

NutritionX

The Nutrition X — CHANGE



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**CONSUMING CALORIES:
THE BIGGEST CHALLENGE THAT
YOUTH ATHLETES FACE?**

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INTRODUCTION

For years youth athletes (typically defined as those under 18 years of age) have competed at the highest echelons of their sport. In 1998, Ian Thorpe became the youngest ever 400m freestyle world champion at 14 years old. Tom Daley competed in the 10m platform (diving) at the 2008 Beijing Olympics, aged 14. At only 11 years old, Anna Hursey competed at the 2018 Gold Coast Commonwealth Games in table tennis. Sky Brown won a bronze medal in skateboarding at the 2020 Tokyo Olympics, becoming Great Britain's youngest ever medal winner at the age of 13. In 2023 Lamine Yamal became Spain's youngest ever capped international and goal scorer (football) aged 16. The list goes on... Yet despite some youth athletes competing against their adult counterparts at the highest level, they should not be considered “mini adults.” Whilst it might be pragmatic to simply apply sports nutrition recommendations for adult athletes to youth athletes, there are many reasons why this is inappropriate.

As a youth athlete progresses from childhood (from birth until the onset of adolescence) through adolescence (identified with the onset of sexual maturation) and into adulthood (achieved once maturation has occurred, i.e., fully ossified skeletal system, a fully functioning reproductive system, or the attainment of adult stature), they undergo many anatomical, physiological, and metabolic changes due to biological growth and maturation (please see Malina, Bouchard and Bar-Or, 2004 for a comprehensive overview).

Growth and maturation are complex processes that are influenced by the interaction of genes, nutrients, and the environments in which an individual lives. Therefore, nutritional recommendations for youth athletes should not only focus on sporting performance but first ensure that the requirements for optimal growth, maturation and development are met. Additionally it is also important to remember the psychosocial development that occurs as

a youth athlete matures and consider the role that nutrition can play in safeguarding a life-long positive relationship with food, drink and body image.

Compared to their adult counterparts, most youth athletes face unique daily challenges which are likely to influence their nutritional intake. This population typically have schooling requirements to fulfil on top of their sporting schedule, resulting in long and busy days during which feeding opportunities may be limited (Stables et al., 2022). Youth athletes typically receive less nutritional support than senior athletes (be that exposure to a qualified nutrition practitioner and/or reduced food and drink provision) despite often experiencing similar training and competition loads (Carney et al., 2023). It is also important to consider that youth athletes are not always in full control of what and when they eat and drink, with parents and guardians often influencing these decisions. If we are to truly use nutrition to enhance the performance of youth athletes, perhaps it is these carers that require as much nutritional support from practitioners as the athletes themselves.

This article will be the first of a two-part article focusing primarily on arguably one of the most important nutritional components of any youth athletes' nutrition, achieving daily energy requirements. Key considerations and the practical application of “how to” achieve these nutritional requirements will be discussed. Part two of this article will cover additional nutritional considerations that require particular attention for the youth athlete including specific micronutrients, diet quality and variety, the importance of instilling lifelong healthy habits and influencing dietary intake.



ENERGY EXPENDITURE

To promote optimal health and performance, one of the key goals for any youth athlete is to ensure they meet their energy requirements for (1) growth, maturation and physical development and (2) for the demands of exercise (i.e. substrate requirements for general activity and their sport specific training and competition). To achieve this, it is essential that a youth athlete at least matches their energy intake to their energy expenditure, ideally achieving a slight yet consistent positive daily energy balance that meets their requirements. As such, the energy expenditure of a youth athlete determines their required energy intake and subsequent macronutrient requirements in line with their individualised health, physical development, and performance goals. Consequently, it is first essential to understand the energy expenditure (and its sub-components) of a youth athlete before considering their dietary energy and macronutrient needs.

RESTING METABOLIC RATE

Resting metabolic rate (RMR; the amount of energy required to sustain homeostatic physiological function in a rested state), the thermic effect of food (also known as diet-induced thermogenesis; the amount of energy required for digestion, absorption and transport of nutrients) and activity energy expenditure (AEE) are the three major components that contribute towards total daily energy expenditure (TDEE; see Figure 1). In growing individuals, such as youth athletes, there is also a small amount of energy required for tissue growth (~5 kcal per gram of weight gain; Torun, 2005).

COMPONENTS OF
TOTAL DAILY ENERGY
EXPENDITURE.

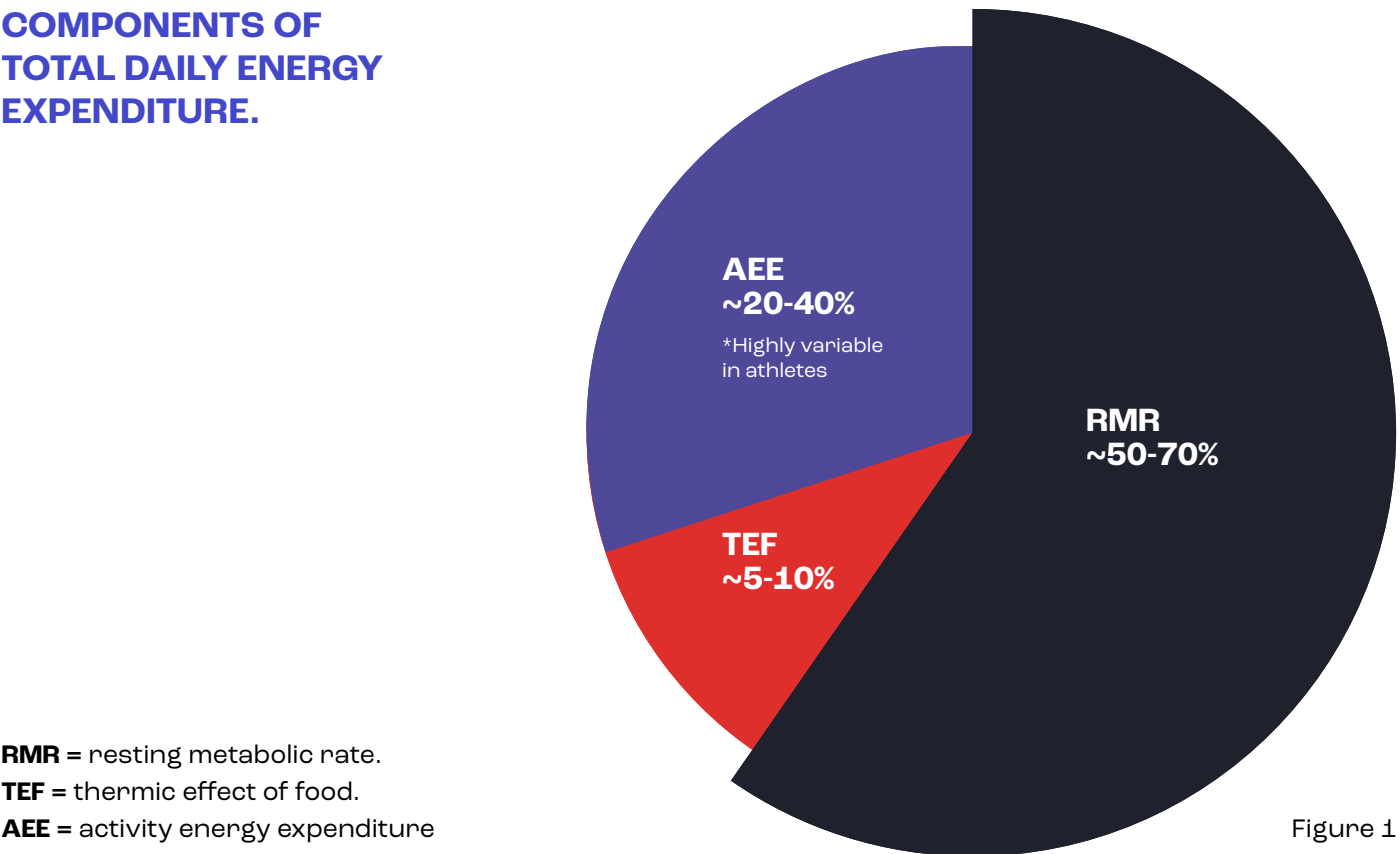


Figure 1

Progressive increases in body size, particularly fat-free mass (FFM; the most metabolically active compartment), lead to increases in RMR (Smith et al., 2018; Hannon et al., 2020). This has been reported in both young male and female athletes from a range of different sports, with RMR values in males typically higher than females due to higher amounts of FFM (Reale et al., 2020). Ethnicity may also influence RMR (Henry, 2005). Recent observations from a large data set of over 6,000 participants, inclusive of youth athletes, concluded that RMR continues to increase with biological and chronological age until 18 years, despite steady decreases of $-3.8 \pm 0.2\%$ per year in body size-adjusted RMR after which there is no further increase in RMR (Pontzer, 2022). RMR may be measured directly (heat production via whole body calorimetry) or indirectly (via oxygen consumption and carbon dioxide production), however the latter is the most commonly used method in both research and applied practice (Compher et al., 2006). Given the difficulties of measuring RMR in youth athletes (due to standardisation of assessment conditions and time), numerous different prediction equations have been developed, however many of these equations underestimate RMR making them unsuitable for use (Smith et al., 2018; Hannon et al., 2020; Reale et al., 2020; O'Neill, Corish and Horner, 2023). A prediction equation should only be used in practice if there is a population specific equation available (i.e. it was developed using data from the same population in which it will be used, e.g. young female footballers). Reale and colleagues recently developed an RMR prediction equation from young male and female athletes ($n = 126$) from various sports between the ages of 13-20 years (Reale et al., 2020), whilst there are more specific equations available, for example, one for male academy (U12-U23 age-groups) footballers (Hannon et al., 2020):

- **Reale equation:** $\text{RMR (kcal}\cdot\text{day}^{-1}) = (11.1 \times \text{body mass, kg}) + (8.4 \times \text{height, cm}) - (340 \text{ for males or } 537 \text{ for females})$
- **Hannon equation:** $\text{RMR (kcal}\cdot\text{day}^{-1}) = 1254 + (9.5 \times \text{body mass, kg})$

Research has also shown that following competitive match-play RMR is significantly elevated (from baseline) for at least 24 hours in academy soccer players ($\sim 12\%$ increase at 24-hours post-match; Carter et al., 2023) and at least 72 hours in academy rugby players (23%, 24% and 9% at 24-, 48- and 72-hours post-match, respectively; Costello et al., 2019). The increased and prolonged elevations in RMR in academy rugby players are likely due to collisions and the contact nature of the sport. These data highlight the increased ‘energy cost’ of recovery and as such energy and macronutrient intake should be adjusted accordingly in this period.

ACTIVITY ENERGY EXPENDITURE

In youth athletes, especially those undertaking high amounts of training and competition, AEE may become the greatest contributor to TDEE (Torun, 2005; Silva et al., 2013). Exercise type, duration and intensity as well as anthropometric profile all influence AEE, and thus TDEE. Considering the many factors that contribute towards a young athlete’s TDEE, this value is highly variable between individuals (even within the same sport) and will almost certainly vary day-to-day, making it difficult to prescribe exact daily energy requirements for young athletes. Research studies using gold-standard methods (such as the doubly labelled water technique) to assess TDEE provide an insight into typical expenditures of the specific youth athlete population that was assessed (see Table 1). For youth athletes training and competing in only one sport their AEE and TDEE will typically increase in a hierarchal manner as they get older, they grow in size and often their training and competition volume and intensity increases (Smith et al., 2018;

Hannon et al., 2020). For example, we reported that the TDEE of Premier League academy football players increased as they progress through the academy pathway (U12/13: $2859 \pm 265 \text{ kcal}\cdot\text{day}^{-1} < \text{U15: } 3029 \pm 262 \text{ kcal}\cdot\text{day}^{-1} < \text{U18: } 3586 \pm 488 \text{ kcal}\cdot\text{day}^{-1}$; Hannon et al., 2021). These data also highlighted that the TDEE of some academy players (as evidenced in all age-groups) is equal to and in some cases higher than professional adult players, also quantified via doubly labelled water (Anderson et al., 2017; Brinkmans et al., 2019). It is also clear that youth athletes enrolled in “formalised” training programmes (e.g. professional academies) expend more calories than their recreational level counterparts. Recent data from our group revealed that football players from a Premier League academy typically expend $\sim 750 \text{ kcal}\cdot\text{day}^{-1}$ more than age-matched “grassroots” level players ($3380 \pm 517 \text{ kcal}\cdot\text{day}^{-1}$ versus $2641 \pm 308 \text{ kcal}\cdot\text{day}^{-1}$) likely due to increased training and match loads (Stables et al., 2023).

TOTAL DAILY ENERGY EXPENDITURES OF YOUTH ATHLETES FROM DIFFERENT SPORTS.

POPULATION / SPORT	TRAINING & COMPETITION LOAD	AGE (Y)	SEX	ENERGY EXPENDITURE $\text{KCAL}\cdot\text{DAY}^{-1}$ ($\text{KCAL}\cdot\text{KG}^{-1}\cdot\text{DAY}^{-1}$)
Active adolescents (Bratteby et al., 1997)	-	~ 15	M & F	M: 3361 ± 557 (~ 55) F: 2546 ± 392 (~ 44)
Basketball (Silva et al., 2013)	~ 10 hours per week	M: 17.0 ± 0.7 F: 16.9 ± 0.7	M & F	M: 4626 ± 682 (~ 57) F: 3497 ± 242 (~ 55)
Gymnastics (Davies et al., 1997)	~ 4 hours per day	M: 7.9 ± 0.6 F: 7.3 ± 0.6	M & F	M: 2072 ± 340 (98 ± 15) F: 1939 ± 140 (103 ± 6)
Football (Hannon, Parker, et al., 2021)	U12/13: ~ 330 min & 19 km per week U15: ~ 435 min & 27 km per week U18: ~ 423 min & 27 km per week	12.2 ± 0.4 (U12/13) 15.0 ± 0.2 (U15) 17.5 ± 0.4 (U18)	M	U12/13: 2859 ± 265 (67 ± 6) U15: 3029 ± 262 (54 ± 5) U18: 3586 ± 488 (49 ± 5)
Rugby League & Rugby Union (Smith et al., 2018)	Per 14 days: 0-4 “light training” days 3-7 “heavy training” days 0-2 match days	~ 15 (U16) ~ 18 (U20)	M	U16: 4010 ± 744 (50 ± 8) U20: 4414 ± 688 (51 ± 9)
Speed skating (Ekelund et al., 2002)	-	18.2 ± 1.3	M	Off-season: 4015 ± 908 (~ 53) Pre-season: 4039 ± 693 (~ 53)
Swimming (Trappe et al., 1997)	~ 5 - 6 hours & 17.5 ± 1.0 km per day	19.0 ± 1.0	F	5593 ± 495 (85 ± 15)
Table tennis (Sagayama et al., 2017)	~ 3 hours per day	19.9 ± 1.1	M	3695 ± 449 (~ 63)
Tennis (Ellis et al., 2023)	131 ± 66 mins per day	16	F	3988 ($78 \text{ kcal}\cdot\text{kg FFM}^{-1}\cdot\text{kcal}\cdot\text{day}^{-1}$)

M = male. F = female.

Table 1

ACHIEVING ENERGY REQUIREMENTS

ENERGY AVAILABILITY

Although it can be difficult to prescribe exact daily energy requirements for youth athletes, it is strongly recommended that young athletes are not in a negative energy balance and have sufficient energy availability (EA) for growth and maturation. Energy availability is the amount of energy left for homeostatic physiological functions and growth once AEE has been deducted from energy intake (EI) and is relative to FFM: $EA = (EI - AEE) / FFM$. Failing to match daily energy intake to energy expenditure chronically may result in low energy availability (LEA), often defined as $<30 \text{ kcal} \cdot \text{kg FFM}^{-1} \cdot \text{day}^{-1}$, though it is noteworthy that this cut-off is based on laboratory investigations of adult populations (Mountjoy et al., 2023). LEA which is prolonged and/or severe may result in negative health and performance outcomes often referred to as relative energy deficiency in sport (REDs). Whilst the negative consequences of LEA are often considered from a performance perspective, perhaps more pertinent and concerning for youth athletes are the detrimental health implications (see Figure 2). Impaired growth and maturation of tissues and organs, delayed sexual maturation, reduced skeletal bone mineral accrual (increasing risk of fractures and of osteoporosis later in life) and suppression of the immune system (Loucks, Kiens and Wright, 2011; Mountjoy et al., 2023) are just some of the consequences which may be detrimental to long-term athletic development.

BE AWARE! SOME OF THE SIGNS AND SYMPTOMS OF LOW ENERGY AVAILABILITY.

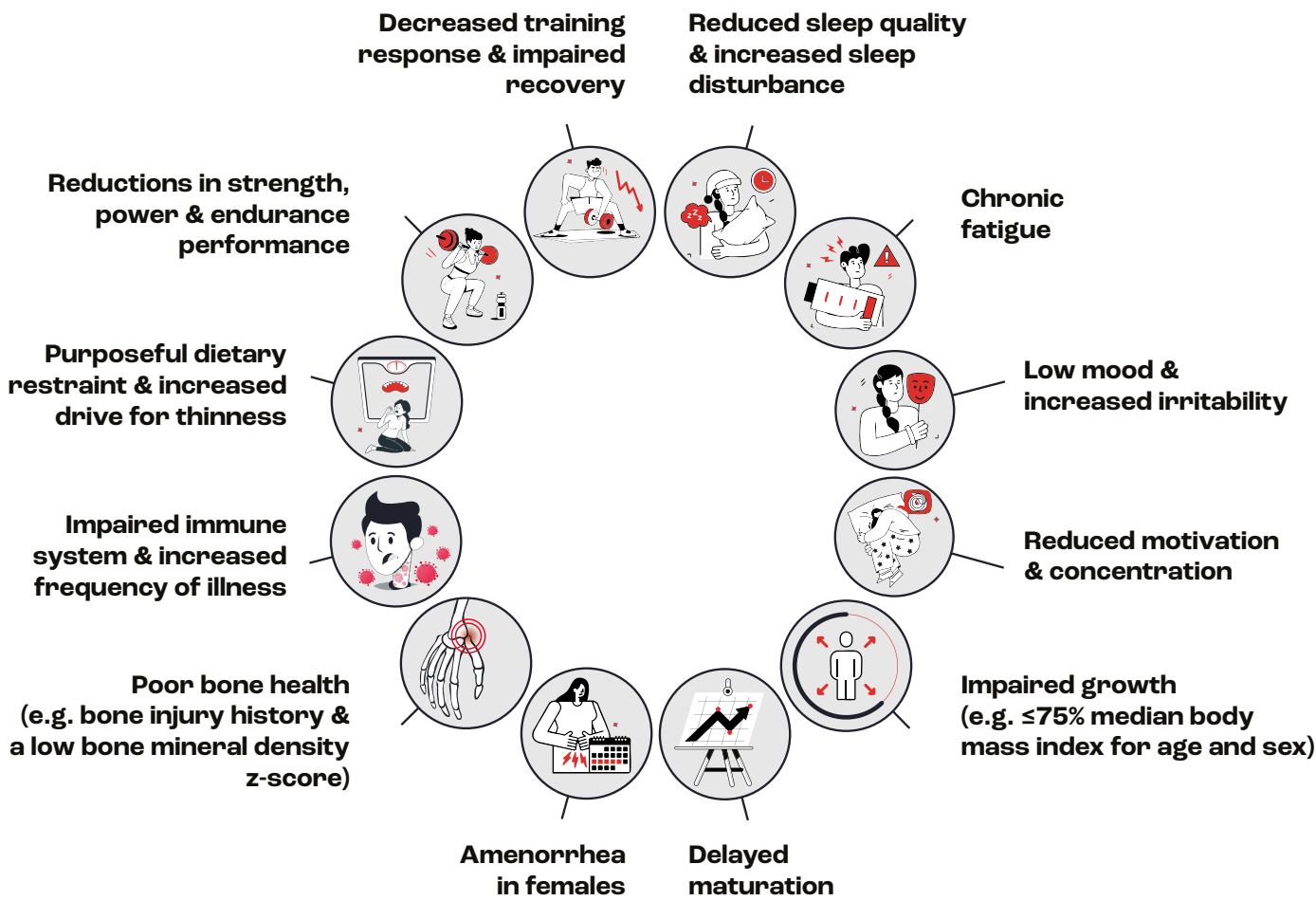


Figure 2

ENERGY INTAKE

Energy intake is provided through the consumption of the macronutrients carbohydrate, fat and protein. While there are some differences in substrate storage and metabolism between youth and adult athletes, the macronutrient requirements of youth athletes are not dissimilar from those of their adult counterparts (see Hannon, Close and Morton, 2020 for a more detailed review). Table 2 provides a summary of the key physiological roles, recommended intakes and dietary sources of these macronutrients. For youth athletes that struggle to

achieve their daily energy requirements, increasing portion size or the frequency of meals and snacks are obvious ways to increase energy intake. Including high fat containing foods such as oily fish, avocado, oils, nuts and nut butters in the diet is also a good way to increase overall energy intake. Choosing full-fat options (e.g. dairy products) and certain food swaps e.g. oily fish over white fish, red meat over chicken, bagels over bread are also easy ways to increase calories and reduce the likelihood of LEA.

A SUMMARY OF THE MACRONUTRIENT'S CARBOHYDRATE, FAT & PROTEIN INCLUDING THEIR KEY PHYSIOLOGICAL ROLES, RECOMMENDED INTAKE AND RECOMMENDED DIETARY SOURCES.

Table 2

CARBOHYDRATE	KEY PHYSIOLOGICAL ROLES Primary fuel source for moderate-to-high intensity exercise. RECOMMENDED INTAKE Influenced by total daily energy requirements, exercise type, duration and intensity. Recovery period - intensity and duration of next exercise bout also need to be considered. Daily: $6-10 \text{ g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ During exercise (moderate-to-high intensity exercise 60 minutes or longer): $30-60 \text{ g} \cdot \text{h}^{-1}$ RECOMMENDED DIETARY SOURCES Most of the time: Higher fibre containing carbohydrates including breads, cereals, oats, potatoes, pasta, rice, fruit. "Slower releasing" carbohydrates. Some of the time: fruit juices, sports drinks, sweets. "Faster releasing" carbohydrates.
FAT	KEY PHYSIOLOGICAL ROLES Required to supply essential fatty acids and promote absorption of fat-soluble vitamins. Fuel source for low-to-moderate intensity exercise. RECOMMENDED INTAKE $\sim 35\%$ of total daily energy intake (typically $1-2 \text{ g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$) RECOMMENDED DIETARY SOURCES Predominately natural sources of fat including oily fish, avocado, nuts and nut butters, seeds, olive oil which are high in Omega 3.
PROTEIN	KEY PHYSIOLOGICAL ROLES Whilst protein is most notably associated with muscle growth and recovery it is required to support turnover and growth of many different cells and tissues. Proteins are contained in all cells in the body which are involved in many different processes including cell signalling (e.g. insulin), biochemical transport (e.g. haemoglobin) and the immune system (e.g. antibodies). RECOMMENDED INTAKE Daily total: $1.4-2 \text{ g} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$ $0.22-0.33 \text{ g} \cdot \text{kg}^{-1}$ should be consumed every 3-4 hours throughout the day (i.e. at each meal and snack). RECOMMENDED DIETARY SOURCES Leucine-rich animal sources including dairy products (milk, yogurts, and cheese), eggs, meat, poultry and fish. Non-animal sources include beans (particularly soybeans), pulses, lentils, nuts, and seeds.

In recent years many adult athletes have begun the practice of manipulating energy intake (primarily via carbohydrate manipulation) on a meal-by-meal or day-by-day basis according to their training schedule to enhance training adaptations or to achieve a desired body composition. The deliberate periodisation of energy is known as “fuelling for the work required” (Impey et al., 2016), however this concept may not be as important for youth athletes compared to adults and indeed, maybe counter-productive and lead to LEA. Youth athletes in many sports strive to develop physically, increasing their FFM towards that of their adult counterparts during which period a slight energy surplus may be advantageous (Smith et al., 2018; Hannon et al., 2020). During adolescence youth athletes are also continually growing until adult stature is achieved and there is often a distinct lack of periodisation in training load throughout the weekly micro-cycle (Hannon, Coleman, et al., 2021). Considering these factors, the deliberate reduction of energy intake on “off / rest days”, particularly in those that are still growing, is not advised for youth athletes (Mathisen et al., 2023).

Nutritional strategies for youth athletes have traditionally focused on meeting total daily requirements, however the importance of timing of energy and macronutrient intake is becoming increasingly recognised. Sub-optimal carbohydrate intake before and/or during training and competition can reduce both physical (Phillips et al., 2010, 2012) and technical skill (Dougherty et al., 2006; Russell, Benton and Kingsley, 2012) performance. Additionally, the intake of carbohydrate before, during and after exercise can also affect the acute regulation of bone turnover (Stables et al., 2024), thus having obvious relevance for the youth athlete given the requirement to accrue bone mass and maximise skeletal development during the adolescent years (Costa et al., 2022). We recently reported that training with reduced carbohydrate availability increases bone resorption in academy soccer players (Stables et al., 2024). If practised

regularly over a period of weeks and months, this may contribute to an increased risk of bone stress related injuries and compromise bone development at a time when growth related injuries are most prevalent (Hall et al., 2020). Protein consumption is of particular importance at breakfast (Karagounis et al., 2018), after exercise (Kimberly A Volterman et al., 2017; Kimberly A. Volterman et al., 2017) and before sleep (Snijders et al., 2019). This regular intake of protein, every 3-4 hours throughout the day is important to stimulate muscle protein synthesis and promote the growth of FFM (Boisseau et al., 2007; Aerenhouts et al., 2013).

Despite this, the energy and macronutrient intake of youth athletes is typically skewed throughout the day. Naughton et al., (2016) reported that carbohydrate and protein intake is lower at breakfast compared to lunch and dinner in academy soccer players. Research also demonstrates that both young male and female athletes from various sports under-consume carbohydrate in the hours before and after training, irrespective of training time (morning, afternoon or evening) (Baker et al., 2014; Stables et al., 2022). These sub-optimal fuelling and recovery practices may be due to the athlete or their parent/guardian lacking the capability (e.g. poor nutrition knowledge and/or food preparation and cooking skills), the opportunity (e.g. face logistical challenges amongst a busy school, travel and training schedule and/or an absence of food and drink provision at the training facility) or the motivation (e.g. lack of belief in the performance implications certain fuelling/recovery practices and/or a fear of carbohydrates) (Michie, van Stralen and West, 2011; McHaffie et al., 2022; Jennie L Carter et al., 2023). It therefore becomes readily apparent that nutrition education programmes for both players and stakeholders (e.g., parents, coaches, support staff, etc.) should align on both the technical knowledge and practical execution of strategies to ensure sufficient energy and macronutrient intake, particularly in the hours before and after training and competition.

PRACTICAL APPLICATION –EASY WAYS TO FUEL AND RECOVER ON THE GO!

● GET THE RIGHT EQUIPMENT – (insulated) food and liquid storage containers and a small cool bag are essential items enabling you to carry the right nutrition on the go! Get a blender so you can make quick, easy and nutritious smoothies!
● CUPBOARD, FRIDGE AND FREEZER ESSENTIALS – oats, cereal and cereal bars, bread, nuts, eggs, milk (including long-life milk), yogurts, cheese, cooked meat (e.g. chicken, ham) tinned fish, baked beans, fruit (including dried and frozen fruit) and fruit juice are just some of the foods and drinks that you should have at home at all times. Quick, easy and nutritious options by themselves or in combinations!
● PLAN AHEAD – at the weekend make a list of meals and snacks that you/your child will have for the upcoming week. Compile your recipes, write your grocery list and do your weekly shop.
● BATCH COOK – meals and snacks can be prepared once or twice a week, portioned up and stored appropriately (fridge / freezer / cupboard) until required – boiled eggs, egg muffins, frittata, overnight oats, flapjacks, energy balls, soup and one-pot dishes e.g. chicken pasta bake, chickpea curry, chili con carne, fishcakes, lasagne are just some meals/snacks that can be made in bulk and eaten throughout the week.
● LIQUID CALORIES – smoothies in the morning (or anytime!) are great for those that struggle with lack of appetite or time. A quick and easy way to obtain all the nutrition you need to kick start your day – try this simple smoothie recipe: milk, yogurt, oats, banana, nut butter and frozen berries. Flavoured milk after training is another simple recovery solution providing carbohydrate, protein and fluids. A glass of milk or fruit juice instead of water at meal/snack time is another way topping up calories!
● “TREAT” FOODS AND DRINKS – whilst a youth athletes’ diet should comprise mostly of unprocessed or minimally processed foods and drinks, there is a time and a place for certain “treat” foods or drinks if consumed in the right amounts at the right times. Before or during training or competition (if over 60 minutes of moderate-to-high intensity) sports drinks or sweets can help with fuelling. Rice pudding, apple crumble or ice-cream may be a good options to increase overall calorie intake and provide faster releasing carbohydrates in the recovery period following training or competition.

Table 3



PHYSICAL DEVELOPMENT AND BODY COMPOSITION MONITORING

ANTHROPOMETRIC CHANGES AND ASSESSMENT

One way to infer if energy intake is sufficient is to monitor the progression of growth (e.g., stature and body mass) and somatic maturation (e. g., maturity offset or percentage of predicted adult stature), in addition to being alert to symptoms of LEA (see Figure 2). This is of particular importance considering the inherent difficulty in accurately measuring both energy expenditure and energy intake in practice. Considering that energy and macronutrient requirements are typically prescribed per kilogram of body mass, regular monitoring of growth (particularly body mass) during adolescence can be a useful tool (when conducted appropriately) to subsequently adjust the nutritional requirements of an individual accordingly and prevent chronic LEA.

Stature and body mass should be measured under standardised conditions no more than once per month. Regular assessments enable calculation of individual growth rates (e.g. cm per year or kg per year) and longitudinal growth curves to be plotted and subsequently compared with age-appropriate reference growth charts (e.g. World Health Organisation data - www.who.int/tools/child-growth-standards/standards). Peak height velocity (PHV - the maximum rate of growth in stature during adolescence) typically occurs around 11-13 years in females and 13-14 years in males although this is highly individual. Youth athletes that reach PHV a year before or after the mean age of PHV for their peers are considered “early” or “late” maturers, respectively. PHV precedes peak weight velocity (PWV - the maximum rate of growth in body mass during adolescence; Lloyd et al., 2014; Malina et al., 2015)

BODY COMPOSITION CHANGES AND ASSESSMENT

Body composition can be separated into different compartments (based on each compartments composition of different tissues), including fat-free mass (FFM), fat mass and bone mineral content. One of the main physical development goals of youth athletes is to increase FFM towards that of their adult counterparts. Therefore, practitioners should prioritise monitoring changes in FFM over changes in body fat, no more than 4-6 times per year (Mathisen et al., 2023). In young female athletes, FFM increases throughout adolescence but at a slower rate compared to males, with adult values achieved by around 15-16 years old. There are also increases in absolute (kg) and relative (%) body fat as young female athletes progress through PHV (Malina R. M.; Geithner, 2011). In males, absolute fat mass is similar between youth and adult athletes, with FFM increasing with (biological and chronological) age. As such, younger athletes typically present with a higher percent body fat compared to adult athletes (Malina R. M.; Geithner, 2011; Geeson-Brown et al., 2020; Hannon et al., 2020). These higher percent body fat values observed in younger athletes are a product of possessing lower FFM and not actually due to higher amounts of absolute fat mass. Therefore, when a youth athlete presents with what is perceived as a high body fat percentage, the most appropriate strategies may be interventions that promote increases in FFM (e.g., optimal energy and protein intakes and exposure to an appropriate resistance training programme), as opposed to strategies designed to reduce body fat per se (e.g., restriction of energy intake and/or increased energy expenditure). In this way, youth athletes are more likely to achieve a body composition that is more representative of adult athletes, and therefore potentially cope with the increased physical training and competition demands. Furthermore, youth athletes that are still growing and that compete in “weight making” or “weight sensitive” sports (e.g. combat sports or gymnastics) are not advised to purposefully manipulate body composition for competition (Mathisen et al., 2023).

To date, body composition assessments in youth athletes (in both scientific research and applied practice) are often measured via skinfold callipers to determine sum of skinfold thickness (Malina R. M.; Geithner, 2011). Whilst this method may be cheap, quick and generally reliable, it provides an indication of fat mass rather than FFM, and as such should not be used in growing and maturing athletes. Skinfold thickness is also often used to estimate percent body fat and percent FFM using different available prediction equations (Malina R. M.; Geithner, 2011). However, these equations are developed on specific populations (e.g., non-athletic adolescents or adults) and when applied to different populations from which they were developed (e. g., youth male or female athletes), often have a high degree of error. As such, many practitioners working with athletes no longer report body fat percentage and instead use sum of skinfolds (Mathisen et al., 2023).

Dual-energy X-ray absorptiometry (DXA) is another method that can be used to determine body composition in youth athletes. DXA is a three-compartmental method (i.e., fat mass, FFM and bone mineral content), which provides body composition at both whole body and regional level (i.e., arms, trunk, legs) and is often considered the reference method for assessing body composition (Nana et al., 2016). However, whilst DXA is a quick and reliable method its use in applied practice is limited due to the availability of necessary equipment and expertise, alongside exposure to radiation (albeit a small and generally safe dose). Body composition assessment by DXA (in particular FFM) is influenced by the nutritional status (e.g., hydration, glycogen and creatine content) of the individual being scanned. Therefore, it is important that scans are completed under standardised conditions, typically in a fasted and euhydrated state, following a day of minimal exercise (Nana et al., 2016).

Youth athletes and relevant stakeholders (including coaches, support staff and parents/guardians) should be educated on the relationship between nutrition, exercise, growth, maturation and physical development and why specific anthropometric and body composition measures are important to monitor. Anthropometric and body composition assessments and subsequent reporting and dissemination of this data should adhere to best practice protocols (Mathisen et al., 2023). Stakeholders working with youth athletes should not place too much emphasis on the influence of body composition on sporting performance and should advocate positive body image.



CONCLUSION

As a youth athlete progresses through adolescence into adulthood, they undergo a period of rapid biological growth and maturation during which their energy requirements increase. Logistical challenges associated with demanding school and sporting schedules, limited nutrition support and a reliance on parents/guardians to oversee their nutrition provision make this population susceptible to periods of low energy availability. As such, ensuring energy requirements are met on a daily basis should be the nutrition priority for all youth athletes. Proper planning and preparation will help

ensure that no meals or snacks are missed and that youth athletes are properly fuelled for training and competition and that they recover optimally after. Regular assessments of stature and body mass are important for monitoring growth and maturation, and from a body composition perspective youth athletes should focus on maximising development of fat-free mass. Whilst consuming enough calories may be the biggest nutritional challenge that a youth athlete faces, there are additional nutritional considerations which will be covered in part 2 of this article.



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