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Research article

Dietary Intake and Daily Distribution of Carbohydrate, Protein and Fat in Youth Tennis Players over a 7-Day Training and Competition Period

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Abstract
During a 7-day training and/or competition period, macronutrient intake and distribution was assessed using food diaries, supported by remote food photography and 24-hr multiple pass recalls of youth tennis players categorised by under 12s, under 14s and under 16+ age groups (n = 27). Total energy did not differ between age groups nor type of day (training [TD], competition day [CD]), irrespective of a significant increase in body mass reported in the older players (U16+; $p < 0.05$). Average intakes were consistently below 2250 kcal·day^{-1} (range 1965 ± 317–2232 ± 612 kcal·day^{-1}). Carbohydrate consumption was below guidelines for all groups (≤6g·kg^{-1}). Conversely, protein intake met or exceeded guidelines throughout, with intakes ≥2 g·kg^{-1} for both the U12 and U14 age groups on both days. Protein intake was ~17% higher on TDs than CDs ($p < 0.05$), with protein intake at lunch significantly higher on TDs than CDs ($p < 0.05$). No further differences were observed between breakfast, lunch or dinner between group or day. Inconsistent snacking was reported, with players consuming snacks on less than half of the days reported (46 ± 12% of TDs and 43 ± 30% of CDs). In conclusion, youth tennis players present sub-optimal nutrition practices, appearing to under fuel and under consume carbohydrate for performance, adaptation, recovery and health.

Key words: Tennis, nutrition, energy, carbohydrate, protein.

Introduction

Tennis is an intermittent sport characterised by prolonged durations of repeated high intensity bouts interspersed with standardised rest periods, demanding high levels of fitness in components including speed, agility, power, and cardiovascular endurance (Fernandez-fernandez et al., 2009). Participation at the highest level of professional tennis is occurring at progressively younger ages. A player's first professional international tournament may be at the age of 15 years for girls and 16.5 years for boys (Juzwiak et al., 2008). To compete at the highest-level, tennis players must manage high training and competition loads (Kovacs, 2007; Ranchordas et al., 2013). It is not uncommon for young talented tennis players aged 12-16 to train 15-20 hours per week (Sabato et al., 2016), and compete in multiple matches a day (Gescheit et al., 2017). As such, ensuring sufficient energy and macronutrient intake for physical performance and recovery is key for practitioners working with young athletes (Desbrow et al., 2019). Nutrition has a direct influence on optimising energy stores, reducing fatigue, preventing injuries, promoting recovery, and improving health status (Thomas et al., 2016). In youth athletes, nutrition is particularly critical to meet training requirements, and support the rapid physical growth and altered body composition (increased height, weight, and muscle mass) that occurs during puberty and maturation (Cotunga et al., 2005; Juzwiak et al., 2008; Steen, 1996).

There is limited research on tennis nutrition and the dietary practices of youth players (Coelho et al., 2013; Fleming et al., 2018; Juzwiak et al., 2008; Yli-Piipari, 2019). Eating habits are variable (Fleming et al., 2018), and carbohydrate intakes are below recommended values of 6-10 g·kg^{-1} (Coelho et al., 2013; Hannon et al., 2020; Juzwiak et al., 2008; Yli-Piipari, 2019). Negative energy balance has been observed in competitive male and female teenage tennis players, with reported deficits between 532-1709 kcal (Juzwiak et al., 2008) and 268-921 kcal (Yli-Piipari, 2019). Furthermore, low energy availability (LEA; defined as <45kcal·kg·FFM·day^{-1}) has been observed in 87.5% of female teenage tennis players (Coelho et al., 2013). Over a prolonged period this may lead to relative energy deficiency in sport (RED-S) syndrome, which can have a negative impact on, *inter alia,* metabolism, menstrual function, bone health, immunity, protein synthesis, and cardiovascular and psychological health (Mountjoy et al., 2018).

In order to support a healthy athletic career and future wellbeing, it is key to provide this population with specific nutrition guidelines and recommendations (Desbrow et al., 2019). There is a need to quantify eating habits of youth tennis players, the daily 'distribution' of energy and macronutrient intakes (Naughton et al., 2016), nutrient timing in relation to training sessions (Mori, 2014) and the composition of main meals (Garaulet and Gómez-Abellán, 2014). These have not been investigated in a tennis population. Therefore, the aims of the present study were twofold; 1) quantify total energy and macronutrient intake and 2) quantify the daily distribution of energy and macronutrient intake of youth tennis players on training and competition days.

Methods

Participants

Twenty-seven youth tennis players (aged 14 ± 3 years) representing their county or above were recruited; see Table 1 for participant characteristics.

Players trained 2 ± 1 times per day (range 1 - 5 sessions) for 3.1 ± 1.4 hours in total duration (range 1 - 6 hours per day). Match/competition days included 2 ± 1

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Table 1. Participant characteristics.

	Under 12s		U14s		U16+	
	M (n = 2)	F (n = 6)	M (n = 4)	F (n = 5)	M (n = 8)	F (n = 2)
Age (years)	12.0 ± 0.0	11.3 ± 0.5	13.3 ± 0.5	13.2 ± 0.4	17.6 ± 1.8	16.5 ± 0.7
Body mass (kg)	46.5 ± 14.8	47.8 ± 7.7	61.5 ± 14.0	51.1 ± 5.4	69.5 ± 6.0	65.9 ± 8.7
Height (m)	1.7 ± 0.1	1.6 ± 0.1	1.7 ± 0.1	1.6 ± 0.1	1.8 ± 0.1	1.7 ± 0.1

Values reported as means ± SD. M = Males, F = Females. U16+ consists of 1 x 15, 3 x 16, 1 x 17, 3 x 18, and 2 x 20-year-olds. Body mass data was self-reported. Significant differences between U12s and U16s, and U14s and U16s body mass ($p < 0.05$).

Table 2. Training and match play characteristics.

	Under 12s	U14s	U16+
No. of training sessions per day	2.1 ± 0.8	2.6 ± 0.9	2.2 ± 1.0
Training session duration (hours)	1.6 ± 0.6	1.3 ± 0.4	1.5 ± 0.5
Daily training duration (hours)	3.1 ± 1.4	3.4 ± 1.3	3.1 ± 1.4
No. of matches	1.4 ± 0.8	1.6 ± 0.8	1.7 ± 0.8
Match duration (hours)	1.6 ± 0.8	1.4 ± 0.3	1.6 ± 0.7
Training session intensity (%)	H77% M23% L0%	H56% M42% L2%	H83% M17% L0%
Match intensity (%)	H93% M7% L0%	H81% M19% L0%	H90% M10% L0%

Values reported as means ± SD. H = High intensity, M = Moderate intensity, L = Low intensity. Intensities were self-reported.

matches per day (ranging between 1-4 matches), with match durations of 1.6 ± 0.6 hours; see Table 2 for training and match play characteristics. Participants were recruited through professional and personal networks of the lead investigator. All participants gave informed consent. When participants were under 18, parental/guardian consent was sought. All data collection was completed in accordance with the declaration of Helsinki and the University of Huddersfield's Human and Health Sciences Research Ethics and Integrity Committee granted ethical approval (reference SREP/2017/032).

Dietary Intake

Participants were asked to record everything they consumed for seven consecutive days during a typical training and/or competition week using a pen in a printed food and training diary. Seven-days provides a more accurate estimation of habitual nutritional intake than a single- or four-day recording (Magkos and Yannakoulia, 2003) and is deemed a preferable means when measuring nutritional behaviours and eating habits (Biltoft-Jensen et al., 2009). Participants were asked to provide as much detail as possible, including the brand names of the food/drink, cooking/preparation methods, and time of consumption. They were also asked to label meals as breakfast, lunch, dinner or snacks. Where possible, participants were asked to quantify the portion of the foods and fluids consumed, referring to the weight/volume provided on food packages, or i) using standardised household measures, or ii) providing the number of items of a predetermined size. Participants were asked to stipulate the type of day (rest, match/competition or training day) and provide detail on what activities were carried out on each day, with approximations of duration and intensity (low, moderate, high).

Food diaries were cross-referenced using the remote food photographic method, as used in Anderson et al. (2017), to better understand portion size and/or retrieve information that players may have missed on their food diary. Participants were asked to download the MealLogger app (Wellness Foundry, USA) and photograph everything they consumed during the same seven-day period. They were asked to upload their pictures (with a short description of the meal and its contents) to the app so the lead researcher could see real time uploads.

To enhance reliability and ensure players missed no food or drink consumption, food diaries and remote food photography were reviewed and cross-checked alongside a 24-hour multiple pass recall (Thompson and Subar, 2008). These three sources of energy intake data were used in combination to estimate daily energy and macronutrient intake/distribution. On the day prior to data collection, the lead researcher conducted a one-to-one meeting or phone call with every participant (parents/guardians encouraged to be present) to ensure they understood what was expected during the data collection period. Participants were also given an information pack reiterating guidelines for each component of data collection.

Food diary data were analysed using Nutritics software (3.74 professional edition, Nutritics Ltd., Dublin, Ireland). All analyses were carried out by a single trained researcher so that potential variation of data interpretation was minimized (Deakin, 2000). To assess intra-tester reliability, the lead investigator selected a sample of dietary intake records (n = 3; ~10%) for one day and analysed the data on three separate occasions, at least one day apart. Intraclass correlation coefficients of >0.980 were established for total energy and macronutrient intakes.

Statistical Analysis

All parametric data is reported as means with standard deviations (SD). Statistical analysis was completed using IBM SPSS statistical software (v23.0 for windows, IBM corporation, Armonk, NY, USA). Normality of data was assessed using Shapiro-Wilks tests, with $p > 0.05$ used as the threshold for normal distribution. A one-way ANOVA was completed to compare body mass between age groups (U12, U14, U16+). Multiple 3 x 2 mixed ANOVAs were used to examine whether age group (between effect; U12, U14, U16+) and type of day (within effect; TD and CD) had an influence on total daily energy and total daily macronutrient intake. Total daily intake included all foods and fluids consumed at breakfast, lunch, dinner, and snacks reported throughout the day. Further 3 x 2 mixed ANOVAs (group x day) were carried out to assess total energy and macronutrient intake for each mealtime (breakfast, lunch, dinner and snacks). Frequency of snack intake was compared across type of day (TD v CD) via multiple one-way ANOVAs. Most frequent sources of dietary intake across all meals (including snacks) were investigated via frequency/inductive analysis. Where significant main effects were established, Tukey post-hoc analysis was conducted to locate specific differences. Assumptions of sphericity and homogeneity of variance were assessed using Mauchly's and Levene's test, respectively. For each, an alpha level of $p < 0.05$ determined a violation of the assumption. Where data was not normally distributed, Kruskal-Wallis H tests were used, with data for these tests reported as median values.

Results

Daily energy and macronutrient total and relative daily intake

No significant interactions were found for total daily energy and relative daily macronutrient intakes between age groups across days (TD and CD; $p > 0.05$). A main effect of day was observed for relative protein intake, with players consuming significantly more protein on TDs compared to CDs (16 ± 14 %, p = 0.037). No other main effects were identified (Table 3).

Energy and macronutrient distribution across meals

There was no significant interaction effect between playing age and day for total energy and relative macronutrient intakes at breakfast, lunch, or dinner ($p > 0.05$). A significant main effect (day; p = 0.01) for relative protein intake at lunch was established, with post-hoc pairwise comparisons indicating a significant difference between TDs and CDs (mean intakes for TDs: 0.73 ± 0.24g·kg^{-1} vs 0.49 ± 0.25g·kg^{-1} on CDs; Figure 1).

Snacking

No significant differences were established in the frequency of snacking between TDs and CDs (p = 0.670), with players consuming snacks on 46 ± 12% of TD and 43 ± 30% of CD, respectively. No significant differences in the composition of mid-morning, afternoon and pre-bed snacks were identified ($p > 0.05$; Table 4).

Table 3. Total energy and macronutrient intake between youth tennis players (U12, U14, U16+) on training and competition days, expressed as absolute and relative values.

	U12		U14		U16+	
	TD	CD	TD	CD	TD	CD
Absolute Energy (kcal)	1965 ± 317	2002 ± 301	2366 ± 122	2224 ± 283	2232 ± 612	2152 ± 807
Relative Energy (kcal·kg^{-1})	41 ± 10	42 ± 7	45 ± 7	42 ± 9	33 ± 10	32 ± 13
Total CHO (g)	220 ± 56	236 ± 43	270 ± 59	257 ± 62	255 ± 46	260± 103
Relative CHO (g·kg^{-1})	4.6 ± 1.5	5.0 ± 1.7	5.2 ± 1.7	5.0 ± 1.7	3.7 ± 0.9	3.8 ± 1.6
Total Protein (g)	105 ± 21	97 ± 10	120 ± 33	105 ± 25	117 ± 45	93 ± 40
Relative Protein (g·kg^{-1})	2.2 ± 0.4	2.1 ± 0.6*	2.2 ± 0.5	2.0 ± 0.6*	1.7 ± 0.7	1.2 ± 0.8*
Total Fat (g)	73 ± 11	74 ± 20	91 ± 9	86 ± 16	75 ± 28	62 ± 21
Relative Fat (g·kg^{-1})	1.5 ± 0.4	1.5 ± 0.3	1.7 ± 0.2	1.6 ± 0.3	1.1 ± 0.4	0.9 ± 0.3

Values reported as means ± SD. TD = training day; CD = competition day. * denotes significant main effect between TD & CD intakes (p<0.05).

Table 4. Breakdown of energy and macronutrient composition of snacks based on timing and type of day.

	Morning Snack		Afternoon Snack		Pre-Bed Snack	
	TD	CD	TD	CD	TD	CD
Absolute Energy (kcal)	208 ± 91	292 ± 175	267 ± 133	305 ± 114	265 ± 154	188 ± 66
Total CHO (g)	31 ± 15	47 ± 40	39 ± 21	51 ± 21	38 ± 27	26 ± 13
Relative CHO (g·kg^{-1})	0.57 ± 0.28	0.84 ± 0.65	0.73 ± 0.44	0.95 ± 0.43	0.72 ± 0.61	0.53 ± 0.40
Total Protein (g)	6 ± 10	8 ± 7	7 ± 6	9 ± 7	10 ± 8	7 ± 4
Relative Protein (g·kg^{-1})	0.10 ± 0.13	0.14 ± 0.10	0.12 ± 0.08	0.15 ± 0.11	0.18 ± 0.16	0.13 ± 0.10
Total Fat (g)	7 ± 4	8 ± 9	9 ± 6	8 ± 7	8 ± 7	7 ± 2
Relative Fat (g·kg^{-1})	0.12 ± 0.08	0.14 ± 0.16	0.17 ± 0.09	0.14 ± 0.11	0.15 ± 0.15	0.13 ± 0.06

Values reported as means ± SD. TD = training day; CD = competition day

Discussion

The aims of the current study were to quantify the total daily macronutrient intake and daily distribution in youth tennis players of different ages. To the authors' knowledge this is the first study to investigate total and daily distribution of macronutrient intake in a youth tennis population. We observed that youth tennis players, irrespective of age, fail to align energy intake and carbohydrate consumption with current guidelines (Table 5). This data illustrates sub-optimal practices which may impair training adaptations (Ackerman et al., 2019), recovery from exercise (Thomas et al., 2016) and physical/sporting development (Sabato et al., 2016).

Energy

Total daily energy intake values are comparable to previous research for players of similar ages, with sub-optimal intakes reported to date (Coelho et al., 2013; Juzwiak et al., 2008). For example, Coelho et al. (2013) reported 54% of players consumed less than 1800 kcal·day^{-1} (mean 1715 ± 321 kcal), considered the minimum energy necessary to maintain positive energy balance (Rodriguez et al., 2009), and 32% of players in Juzwiak et al. (2008)

reported calorie deficits greater than 10% of energy expenditure (mean intakes of 2635 ± 727 kcal and 2967 ± 775 kcal for 10-13 and 14-18 year olds respectively). In the present study, mean intakes of 2027 ± 261 kcal for U12s, 2275 ± 196 kcal for U14s, and 2243 ± 431 kcal for U16+ players were reported, with no significant differences established between groups. Older youth athletes require increased energy needs to support maturation, physical development and increases in body mass (Aerenhouts et al., 2011), thus this is a notable finding illustrating particularly concerning intakes amongst older players. This could be due to an increase in dietary autonomy associated with older teenagers, and reduction in parental control of dietary intake typically observed during early adolescence (10 - 14 years old; Reicks et al., 2015), suggesting older players may benefit from greater nutritional education and support.

Table 5. Mean daily macronutrient intake in comparison to sports nutrition recommendations.

Macronutrient		Dietary Intake				Sports Nutrition Recommendations
		All	U12	U14	U16+	
Carbohydrate	$g \cdot kg^{-1}$	4.6 ± 1.4	5.2 ± 1.2	4.9 ± 1.8	3.9 ± 0.8	6-10 $g \cdot kg^{-1}$ per day
	% TEI	46 ± 5	47 ± 3	45 ± 8	47 ± 3	
Protein	$g \cdot kg^{-1}$	1.9 ± 0.4	2.0 ± 0.3	2.1 ± 0.4	1.6 ± 0.4	1.4-2 $g \cdot kg^{-1}$ per day
	% TEI	20 ± 4	19 ± 2	20 ± 6	20 ± 3	
Fat	$g \cdot kg^{-1}$	1.5 ± 0.4	1.7 ± 0.3	1.6 ± 0.3	1.3 ± 0.5	30-35% TEI
	% TEI	35 ± 4	34 ± 3	35 ± 3	35 ± 6	

Recommendations based on the Energy and Macronutrient Considerations for Young Athletes review paper (Hannon et al., 2020). Values are reported for the full sample, U12, U14 and U16+ groups and are reported as means ± SD. TEI = Total Energy Intake.

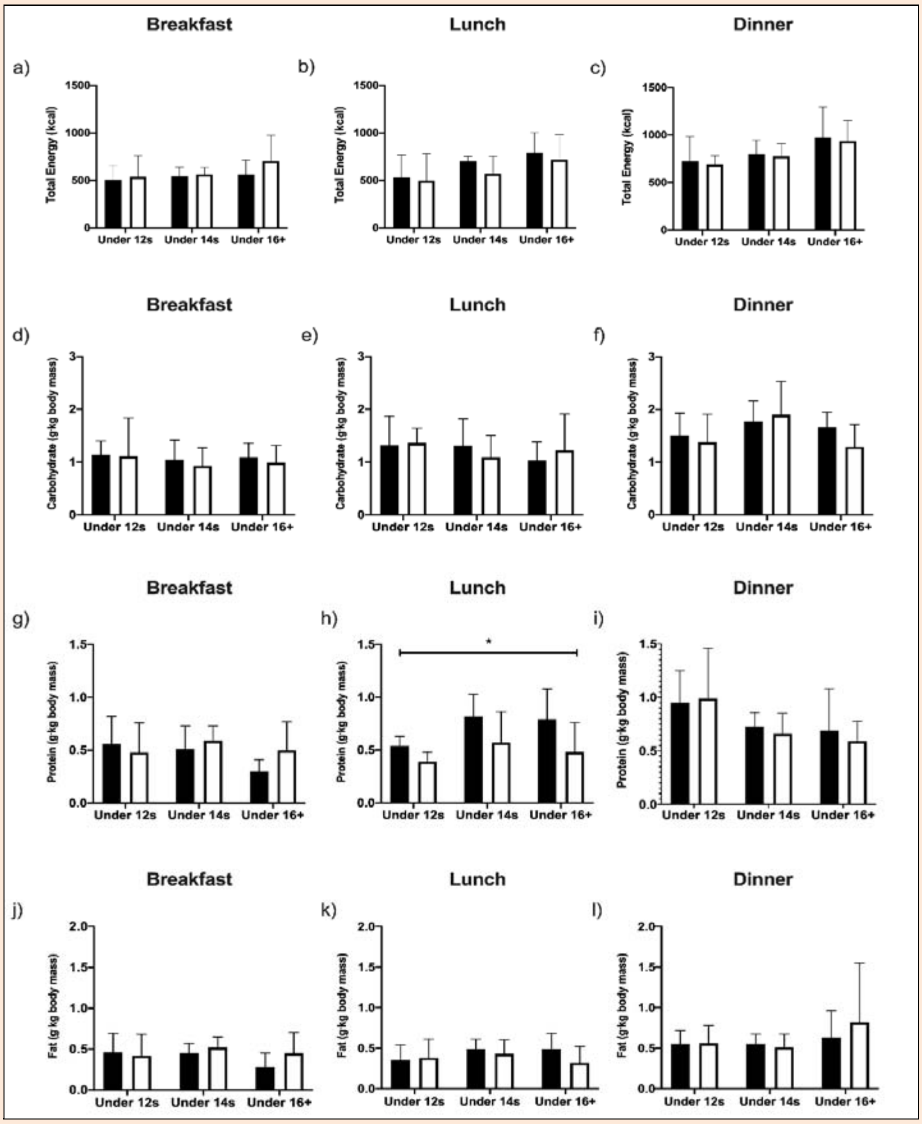

Figure 1. Total energy and relative macronutrient intakes for U12s, U14s and U16+ age groups during TDs and CDs. Black bars represent TDs and white bars represent CDs. Values presented as mean ± SD. * denotes a significant main effect of day ($p<0.05$) between all age groups. TD = training day; CD = competition day.

Tennis players have high training and match loads (Kovacs and Baker, 2014; Sabato et al., 2016). Match-play has been shown to elicit energy expenditures >650 kcal and >1000 kcal per match (90 and 150 minute matches respectively; Ranchordas et al. 2013). With high energy demands reported during tennis (Kovacs, 2007; Ranchordas et al., 2013) and considerations of sub-optimal energy intakes reported to date (Coelho et al., 2013; Juzwiak et al., 2008; Yli-Piipari, 2019), it is possible that players in the present study did not consume sufficient calories to optimise performance and recovery. This requires close attention, as failing to meet energy needs for sustained periods may increase the risk of RED-S; a syndrome associated with decreased response to training, impaired judgement, co-ordination and concentration, and increased feelings of depression and irritability (Ackerman et al., 2019).

Carbohydrates

Carbohydrate intake recommendations for young athletes are 6 - 10 $g{\cdot}kg^{-1}$ (Hannon et al., 2020), with tennis specific guidelines, albeit limited to an adult population, recommending players consume a minimum of 6 $g{\cdot}kg^{-1}$ during a training phase and a minimum of 7 $g{\cdot}kg^{-1}$ during competition (Ranchordas et al., 2013). We observed no significant difference in carbohydrate intake between age group and day; however, the U16+ group had the lowest relative intake (3.7 ± 0.9 $g{\cdot}kg^{-1}$ and 3.8 ± 1.6 $g{\cdot}kg^{-1}$) on TDs and CDs, respectively. These values are in line with previous literature in tennis (Coelho et al., 2013; Juzwiak et al., 2008) and other youth sports (Naughton et al., 2016) where carbohydrate intakes have consistently been below recommendations (<6 $g{\cdot}kg^{-1}$). Given the importance of carbohydrates for sustained energy and prolonged high-intensity efforts (Burke et al. 2011), recovery (Kovacs and Baker, 2014) and aiding growth (Montfort-Steiger and Williams, 2007), our data suggests that youth tennis players are not consuming sufficient quantities of carbohydrate to optimise performance and physical development. This study extends the findings of previous research identifying that low carbohydrate intake during tennis is a key contributor towards sub-optimal energy availability (Juzwiak et al., 2008; Yli-Piipari, 2019).

Protein

Current daily protein intakes of 1.4 to 2.0 $g{\cdot}kg^{-1}$ are recommended for young athletes (Hannon et al., 2020). Even during periods of peak growth in adolescents, there is no increase in protein requirements (Aerenhouts et al., 2013), with ~1.5 $g{\cdot}kg^{-1}$ deemed sufficient to sustain a positive nitrogen balance (Mazzulla et al., 2018). A theme emerging from the literature illustrates that athletes' protein intakes meet and/or exceed current guidelines (Coelho et al., 2013; Juzwiak et al., 2008; Naughton et al., 2016). This was evident in the current study, with intakes of 2.0 ± 0.3 $g{\cdot}kg^{-1}$ for U12s, 2.1 ± 0.4 $g{\cdot}kg^{-1}$ for U14s, and 1.6 ± 0.4 $g{\cdot}kg^{-1}$ for U16+ (Table 5). The overconsumption of protein has been associated with reduced carbohydrate and overall calorie intake due to its satiating effect (Kanter, 2018), and this may have contributed to the inadequate carbohydrate intake observed in the current study. Excessive intakes of protein may be explained by the overvaluing of protein amongst coaches and players (Juzwiak et al., 2008; Juzwiak and Ancona-Lopez, 2004). Therefore, better nutrition education may be warranted in this population.

Daily distribution

The type, timing and dose of dietary intake is critical in optimising energy availability for performance, training adaptation and recovery (Thomas et al., 2016). No significant difference in quantities of carbohydrate were consumed at breakfast, lunch or dinner between ages (Figure 1). Most frequent sources of carbohydrates included cereal and toast at breakfast, and pasta, sandwiches/baguettes at lunch on both days. Minor fluctuations in intake at dinner were noted; with meals largely consisting of rice/potatoes on TDs compared to chips and pizza on CDs. Albeit anecdotal, these differences at dinner on CDs may have been a result of players eating comfort foods as a treat following a day of competition.

To optimise pre-event fueling, athletes should consume between 1-4 $g{\cdot}kg^{-1}$ of carbohydrates 1-4 hours prior (Thomas et al., 2016). When considering match-play or prolonged high-intensity training sessions (>60 minutes) a structured programme of carbohydrate feeding is required to maintain adequate energy and carbohydrate availability (Kovacs, 2006a, 2006b). The consumption of 30-60 $g{\cdot}hr^{-1}$ of multi-transportable carbohydrates are suggested during matches and prolonged training to maintain high carbohydrate availability and to maximise exogenous carbohydrate oxidation (Burke et al., 2011; Kovacs, 2006b). When training twice a day or subject to multiple matches in quick succession, early intake of carbohydrate in the recovery period is recommended (~1-1.2 $g{\cdot}kg{\cdot}hr^{-1}$), allowing for sufficient digestion time (Thomas et al., 2016). Our data suggest that players were not optimising dietary carbohydrate intake, with infrequent snack intake across the day, and no clear evidence of fueling for training and/or match-play performance or recovery (Figure 1 for meal distribution and Table 4 for snack composition).

Distribution of daily protein may have a more influential role in modulating muscle protein synthesis (MPS) than total daily protein intake (Volterman et al., 2017). Research supports doses of 0.22-0.33 $g{\cdot}kg^{-1}$ per meal/snack every 3-4 hours throughout the day with a pre-sleep feed to optimise MPS (Snijders et al., 2015; Volterman et al., 2017). Although all age groups met protein targets per main meal (ranging from 0.30-0.99 $g{\cdot}kg^{-1}$; most frequent sources including eggs, pork sausages, chicken and fish), this was not the case for snacking (Table 4). Relative intakes of snacks ranged from 0.10 to 0.18 $g{\cdot}kg^{-1}$, identifying effective snacking (with particular reference to pre-bed feeds) as key towards improving optimal protein distribution in this population.

Type of day: Training versus competition day

To optimise performance, adaptation, recovery and health, players should periodise their energy and macronutrient intake (Burke et al., 2011; Thomas et al., 2016). Although there was some minor day-to-day variation in dietary intake, the patterns of variation do not reflect purposeful nutritional periodisation (Figure 1). The only difference established in protein intake was at lunch (with players consuming significantly more protein during TDs than CDs). No difference was found between playing age and day for total energy, carbohydrates or fats across meals.

Competitive tennis/match-play is typically played at higher intensities than training sessions and elicits greater physical and mental demands (heart rate, perceived exertion, error rates) than training (Moreira et al., 2016; Murphy et al., 2016). Fueling to maximise performance is extremely challenging during competitions. Players do not know how long matches may last, whether their start time will be delayed/amended, and are often subject to inadequate or unknown recovery durations between matches (Ranchordas et al., 2013). Youth tennis players are often exposed to multiple matches per day, especially when competing in both singles and doubles events, and often entering multiple tournaments across different age groups (i.e., both under 14 and under 12 competitions; Gallo-Salazar et al., 2017; LTA, 2020). Carbohydrate intake should take sole focus during recovery when exposed to such conditions, at the expense of protein, to maintain adequate energy and glycogen availability (Kovacs, 2006b; Ranchordas et al., 2013). Despite this, our findings did not indicate increased carbohydrate intake on CDs, nor an increase in carbohydrate intake at dinner as an acute recovery strategy. Such practices are likely to negatively impact player readiness and subsequent match performance.

Snacking

Snacking can be an effective means of increasing calorie intake to optimise nutritional needs, whilst also giving players flexibility to eat around busy training and competition periods. Whilst anecdotal, one would expect players to consume snacks more readily during competition periods due to the aforementioned challenges posed. However, we observed no difference in snack intake between TDs and CDs. In fact, a general lack of snacking was observed, with less than 50% of players consuming snacks in addition to their three main meals. Where snacking was reported, typical sources included cereal bars and fruit (predominantly bananas) on TDs, with fruit and isotonic drinks most favoured on CDs. Treats including biscuits and sweets were the third most frequent snack choice on both days with no evident patterns emerging between timing of snack intake.

Limitations

Although the current study is the first to measure dietary intakes and daily distribution of dietary intake in youth tennis players, there are several limitations. Firstly, previous literature has shown a potential for under-reporting (up to 20%) with the use of food diaries (Burke et al., 2001). Although measures were put in place to increase the validity of the data with the inclusion of remote food photography and 24-hour multiple-pass recall procedures, we cannot rule out significant under-reporting. Secondly, the sports nutrition guidelines present as a comparison point through-
out the discussion are general guidelines not specific to a youth tennis population. The development of specific guidelines for a youth tennis population is required. Thirdly, more detailed quantification of player training load would enable practitioners to set nutritional requirements specific to the training demands imposed, rather than adopting standard guidelines. Finally, the inclusion of further research of a larger sample size from different age groups may enable a more accurate account of this under researched population.

Conclusion

In summary, we simultaneously quantified for the first-time total energy and macronutrient intake and the daily distribution of energy and macronutrient intake during training and competition days of youth tennis players. Irrespective of age, tennis players seemed to under fuel and under consume carbohydrate for training and competition. We also observed no distinguishable differences between meals or days, yet there seemed to be an overemphasis on protein intake. Our data suggests that this population are not making optimal nutritional choices with no indication of nutrition planning or meal consideration to optimise performance, adaptation, recovery and health. Given the importance of optimising energy availability during adolescence and periods of high training loads, it is imperative that players, coaches and parents/guardians seek guidance from suitably qualified sports nutrition specialists where necessary. Youth athletes should be encouraged to learn about nutrition to ensure a safe and healthy sporting career that promotes and protects their health and future well-being.

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Key points

- Competitive youth tennis players seem to under fuel and under consume carbohydrates for training and competition.
- Sub-optimal nutritional choices are evident, with no indication of nutrition planning to optimise performance, adaptation, recovery and health.
- Nutritional support is deemed necessary for this sporting population.

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