented some limitations, including the inability to separate the statistical analysis by sex and sport category due to the limited sample size (n=12), because sample size calculation was not performed. Furthermore, only 4 padel players participated in this study, so it would be interesting to include a more balanced sample with more representativity. Some previous research showed a potential under-reporting with the use of food diaries^(9, 38). The nutrition recommendations used, are not specific for the studied population, so it would be fundamental in the future to have guidelines for young tennis and padel players.

6. Conclusion

In summary, young female and male tennis and padel players seemed to have an energy and carbohydrates intake below recommendations. Protein consumption seems to be within recommended values, however very close to the upper limit advised. Fat consumption seems to be slightly higher than what is recommended. Muscle mass and fat body mass appeared to be the most correlated anthropometric characteristics with physical performance. Dietary intake does not show any association with physical performance tests. More research on this specific population and sports is needed.

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References

1. Vicente-Salar N, Santos-Sanchez G, Roche E. Nutritional Ergogenic Aids in Racquet Sports: A Systematic Review. *Nutrients*. 2020; 12(9)
2. Lees A. Science and the major racket sports: a review. *J Sports Sci*. 2003; 21(9):707-32.
3. Sanchez-Munoz C, Muros JJ, Canas J, Courel-Ibanez J, Sanchez-Alcaraz BJ, Zabala M. Anthropometric and Physical Fitness Profiles of World-Class Male Padel Players. *Int J Environ Res Public Health*. 2020; 17(2)
4. García-Giménez A, Pradas de la Fuente F, Castellar Otín C, Carrasco Páez L. Performance Outcome Measures in Padel: A Scoping Review. *International Journal of Environmental Research and Public Health*. 2022; 19(7):4395.
5. Luna-Villouta P, Paredes-Arias M, Flores-Rivera C, Hernandez-Mosqueira C, Souza de Carvalho R, Faundez-Casanova C, et al. Anthropometric Characterization and Physical Performance by Age and Biological Maturation in Young Tennis Players. *Int J Environ Res Public Health*. 2021; 18(20)
6. Courel-Ibanez J, Llorca-Miralles J. Physical Fitness in Young Padel Players: A Cross-Sectional Study. *Int J Environ Res Public Health*. 2021; 18(5)
7. Martínez-Rodríguez A, Roche Collado E, Vicente-Salar N. Body composition assessment of paddle and tennis adult male players. *Nutr Hosp*. 2014; 31(3):1294-301.
8. Sanchez-Pay A, Ramon-Llin J, Martinez-Gallego R, Sanz-Rivas D, Sanchez-Alcaraz BJ, Frutos S. Fitness testing in tennis: Influence of anthropometric characteristics, physical performance, and functional test on serve velocity in professional players. *PLoS One*. 2021; 16(11):e0259497.
9. Fleming JA, Cathain CO, Harper LD, Naughton RJ. Dietary Intake and Daily Distribution of Carbohydrate, Protein and Fat in Youth Tennis Players over a 7-Day Training and Competition Period. *J Sports Sci Med*. 2021; 20(3):413-20.
10. Hannon MP, Close GL, Morton JP. Energy and Macronutrient Considerations for Young Athletes. *Strength & Conditioning Journal*. 2020; 42(6):109-19.
11. Purcell LK. Sport nutrition for young athletes. *Paediatr Child Health*. 2013; 18(4):200-5.
12. Stewart A, Marfell-Jones M, Olds T, De Ridder J. International Standards for Anthropometric Assessment. 2011.
13. Khosla T, Lowe CR. Indices of obesity derived from body weight and height. *Br J Prev Soc Med*. 1967; 21(3):122-8.
14. Slaughter MH, Lohman T, Boileau R, Horswill C, Stillman RJ, Loan M, et al. Skinfold Equations for Estimation of Body Fatness in Children and Youth. *Human biology*. 1988; 60:709-23.
15. Durnin JV, Rahaman MM. The assessment of the amount of fat in the human body from measurements of skinfold thickness. *British Journal of Nutrition*. 1967; 21:681 - 89.
16. Sarría A, García-Llop LA, Moreno LA, Fleta J, Morellón MP, Bueno M. Skinfold thickness measurements are better predictors of body fat percentage than body mass index in male Spanish children and adolescents. *Eur J Clin Nutr*. 1998; 52(8):573-6.

17. Poortmans JR, Boisseau N, Moraine JJ, Moreno-Reyes R, Goldman S. Estimation of total-body skeletal muscle mass in children and adolescents. *Med Sci Sports Exerc.* 2005; 37(2):316-22.
18. Vuong JL, Fett J, Ulbricht A, Ferrauti A. Physical determinants, intercorrelations, and relevance of movement speed components in elite junior tennis players. *Eur J Sport Sci.* 2022:1-11.
19. Ulbricht A, Fernandez-Fernandez J, Ferrauti A. Conception for Fitness Testing and individualized training programs in the German Tennis Federation. *Sport-Orthopädie - Sport-Traumatologie - Sports Orthopaedics and Traumatology.* 2013; 29(3):180-92.
20. Balsalobre-Fernandez C, Glaister M, Lockey RA. The validity and reliability of an iPhone app for measuring vertical jump performance. *J Sports Sci.* 2015; 33(15):1574-9.
21. Ulbricht A, Fernandez-Fernandez J, Mendez-Villanueva A, Ferrauti A. Impact of Fitness Characteristics on Tennis Performance in Elite Junior Tennis Players. *J Strength Cond Res.* 2016; 30(4):989-98.
22. Draper NaW, G. Here's a new running based test of anaerobic performance for which you need only a stopwatch and a calculator. *Peak Performance.* 1997; 96:3-5.
23. Torres D FN, Sousa N, Teixeira S, Soares R, Amorim H, et al. Inquérito Alimentar Nacional e de Atividade Física, IAN-AF 2015-2016: Manual Fotográfico de Quantificação de Alimentos. Universidade do Porto. 2017
24. al SPCe. Manual Fotográfico de Quantificação Alimentar. Globo Diet Latin America. 2017
25. Goios AM, M.; Oliveira, A.; Afonso, C.; Amaral, T. *Peso e Porções de Alimentos.* 3ª edição ed.; 2014.
26. Juzwiak CR, Amancio OM, Vitalle MS, Pinheiro MM, Szejnfeld VL. Body composition and nutritional profile of male adolescent tennis players. *J Sports Sci.* 2008; 26(11):1209-17.
27. Ranchordas MK, Rogerson D, Ruddock A, Killer SC, Winter EM. Nutrition for tennis: practical recommendations. *J Sports Sci Med.* 2013; 12(2):211-24.
28. Kanter M. High-Quality Carbohydrates and Physical Performance: Expert Panel Report. *Nutr Today.* 2018; 53(1):35-39.
29. Juzwiak CR, Ancona-Lopez F. Evaluation of nutrition knowledge and dietary recommendations by coaches of adolescent Brazilian athletes. *Int J Sport Nutr Exerc Metab.* 2004; 14(2):222-35.
30. Burke LM, Hawley JA, Wong SH, Jeukendrup AE. Carbohydrates for training and competition. *J Sports Sci.* 2011; 29 Suppl 1:S17-27.
31. Thomas DT, Erdman KA, Burke LM. American College of Sports Medicine Joint Position Statement. Nutrition and Athletic Performance. *Med Sci Sports Exerc.* 2016; 48(3):543-68.
32. Girard O, Millet GP. Physical determinants of tennis performance in competitive teenage players. *J Strength Cond Res.* 2009; 23(6):1867-72.
33. Girard O, Lattier G, Micallef JP, Millet GP. Changes in exercise characteristics, maximal voluntary contraction, and explosive strength during prolonged tennis playing. *Br J Sports Med.* 2006; 40(6):521-6.
34. Fernandez-Fernandez J, Ulbricht A, Ferrauti A. Fitness testing of tennis players: how valuable is it? *Br J Sports Med.* 2014; 48 Suppl 1:i22-31.

35. Gameiro PF, C.; Granja, D.; Caetano, C.; Ferreira, D.; Godinho, C. Relationship between body composition, sprint performance and vertical jump tests in young elite soccer players. 2018
36. Nikolaïdis PT. Physical fitness is inversely related with body mass index and body fat percentage in soccer players aged 16-18 years. *Med Pregl.* 2012; 65(11-12):470-5.
37. Hermassi S, Hayes LD, Schwesig R. Can Body Fat Percentage, Body Mass Index, and Specific Field Tests Explain Throwing Ball Velocity in Team Handball Players? *Applied Sciences.* 2021; 11(8):3492.
38. Burke LM, Cox GR, Culmings NK, Desbrow B. Guidelines for daily carbohydrate intake: do athletes achieve them? *Sports Med.* 2001; 31(4):267-99.

