An exploration of performance nutrition service provision within academy soccer environments: implications for player development and performance

DANIEL JOEL CARNEY

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Abstract

The aim of a soccer academy is to enhance the technical, tactical, physical, and psychological skills of young players, with the primary objective being to develop players who can play for their first team squad or generate profit via a future potential sale. To cultivate more high-quality home-grown players, the English Premier League (EPL), the Football Association (FA), and representatives from the Football League developed the 'Elite Player Performance Plan (EPPP) (Premier League, 2011). Within the EPPP framework, clubs are audited and categorized from one (the highest) to four, yet despite the mandate for 'interdisciplinary specialists' (e.g., lead sports scientist, senior academy physiotherapist, performance analysts, coaches) to obtain Category One status clubs are required to employ a nutritionist only on a part-time basis. Given the training demands the players experience as they progress through the academy pathway, the subsequent implications for energy requirements, and the impact on growth and maturation, it is imperative that clubs provide appropriate nutritional support to optimize the performance and development of their players and minimize time lost through injury. With this in mind, this thesis aimed to explore the performance nutrition service provision within and across academy soccer environments in England and explore the barriers and enablers that underpin the dietary behaviours of male youth soccer players.

Study 1 (Chapter 3) aimed to audit the current provision of performance nutrition services provided to male youth soccer players within academies of all category status' (1-4) in English Soccer. Using a cross-sectional design, Practitioners from all 89 academies completed an online survey to audit: a) the job role and professional accreditation status of persons delivering nutrition support, b) activities that were inherent to service provision, c) topics of education delivered to players, care givers and staff, d) on-site food, fluid and supplement provision and e) the type of nutritional related data collected for objective monitoring. Findings demonstrate

that more full-time accredited nutritionists (holding either graduate or practitioner status with the UK Sport and Exercise Nutrition Register (SENr) or a relevant governing body (e.g., Association for Nutrition)), were employed within Category One (14/26) versus Category Two (0/18), three (1/41) and four (0/4). Respondents from Category One clubs reported more hours of monthly service delivery (62 ± 57 h) than Category Two (12 ± 9 h), three (14 ± 26 h) and four (12 ± 14 h), inclusive of one-to-one player support and stakeholder education programmes. A greater prevalence of on-site food, fluid and supplement provision on training and match days was reported in Category One clubs. Across all categories, players from the professional development phase received more frequent support than players from the youth development phase. Data suggests distinct differences in the extent of service provision provided between categories, as a result of the reduced presence of accredited nutritionists in categories two-four in comparison to Category One clubs. Given the presence of only 15 full-time academy nutritionists across the 89 academies, data demonstrate that performance nutrition appears an under-resourced component of academy sport science and medicine programmes in England, despite being an integral component of player development.

Having established the current landscape of performance nutrition service provision in Study 1 (Chapter 3), Study 2 (Chapter 4) aimed to explore stakeholder perspectives on the role of nutrition in influencing academy soccer player performance (in both training and matches) and development (e.g., growth and maturation, bone health, injury prevention). Qualitative semi-structured interviews (28 ± 13 mins in length) were conducted with 31 participants from an English Category One academy, including players (Youth Development Phase, YDP: n = 6; Professional Development Phase, PDP: n = 4), parents/guardians (n = 10), coaches (n = 3), sport scientists (n = 3), physiotherapists (n = 3), and catering (n = 2). Via reflexive thematic analysis, data demonstrated an apparent lack of understanding and awareness on the role of nutrition in influencing player development, especially in relation to growth, maturation and reducing injury risk. Players frequently highlighted the influence of their parents on their dietary behaviours, whilst parents also called for education to better support their sons. Notably, all stakeholders perceived that the daily schedule of an academy soccer player presents as “too busy to eat”, especially in relation to before school, and before and after training. The results demonstrate the necessity for the co-creation of stakeholder specific nutrition education programmes as an initial step towards positively impacting the nutrition culture associated with the academy soccer environment.

Given the varying levels of reported nutrition support across academies (Study 1, Chapter 3), the reduced service provision for the YDP (Study 1, Chapter 3), and the lack of understanding, influence of stakeholders and the scheduling demands of academy soccer players highlighted in Study 2 (Chapter 4), Study 3 (Chapter 5) aimed to establish dietary practices, and understand the enablers and barriers of positive dietary behaviours in male youth soccer players. In a cross-sectional design, fourteen ($n = 14$) male youth soccer players from the U13 and U14 age-groups of a Category 1 English soccer academy were assessed for energy intake (remote food photography method) over a 3-day in-season period and the factors underpinning their dietary behaviours were explored (structured interviews). Data demonstrate a mean energy intake on training days of 2458 kcal and 2168 kcal on the rest day. In using the COM-B model to analyse the dietary behaviours of the players, it is apparent that the most common influences on behaviour were physical opportunity (i.e., time and food availability/options) and automatic motivation (i.e., wants and desires). In contrast, players rarely make informed choices or take in to consideration their fuelling or recovery demands (psychological capability), for example. Additionally, the context (i.e., meal-time, location, who they are with) has a significant impact on the barriers and enablers to dietary behaviours. For example, physical opportunity (food availability/options and time) was predominantly perceived to be a barrier at breakfast (home & school) and lunch (school) yet transpired as an enabler at the pre and post-training provision (training ground). The context of the meal should therefore be considered when practitioners are providing nutritional support to academy soccer players.

This thesis provides the first report to explore performance nutrition service provision across academies in England, stakeholder perspectives on the impact of nutrition in this population and the enablers and barriers to the positive dietary behaviours of academy soccer players. This thesis demonstrates the requirement for:

1. Academies to employ accredited nutritionists to deliver support to key stakeholders in male youth soccer academies; increased nutritional support to players aged between 11-16 in the YDP
2. The development of stakeholder specific education programmes to positively influence the understanding of how nutrition can impact the performance and development of male youth soccer players.
3. Future research to consider the integration and consideration of models of behaviour change when attempting to understand behaviour and develop interventions to positively influence the dietary behaviours of male youth soccer players.

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Declaration

I declare that the work in this thesis, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own. Additionally, all attempts have been made to ensure that the work is original, does not, to the best of my knowledge, breach any copyright laws and has not been taken from the work of others, apart from the works that have been fully acknowledged within the text.

Publications & Presentations

Publications of the work listed within this thesis are as follows:

1. Carney, D.J., Hannon, M.P., Coleman, N.M., Murphy, R.C., Close, G.L., & Morton, J.P. (2022). An audit of performance nutrition services in English soccer academies: implications for optimising player development. *Science and Medicine in Football*, 7 (2), p.146-156.
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Table of Contents

Abbreviations

AEE	Activity energy expenditure
AN	Accredited Nutritionist
BCW	Behaviour change wheel
BCT	Behaviour change techniques
COM-B	Capability Opportunity Motivation – Behaviour
CHO	Carbohydrate
DLW	Doubly labelled water
DXA	Dual-energy X-ray absorptiometry
EPL	English Premier League
EE	Energy expenditure
EI	Energy intake
EPPP	Elite Player Performance Plan
FA	Football Association
FP	Foundation Phase
FC	Football Club
FFM	Fat free mass
HSR	High speed running
I/V	Interns or Volunteers
Kcal	Kilocalories
LEA	Low energy availability
NHS	National Health Service
PDP	Professional Development Phase
RED-S	Relative energy deficiency in sport
RFPM	Remote food photography method
RMR	Resting metabolic rate
SENr	Sport and Exercise Nutrition Register
SSM	Sport Science and Medicine
SD	Standard Deviation
TEE	Total energy expenditure
TEF	Thermic effect of food
TML	Total match load
TD	Total distance
TDF	Theoretical Domains Framework
U	Under
UK	United Kingdom
WHO	World Health Organisation
YDP	Youth Development Phase

List of Figures

Figure 9. A comparison between categories one, two, three and four, of the proportion (%) of clubs who monitor (a) anthropometrics, (b) body composition, (c) bloods and (d) hydration, and the frequency at which they do so for the foundation phase (FP), youth development phase (YDP) and the professional development phase (PDP).

Figure 10. Overview of the mean daily absolute energy (a), carbohydrate (c), protein (e) and fat (g) intake, and their relative values (b), (d), (f) and (g) respectively on training days (grey bars) and a rest day (white bar). [a] Denotes significant difference from Training day 2 ($P < 0.05$).

Figure 11. The distribution of mean relative (a) energy, (c) carbohydrate, (e) protein and (g) fat intake on training days (grey bars) and rest day (white bars) (b,d,f,h) respectively. Mean values are represented by solid bars, black circles represent each player's mean intake. On training days, a denotes significant difference from Breakfast, c denotes significant difference from Pre-Training, and d denotes significant difference from Post-Training (all $P < 0.05$). On the rest day, a denotes significant difference from Breakfast, c denotes significant difference from Afternoon Snack, and e denotes significant difference from Evening Snack (all $P < 0.05$).

Figure 12. Frequency analysis of each component of COM-B at each mealtime from the perspective of players.

List of Tables

Chapter 1

General Introduction

The aim of this General Introduction is to provide a brief overview and introduction to the area in order to provide the rationale for the aims and objectives of this thesis.

1.1 Background

Soccer (or Football, as it is more commonly called in the United Kingdom) is well regarded as one of the most popular sports in the world. This popularity has led to increased revenues for clubs, allowing for the value of players to increase exponentially over the past decade (Foster, 2016). For example, England International, Jack Grealish, was bought for an English record fee of £100 million in the summer of 2021, by Manchester City Football Club (FC) from Aston Villa FC. Whilst this highlights the success of an academy producing a player of this value for financial gain, it also demonstrates the importance of academies for developing players of their own to avoid the need to spend such fortunes (Elferink-Gemser *et al.*, 2012). In order to develop more high-quality home-grown players, the English Premier League (EPL), the Football Association (FA) and representatives from the Football League, developed a strategic plan known as the 'Elite Player Performance Plan' (EPPP), with the aim of developing players technically, tactically, physically, and psychosocially (Premier League, 2011). Given the multi-faceted nature of a male academy soccer player's development, it is therefore of no surprise that there has been a rise in research investigating these developmental areas since the formation of the EPPP (Wrigley et al., 2012; Rowat, Fenner and Unnithan, 2017; Saward et al., 2019; Hannon et al., 2020; Hannon et al., 2021a and b).

During a soccer player's transition through the academy pathway, they undergo rapid biological growth and maturation, resulting in multiple anatomical, physiological, and metabolic changes (Malina, Bouchard and Bar-Or, 2004). For example, in a cohort of male academy soccer players from the EPL, between the ages of 12 and 18 players increased their body mass (30 kg), fat-free mass (23 kg), and stature (25 cm) (Hannon et al., 2020). Sufficient energy is therefore required to synthesize new tissues (Torun, 2005), however this comes at a time when academy soccer players (U12-U23) may experience similar absolute physical loading patterns to that of adult players within the EPL (Anderson et al., 2016; Brownlee et al., 2018; Hannon et al., 2021a). It is therefore important for sports science and medicine practitioners working with academy soccer players to be aware of these demands, as well as the subsequent nutritional requirements, in order to optimise growth, maturation and physical development in this population.

In this regard, Hannon et al., (2020) reported increases in resting metabolic rate (RMR) of approximately 400 kcal·d^{-1} during the transition through the academy pathway (U12-U23). Furthermore, via the doubly labelled water technique (Westerterp, 2017), the same research group also reported that individual players across the academy pathway (i.e., from U12 to U18) may present with an absolute total daily energy expenditure (i.e., 3000 – 5000 kcal·day^{-1}) that is comparable to (or exceeds) previous observations from adult players of the EPL (Anderson et al., 2017). In this way, academy soccer players present with a higher relative daily energy requirement compared to their adult counterparts (i.e., 60-80 kcal·kg^{-1} fat free mass (FFM) versus 40-60 kcal·kg^{-1} FFM) (Hannon et al., 2021b). The researchers also assessed energy intake, reporting no differences between self-reported energy intake and energy expenditure, perhaps in part due to the employment of a full-time performance nutritionist at the club's training facilities. However, this is not always the case, as other researchers have reported energy intake in this population of ~1900-2899 kcal·day^{-1} in players aged 12-17 (Russell and Pennock, 2011; Briggs, Cockburn et al., 2015; Naughton et al., 2016), suggesting that energy availability may often be compromised in this population, potentially resulting in negative consequences to players' health and performance (Loucks, Kiens and Wright, 2011). Chronic periods of low energy availability (LEA) may present as reductions in skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks, Kiens and Wright, 2011), all of which can be detrimental to long-term player development.

On this basis, there is a need for clubs to provide support to and educate players and key stakeholders (e.g., coaches, parents / guardians etc) on the nutritional requirements of an academy soccer player. The distinct differences in daily energy intake previously reported in cohorts of adolescent soccer players from two different Category One academies (Naughton et al., 2016; Hannon et al., 2021b) may be due in part to differences in the extent of service provision and education provided between clubs. Potential differences in service provision within and between category status could initially be underpinned by nature of practitioner employment (i.e., full versus part-time) and accreditation status (i.e., qualified versus non-qualified staff), the result of which has implications on the quality and extent of service provided. Although the EPPP have specified that Category One clubs should employ a professionally accredited sports nutritionist (or working under a line manager who is), it is not currently known how clubs in England are currently delivering their nutrition programme, or how this is impacting the players' dietary behaviours.

1.2 Aims and objectives of this thesis

The aim of this thesis is to explore the performance nutrition service provision across and within academy soccer environments in England, establish stakeholder perspectives on the impact of performance nutrition on the development and performance of male academy soccer players, and provide an understanding of the factors underpinning the dietary behaviours of this population.

This will be achieved through the following objectives:

1. To audit the performance nutrition services in English soccer academies. This objective will be achieved through the completion of Study 1 (Chapter 4).

2. To explore key stakeholder perspectives on the role of nutrition in influencing player development and performance. This objective will be achieved through the completion of Study 2 (Chapter 5).

3. To quantify the energy and macronutrient intake and distribution across meals and explore the enablers and barriers to positive dietary behaviours in male academy soccer players in the YDP. This objective will be achieved through the completion of Study 3 (Chapter 6).

1.3 Biographical Positioning

Given my relationship with, and influence on the social world that is being studied throughout this thesis, it is important to make the reader aware of my biographical positioning, as I believe this has shaped and influenced the nature of this thesis.

From an early age my passion was, and always has been, Football. Like any young, Football fanatic, I dreamt of becoming a professional Footballer and getting the opportunity to play in some of the world's most famous stadiums. Whilst my playing ability never led to me accomplishing this dream, my alternative career path as a performance nutritionist has allowed me to experience working at some of the most famous stadiums in the world, such as the Bernabeu in Madrid, and the iconic Wembley Stadium.

After finishing my undergraduate degree in Sport and Exercise Science, I chose to pursue an MSc in Sports Nutrition, which led to the opportunity to gain experience at Everton Football Club's Academy, working alongside Dr. Marcus Hannon during his PhD research. Being part of his research process and seeing how his findings directly influenced his applied work sparked my own ambition to pursue an applied PhD after completing my MSc. The opportunities that I have been presented with since completing the MSc have allowed me to gain experience at 3 different Category 1 academies over the past 7 years, all of which have provided me with a rich understanding of the social context researched throughout this thesis and influenced the nature of each of the studies presented.

In this regard, when I moved from my first club to a new academy, it was evident how differently nutrition was perceived and understood within the club, largely due to the support and service delivery prior to me commencing my role at each club. This had me wondering, if there are such differences between these 2 clubs I have experienced, what would the differences be on a larger scale? Fast forward 2 years and I then found myself moving on to a different academy again, to further progress my career. I also believed that this would strengthen my research, as gaining experience of working at a third club would further expand my insights into the ways in which performance nutrition is practiced and understood at different clubs.

My experiences from working at 3 different academies when conducting the research in the present thesis, have of course not only influenced the research process and the subsequent findings, but have provided me with a deep understanding of the context of nutrition in academy soccer clubs, and I believe this allows for the reader to connect each of the chapters to their own lived experiences, making the findings meaningful and useful in a more personal, intuitive way.

Chapter 2

Literature Review & Methodology

The aim of this Literature Review is to introduce key theoretical concepts and provide a summary and critical appraisal of the relevant current literature.

2.1 Introduction to soccer academies

2.1.1 History and objectives of English Premier League academies

In 2011, there were 12,067 male academy soccer players registered with professional clubs in the UK (Premier League, 2011). To develop more high-quality home-grown players, the English Premier League (EPL), the Football Association (FA) and representatives from the Football League, developed a strategic plan known as the 'Elite Player Performance Plan' (EPPP) (Premier League, 2011). The aim of this long-term strategy was to provide evidence informed and multi-disciplinary support to develop academy players technical, tactical, physical, and psychological ability, from U5 through to U21, with formal registration commencing when players reach the U9 age-group. Whilst the ultimate outcome for an academy is to develop players to represent the first team to reduce the financial strain of having to buy players and/or potentially prof from their future sale (Elferink-Gemser *et al.*, 2012), it is also their responsibility to provide young, talented players, with not only the opportunity to develop their abilities as a player, but to also enhance their future career prospects. To achieve these objectives, academies deliver a formalised programme inclusive of; coaching, a games programme, sports science and medicine, welfare and lifestyle management, and an education programme.

2.1.2 EPPP Category Status

In accordance with the EPPP framework, clubs are independently audited and categorised from Category One (the best) to Category Four, largely dependent on the extent of support they provide to their players. Whilst academies are encouraged to design and deliver their own bespoke programmes to develop players, auditors take into consideration up to ten different factors including productivity rates, coaching, training facilities, education and welfare provisions. This independent audit takes place every two years to (re)classify academies and ensure standards are maintained. The EPPP works across three phases: Foundation (U9-U11), Youth Development (U12-U16) and Professional Development (U18-U21), however clubs with category four status will have players only in the Professional Development Phase (PDP) (Premier League, 2011).

2.1.3 Staffing Structure

Academies have many staff working in different departments such as management, coaching, recruitment, sport science and medicine, and education. Clubs of Category One status typically employ a greater number of staff and in some cases are required to do so to obtain Category One status. The sport science and medicine department are required to provide nutrition support to players, however the employment of a nutritionist is only required on a part-time basis for Category One status. In contrast, lead sport scientists, lead strength and conditioning coaches, and academy psychologists must be employed full-time. Although clubs of Category One status are required to (at least) employ a nutritionist on a part-time basis (i.e., working <35 hours per week), those in categories two to four do not require any formalised nutrition service provision (Premier League, 2011).

2.1.4 Typical Schedule

The EPPP initially advised ~12 hours of pitch-based training per week for an U12 player, increasing to ~16 hours per week for U21 players (Premier League, 2011). In a Category One academy, this is typically spread across four training days and one match day per week, subject to fixture schedules in the PDP. In this regard, male academy soccer players (U12-U23), albeit from a single Premier League club, may experience similar absolute physical loading patterns to that of adult players within the English Premier League (EPL) (Anderson et al., 2016; Brownlee et al., 2018; Hannon et al., 2021a). In addition to the training and games programme, an academy player is required to partake in a minimum of four hours per weekday of education, sport science activities and also video analysis of training or games (Premier League, 2011). The demanding nature of the academy schedule often amounts to long days for the players, providing challenges for the academies, the players and their parents. Given that the sport science department is responsible for optimising growth, maturation and the physical development of their players, it is imperative that appropriate nutritional support is provided to players and all key stakeholders at clubs to fuel the significant energetic demands of the players (Hannon et al., 2021b).

2.2 Physiological demands of soccer, energy expenditure and dietary intakes of academy soccer players

2.2.1 Physiological demands of soccer

The total distance covered in a match varies from ~4 km for U9 players (Goto, Morris, and Nevill, 2015a) ~9 km for U18 players (Buchheit et al., 2010), with older players typically covering greater distances than younger ones (Saward et al., 2016). Comparing running intensities can be challenging due to differences in methodologies (such as absolute vs. relative thresholds and different speed thresholds). However, higher running speeds are generally associated with increased age in academy soccer players during match play (Goto, Morris, and Nevill, 2015a; Brito et al., 2018). Mendez-Villanueva et al., (2012) found no difference in relative heart rate response (% HRmax) between U13-U18 players during match play. While players spent time in various heart rate thresholds, around 75% of the time was spent at >80% HRmax. Wrigley et al., (2012) reported that the average intensity (% HRmax) of match play was significantly higher than that of pitch-based training in U14 (83 ± 2 vs. 74 ± 2 %), U16 (84 ± 2 vs. 74 ± 1 %), and U18 (81 ± 3 vs. 69 ± 2 %) EPL academy soccer players. Factors such as match duration, pitch size, and the number of players can vary by age group and league, affecting the physical demands on academy soccer players (Goto, Morris, and Nevill, 2015a, 2015b; Brito et al., 2018). Furthermore, playing position (especially in older age groups) and tactical strategies can impact the physical demands of match play for male academy soccer players (Mendez-Villanueva et al., 2012).

It is well-established that carbohydrate is the primary substrate utilised during soccer match-play (Collins et al., 2021). However, there are numerous physiological and metabolic differences to suggest that the nutritional needs of academy soccer players may differ from those of adult players. In this regard, children exhibit higher aerobic metabolism rates during exercise (Malina, Bouchard, and Bar-Or, 2004; Ford et al., 2011). Fat oxidation rates during sub-maximal exercise (at the same relative intensity) are higher in both male and female children and adolescents compared to adults. Younger children tend to rely more on fat as a fuel source than older adolescents and adults (Timmons, Bar-Or, and Riddell, 2003). These elevated fat oxidation rates during exercise may result from lower endogenous carbohydrate stores and reduced glycolytic capacities. Pre-pubertal children have lower glycogen storage capacities compared to older adolescents (Eriksson and Saltin, 1974), which coincides with less developed glycolytic capabilities, with full anaerobic potential typically developing toward the end of puberty (Stephens, Cole, and Mahon, 2006). As a result, children and adolescents produce less lactate than adults during high-intensity exercise at the same relative intensity (Eriksson, Gollnick, and Saltin, 1973; Eriksson and Saltin, 1974). Youth athletes also depend more on exogenous carbohydrates as a fuel source, with these carbohydrates contributing more to total energy during exercise in children and adolescents than in adults (Timmons, Bar-Or, and Riddell, 2003). Exogenous carbohydrate oxidation rates are higher in younger boys compared to their more mature peers of the same chronological age (Timmons, Bar-Or, and Riddell, 2007b).

2.2.2 Energy expenditure

Total energy expenditure (TEE) is comprised of three components. Firstly, resting metabolic rate (RMR) represents the energy required to maintain normal homeostatic physiological functions (cellular, central nervous system and organ homeostasis) at rest, plus the energy cost of arousal (Manore and Thompson, 2015). Secondly, the thermic effect of food (TEF), which is the energy required to digest, absorb, transport, metabolise and store nutrients following their consumption (Manore and Thompson, 2015). Finally, activity energy expenditure (AEE), which represents the amount of energy expended as the result of physical activity (Poehlman, 1989) and is often the largest component of TEE in both adult (Morehen et al., 2016) and youth athletes (Silva et al., 2013).

The first study to examine the energy expenditure of top-tier English soccer players (adults) was conducted in the late 1970s by Reilly and Thomas (1979). In more recent times, Anderson and colleagues have quantified the TEE of adult EPL soccer players using the gold standard doubly labelled water method. The observed mean daily TEE for outfield players was 3566 ± 585 kcal/day (range: 3047 – 4400 kcal·day^{-1}) (Anderson et al., 2017) and 2894 kcal·day^{-1} for a goalkeeper (Anderson, et al., 2019), over a seven-day in-season period with two matches and five training sessions. The authors suggested that the variation in mean daily TEE was perhaps due to individual difference in anthropometric profiles and total match load (TML) among players.

In academy soccer players, there have been a number of studies that have attempted to measure mean daily TEE via a variety of methods (Table 1). Mean daily TEE of 3618 ± 61 kcal/day (Russell and Pennock, 2011) and 2551 ± 245 kcal·day^{-1} (Briggs et al., 2015) were observed in U18 English Championship and U15 EPL academy players, respectively. Despite the different methodologies used to estimate TEE between these studies, the data reveals significant difference in TEE between the two age-groups, which aligns with variations in body mass (Russell and Pennock, 2011; Briggs et al., 2015). In this regard, Hannon et al., (2020) observed progressive increases in stature, body mass, and fat-free mass (FFM) in academy players aged 12-16, as well as increases in RMR by ~400 kcal·day^{-1}. Moreover, in using the gold standard doubly labelled water method (Hannon et al., 2021b) the same researchers reported that individual players throughout the academy pathway (U12 to U18) may have an absolute TEE of 3000-5000 kcal·day^{-1}, which is comparable to or exceeds previous observations in adult EPL players (Anderson et al., 2017). Consequently, male academy soccer players present with a higher relative daily energy requirement compared to their adult counterparts (60-80 kcal·kg FFM^{-1}·day^{-1} versus 40-60 kcal·kg FFM^{-1}·day^{-1}). Moreover, data demonstrate that academy players (within the U13 age group) typically expend 750 kcal·d^{-1} more than age matched soccer players playing at "grassroots" standard (Stables et al., 2023), highlighting the additional energy requirements of male youth soccer players within formalised academy programmes.

Table 1. Reported total energy expenditures of male soccer players of different ages.

Reference	Population (age and status)	Anthropometric Profile (stature & body mass)	Training & Match Load	Assessment Method & Duration	TEE ($kcal \cdot day^{-1}$)
(Reilly and Thomas, 1979)	English First Division players 22.6 ± 3.2 years	73.0 ± 7.0 kg	Mean training duration: 75 min Mean match TD: 8.7 ± 1.0 km	23 weeks Training activity: heart rate Match play: motion analysis Habitual activity: activity diary	3449 (range: 3025 – 4133)
(Anderson et al., 2017)	English Premier League outfield players 27 ± 3 years	180 ± 7 cm 80.5 ± 8.7 kg	**Weekly Total:** Duration: 321 ± 33 min TD: 26.4 ± 5.4 km HSR distance: 1322 ± 717 m Sprint distance: 430 ± 274 m	DLW 7 days (in-season)	3566 ± 585 (range: 3047 – 4400)
Anderson, et al., 2019)	27-year-old English Premier League goalkeeper	191 cm 85.6 kg	**Weekly total:** Duration: 484 min TD: 20.9 km	DLW 7 days (in-season)	2894
Russell and Pennock, 2011)	English Championship academy players 17 ± 1 years	172 ± 1 cm 67.5 ± 1.8 kg	**Weekly total:** ~540 min	RMR: prediction equation AEE: activity diary 7 days (in-season)	3618 ± 61
(Briggs et al., 2015)	English Premier League academy players 15.4 ± 0.3 years	170 ± 6 cm 57.8 ± 7.8 kg	Typical weekly mean: ~1200 min (estimated, not measured)	RMR: prediction equation AEE: accelerometery 7 days (in-season)	2552 ± 245
(Hannon et al., 2021b)	English Premier League academy players U12/13 (1): 12.2 ± 0.4 yrs U15 (2): 15 ± 0.2 yrs U18 (3): 17.5 ± 0.4 yrs	1: 157.1 ± 4.1 cm 43.0 ± 4.8 kg 2: 173.9 ± 5.6 cm 56.8 ± 6.2 kg 3: 181.2 ± 5.2 cm 73.1 ± 8.1 kg	**Accumulative 14-d total:** 1: 659 ± 81 min 38.3 ± 5.1 km 2: 869 ± 72 min 53.7 ± 4.5 km 3: 846 ± 39 min 54.4 ± 7.1 km	DLW 14 days (in-season)	1: 2859 ± 265 (range: 2275–3903) 2: 3029 ± 262 (range: 2738–3726) 3: 3586 ± 487 (range: 2542–5172)
(Stables et al., 2023)	(1) English Premier League academy players 13.4 ± 0.2 yrs (2) Non-academy players 13.1 ± 0.5 yrs	1: 165.7 ± 7.2 cm 51.2 ± 8.4 kg 2: 162.9 ± 6.4 cm 52.7 ± 12.4 kg	**Match Load** 1: 7.3 ± 0.9 km 1: 4.4 ± 2.0 km	DLW 14 days (in-season)	1: 3380 ± 517 2: 2641 ± 308

2.2.3 Energy intake and availability

As academy soccer players advance through the academy pathway, it is vital that their energy intake (EI) meets the demands of their total energy expenditure (TEE). Unlike adult players, young academy players need additional energy for building new tissue (~5 kcal per gram of weight gain; Torun, 2005). Ensuring sufficient energy availability (EA) is crucial not just for maximizing growth, maturation, and physical development, but also for safeguarding health and reducing the chances of illness and injury (Loucks, Kiens, and Wright, 2011). EA refers to the energy remaining for essential physiological functions and growth after deducting Activity Energy Expenditure (AEE) from Energy Intake (EI) and is relative to Fat-Free Mass (FFM) ($EA = (EI - AEE) / FFM$). This differs from the traditional energy balance equation ($energy\ balance = EI - Total\ Energy\ Expenditure\ (TEE)$) (Loucks, Kiens, and Wright, 2011). Prolonged periods of low EA (<30 kcal·kg $FFM^{-1} \cdot day^{-1}$) can lead to impaired tissue and organ growth and maturation, reduced accrual of skeletal bone mineral, heightened risk of stress fractures and osteoporosis in later life, delayed sexual maturation, and compromised immune function (Loucks, Kiens, and Wright, 2011; Mountjoy et al., 2014, 2018). These effects not only potentially harm the performance of academy soccer players but also their physical and mental well-being. However, it is important to note that many studies examining the consequences of LEA have been conducted with adult populations, and the thresholds for LEA are mainly based on findings from female subjects.

It is suggested that adult athletes maintain an energy availability of ≥45 kcal·kg $FFM^{-1} \cdot day^{-1}$ to support normal physiological function and overall health (Loucks, Kiens, and Wright, 2011). Considering that academy soccer players have higher relative energy requirements compared to adult players (Anderson et al., 2017; Hannon et al., 2021b), it is likely that ≥45 kcal·kg $FFM^{-1} \cdot day^{-1}$ would be the minimum needed for young athletes, although further investigation is needed. Koehler et al., (2013) found that young male and female athletes (aged 11-25 years) participating in various sports (aesthetic, ball, endurance, racquet, water sports) at national or international levels had a mean energy availability of 28.5 and 29.4 kcal·kg FFM^{-1}·day^{-1}, respectively.

Research on the dietary intake of male academy soccer players in England has shown that players aged 12-18 typically consume ~1900-3200 kcal·day^{-1} (Russell and Pennock, 2011; Briggs, Cockburn, et al., 2015; Naughton et al., 2016; Hannon et al., 2021b; Stables et al., 2023). These intake levels are notably lower than those observed in Spanish academy players aged 14-17, who reportedly consume approximately 3500 kcal·day^{-1} and have a higher dietary fat intake compared to their English counterparts (Ruiz et al., 2005). The variance in fat consumption could stem from cultural disparities and dietary practices between the two nations (Birkenhead and Slater, 2015). Across European academy players, regardless of nationality or age, there is a general trend of consuming around 5-6 g·kg^{-1}·day^{-1} of carbohydrates and 1.5-2.0 g·kg^{-1}·day^{-1} of protein (Table 2). Taking into account these EI values in conjunction with the reported TEE values among academy soccer players in England (Table 1), it seems reasonable to suggest that energy availability may be compromised within this population, as previously indicated by Briggs et al., (2015). However, it is important to acknowledge that evaluating EA is notoriously challenging due to the complexities in accurately measuring EI data (Burke et al., 2018). When players do not consistently meet their energy requirements, they may experience chronically low energy availability (LEA), often defined as less than 30 kcal·kg FFM^{-1}·day^{-1} (Mountjoy et al., 2018). This can lead to symptoms associated with relative energy deficiency in sport (RED-S) syndrome, including reduced skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks et al., 2011), all of which can be detrimental to the long-term development of the player.

Table 2. Reported dietary intakes of European male academy soccer players.

Reference	Population (Ethnicity & Age)	Assessment Method & Duration	Energy (kcal·day^{-1})	Carbohydrate		Protein		Fat	
				g day^{-1}	g.kg^{-1} day^{-1}	g day^{-1}	g.kg^{-1} day^{-1}	g day^{-1}	g.kg^{-1} day^{-1}
(Ruiz et al., 2005)	Spanish academy players U15 (1): 14.0 ± 0.3 yrs U16 (2): 14.9 ± 0.2 yrs U17 (3): 16.6 ± 0.6 yrs	Food diary 3 days (in-season)	1: 3456 ± 309 2: 3418 ± 182 3: 3478 ± 223	1: 339 ± 89 2: 391 ± 27 3: 392 ± 37	1: 6.7 ± 0.9 2: 5.9 ± 0.4 3: 5.3 ± 0.4	1: 129 ± 10 2: 142 ± 10 3: 150 ± 5	1: 2.0 ± 0.2 2: 2.1 ± 0.1 3: 2.0 ± 0.2	1: 139 ± 11 2: 142 ± 6 3: 154 ± 5	1: 2.2 ± 0.2 2: 2.2 ± 0.1 3: 2.2 ± 0.1
(Caccialanza, Cameletti and Csvallaro, 2007)	Italian academy players 16 ± 1 yrs	Food diary 4 days (in-season)	2560 ± 636	339 ± 89	4.9 ± 1.5	1.1 ± 23	1.5 ± 0.4	87 ± 25	-
(Russell and Pennock, 2011)	English Championship academy players 17 ± 1 yrs	Food diary 7 days (in-season)	2831 ± 164	393 ± 18	5.9 ± 0.4	114 ± 8	1.7 ± 0.1	100 ± 9	1.5 ± 0.1
(Iglesias-Guitierrez et al., 2012)	Spanish academy players 18 ± 2 yrs	Food diary 6 days (in-season)	2794 ± 526	338 ± 70	4.7 ± 1.1	119 ± 24	1.6 ± 0.4	116 ± 30	-
(Briggs et al., 2015)	English Premier League academy players 15.4 ± 0.3 yrs	Food diary & 24 hour recall 7 days (in-season)	2245 ± 321	318 ± 24	5.6 ± 0.4	86 ± 10	1.5 ± 0.2	70 ± 7	1.2 ± 0.1
(Bettonviel et al., 2016)	Dutch academy players 17.3 ± 1.1 yrs	24 hour recall x 4 occasions	2938 ± 465	411 ± 87	6.0 ± 1.5	119 ± 22	1.7 ± 0.4	84 ± 14	1.2 ± 0.2
(Naughton et al., 2016)	English Premier League academy players U13/14 (1): 12.7 ± 0.6 yrs U15/16 (2): 14.4 ± 0.5 yrs U18 (3): 16.4 ± 0.5 yrs	Food diary 7 days (in-season)	1: 1903 ± 432 2: 1927 ± 317 3: 1958 ± 390	1: 266 ± 58 2: 275 ± 62 3: 224 ± 80	1: 6.0 ± 1.2 2: 4.7 ± 1.4 3: 3.2 ± 1.3	1: 97 ± 21 2: 96 ± 14 3: 143 ± 24	1: 2.2 ± 0.5 2: 1.6 ± 0.3 3: 2.0 ± 0.3	1: 56 ± 18 2: 55 ± 11 3: 60 ± 15	1: 1.3 ± 0.5 2: 0.9 ± 0.3 3: 0.9 ± 0.3

(Hannon et al., 2021b)	English Premier League academy players U12/13 (1): 12.2 ± 0.4 yrs U15 (2): 15 ± 0.2 yrs U18 (3): 17.5 ± 0.4 yrs	Remote food photography method 7 days (including x1 24 hour recall) (in-season)	1: 2659 ± 187 2: 2821 ± 338 3: 3180 ± 279	1: 309 ± 27 2: 325 ± 44 3: 346 ± 28	1: 7.3 ± 1.0 2: 5.8 ± 0.8 3: 4.8 ± 0.6	1: 107 ± 11 2: 117 ± 12 3: 152 ± 28	1: 2.5 ± 0.4 2: 2.1 ± 0.3 3: 2.1 ± 0.5	1: 110 ± 12 2: 117 ± 18 3: 131 ± 17	1: 2.6 ± 0.4 2: 2.1 ± 0.4 3: 1.8 ± 0.4
(Stables et al., 2023)	(1) English Premier League academy players 13.4 ± 0.2 yrs (2) Non-academy players 13.1 ± 0.5 yrs	Remote food photography method 7 days (including x1 24 hour recall) (in-season)	1: 2178 ± 319 2: 1768 ± 362	1: 279 ± 42 2: 217 ± 24	1: 5.6 2: 4.3	1: 86 ± 18 2: 71 ± 19	1: 1.7 ± 0.6 2: 1.4 ± 0.3	1: 79 ± 18 2: 69 ± 25	1: 1.6 ± 0.6 2: 1.4 ± 0.5
(Martinho et al., 2023)	Portuguese academy players 15.3 ± 0.3 yrs	Food diary 5 days (in-season)	1929 ± 388	254 ± 61	4.0 ± 1.0	114 ± 22	1.9 ± 0.4	55 ± 15	0.9 ± 0.2

2.2.4 Methods to assess dietary intake

Accurately determining dietary intake is of utmost importance, yet it poses significant challenges and complexities (Capling et al., 2017; Burke et al., 2018). This challenge is particularly pronounced when evaluating the dietary habits of children and adolescents. Self-reported dietary assessments in this demographic tend to be unreliable, as individuals often struggle to maintain focus and motivation, especially over prolonged periods (Livingstone, Robson, and Wallace, 2004). In a systematic review, Capling et al., (2017) found that compared to TEE (assessed by Doubly Labelled Water) and changes in body weight, self-reported EI was typically underestimated by approximately 19% in athletic populations, possibly due to conscious or subconscious factors. Athletes often under-report consumption of perceived "unhealthy" foods while over-reporting intake of perceived "healthy" foods during dietary assessments (Burke et al., 2018). Given that most dietary assessments rely on self-reporting, there is a burden placed on the individuals being assessed. Therefore, researchers and practitioners should carefully select the most appropriate method(s) for the population and situation, while recognizing the limitations of the chosen dietary assessment method (Burke, 2015).

While there is not a universally accepted gold standard method for evaluating dietary intake, several commonly utilised approaches exist, each with its own strengths and limitations (Burke, 2015; Capling et al., 2017). Common retrospective methods include the 24-hour recall (Briggs, Cockburn, et al., 2015), whilst prospective methods commonly employed include traditional food diaries (Naughton et al., 2016) and the more recent remote food photographic method, such as 'snap and send' (Anderson et al., 2017; Costello et al., 2017; Hannon et al., 2021b; Stables et al., 2022. 2023). However, when assessing the validity of the Remote food photography method (RFPM), underestimations of total ‘daily’ carbohydrate (CHO) intake by 54 and 66 g, respectively, have been observed in both experienced and inexperienced nutrition practitioners, as obtained from 2-days of dietary assessment comprising 4 meals per day (Stables et al. 2021). Meanwhile, Briggs and colleagues found that combining two dietary intake methods (food diary and 24-hour recall) enhanced the accuracy of dietary intake data compared to using a single method alone in academy soccer players (Briggs, Rumbold, et al., 2015). Typically, dietary intake assessments for academy soccer players span 4-7 days (Caccialanza, Cameletti, and Cavallaro, 2007; Russell and Pennock, 2011; Iglesias-Gutiérrez et al., 2012; Naughton et al., 2016; Hannon et al., 2021b; Stables et al., 2022, 2023). This duration is considered adequate for capturing habitual dietary patterns in athletes while maintaining scientific rigor and minimizing athlete burden (Braakhuis et al., 2003; Capling et al., 2017).

2.2.4.1 24-hour recall

The retrospective method known as the 24-hour recall is utilised to estimate dietary intake, whereby the individual provides details regarding their food and beverage consumption from the preceding day (Burke, 2015). This technique is time efficient, imposes minimal burden on the individual under assessment, and can be flexibly scheduled to accommodate the athlete's schedule. It is often advised to incorporate the triple or multiple pass method, as this allows the practitioner to revisit the initial recall to extract additional information, enhancing the precision of subsequent dietary intake data, although this does require sufficient practitioner skill and experience (Nightingale et al., 2016). Given the retrospective nature of this method, it is advantageous that it does not influence the athlete's dietary behaviour, but it does rely on truthful and accurate memory recall from the athlete (Burke, 2015). As this method captures only the previous day's intake, the acquired information may not fully reflect the athlete's habitual diet, therefore it may be necessary to conduct multiple 24-hour recalls to obtain an accurate portrayal of the athlete's true dietary patterns and habits (Burke, 2015). This consideration holds particular relevance in soccer players, who may adjust their dietary behaviours, particularly carbohydrate consumption, in response to training and match demands (Anderson et al., 2017). Combining this method with another prospective approach to evaluate dietary intake may be appropriate, and has been demonstrated to enhance the accuracy of data acquisition in academy soccer players (Briggs, Rumbold et al., 2015).

2.2.4.2 Food Diary

The food diary is the most commonly employed method for evaluating dietary intake in athletic populations (Burke, 2015), and is also the case for research in academy soccer players (Caccialanza, Cameletti, and Cavallaro, 2007; Russell and Pennock, 2011; Iglesias-Gutiérrez et al., 2012; Naughton et al., 2016; Martinho et al., 2023). This approach involves individuals recording specific details such as food and beverage consumed, quantity, brand, preparation and cooking method (if applicable), time of consumption, and any leftovers (if applicable), with as much detail as possible (Braakhuis et al., 2003; Manore and Thompson, 2015). Portion sizes can be determined by weighing or approximated using common household measures (e.g., teaspoon). While weighed food diaries offer more precise measurements of dietary intake compared to household measures, the meticulousness required in weighing all foods and drinks (including individual components of meals) imposes a significant burden on athletes (Burke, 2015). This burden may result in athletes either failing to report consumed items (i.e., under-reporting) or altering their typical dietary patterns and habits (Burke, 2015). Employing household measures to assess dietary intake is less demanding but sacrifices accuracy, often due to inaccuracies in subjective assessments of portion size (Burke, 2015). It is also noteworthy that parental assistance is typically necessary when food diaries are used to evaluate the dietary intake of children and adolescents (Livingstone, Robson, and Wallace, 2004).

2.2.4.3 Remote food photography method

The novel prospective technique known as the remote food photography method (RFPM) entails the individual being assessed capturing images of their food and drink both before consumption and immediately after, to accurately determine their intake (Boushey et al., 2017). These images, accompanied by descriptions of the items, are then sent to the investigator via a smartphone application (e.g., WhatsApp, Threema etc.). This real-time transmission of photos and descriptions also provides a timestamp indicating when the times were consumed (Boushey et al., 2017; Costello et al., 2017). The method is typically favoured by adolescents over conventional approaches such as food diaries, as it alleviates their responsibilities and does not require parental assistance (Boushey et al., 2017). The RFPM exhibits strong ecological validity, mitigates memory bias, and has been shown to reduce under-reporting among adolescents when compared to traditional food diaries (Boushey et al., 2017). Costello et al., (2017) introduced the 'snap-n-send' variation of this method, in which individuals are regularly reminded of the importance of providing accurate dietary data, urged to report all consumed food and drink, and continuously encouraged throughout the assessment period. These prompts prove particularly beneficial when evaluating the dietary habits of adolescent athletes. It has been demonstrated that the 'snap-n-send' method is a reliable technique for assessing the dietary intake of adolescent athletes, with a minor bias for under-reporting (CI = -5.7% to -2.2%) compared to a researcher-observed weighed method (Costello et al., 2017). However, when evaluating the accuracy of the RFPM, both seasoned and novice nutrition practitioners have noted underestimations in total daily carbohydrate intake by 54 and 66 grams, respectively. These observations were derived from a two-day dietary assessment involving four meals per day (Stables et al., 2021). Nevertheless, this method has been employed in recent research in which the dietary intakes of academy soccer players have been assessed (Hannon et al., 2021b; Stables et al., 2022; Stables et al., 2023).

2.3 Dietary behaviours of adolescents and athletes, and Behaviour Change Theory

2.3.1 Factors influencing the dietary behaviours of adolescents

Adolescence is the phase during which a child progresses towards adulthood, with the World Health Organisation (WHO) defining this as the broad age range from 10-24 years (Sawyer et al., 2018). This can be further categorised into early adolescence (10-15 years), late adolescence (15-18 years), and early adulthood, often referred to as 'emerging adulthood' (18-24 years) (Patton et al., 2016; Arnett, 2000). Nevertheless, the term 'adolescent' commonly refers to those between the age of 13-18 years old, whilst an adult is considered older than 18 years old given that this is the age of legal dependence in most countries (Sawyer et al., 2018). The transition between adulthood and childhood is recognised as the most rapid phase of physical development, when up to 37% of total bone mass is accumulated, 15-25% of adult height is achieved and 45% of skeletal growth occurs (Bogin et al., 2018). These significant developmental changes lead to increased nutritional requirements, increasing the risk of nutrient deficiencies (Spear et al., 2007). Consequently, maintaining healthy dietary choices and adopting positive eating habits are imperative to ensure optimal development in adolescents.

A lack of knowledge about healthy eating is often cited as the reason underpinning the dietary behaviours of adolescents, however there is research to suggest that they generally have a good understanding of what constitutes a healthy diet but find it difficult to implement this (Kelly, Callaghan & Gabhainn, 2021; Browne et al., 2020). Information about nutrition primarily comes from school textbooks, public health campaigns, family or friends, and increasingly from social media or online sources. The varied sources and quality of information, accompanied with misinterpretations of conflicting assumptions about foods, often result in mixed levels of knowledge about nutrition, which can inevitably influence dietary behaviours (Klassen et al., 2018; Qutteina et al., 2019). In addition to nutrition knowledge, adolescents also face practical barriers such as lack of skills or ability to cook or prepare healthy foods, even if they are aware of what they should be eating and drinking (Carter et al., 2022).

Taste is often reported as a significant factor in adolescent food choices, serving as both a barrier and enabler to positive dietary behaviours (Shepherd et al., 2006; Kebbe et al., 2017; Stevenson et al., 2007). While the taste preferences varies between individuals, adolescents generally prefer sweet tastes over bitter ones, whilst adults tend to favour, or tolerate, bitter-tasting foods, possibly due to a greater awareness of their health benefits and the potential negative impact of sweet foods (Bawajeeh et al., 2020). For adolescents, the appeal of taste and other sensory rewards often takes precedence over the healthfulness of the food (Stevenson et al., 2007). In fact, regardless of the availability of healthy food that taste nice, the presence and temptation of less healthy and better-tasting foods still makes it difficult for adolescents to make healthier dietary choices (Fleming et al., 2020; Kebbe et al., 2017). Moreover, taste must be in conjunction with convenience and cost, and less healthy food is often perceived as being cheaper (Fleming et al., 2020; Shepherd et al., 2006). The affordability of healthier, more expensive food options has been reported as a concern for adolescents, with convenience and cost often emerging as barriers to healthy food choices (Ziegler et al., 2021; Fleming et al., 2020; Share & Stewart-Knox, 2012; Kelly, Callaghan & Gabhainn, 2021; Shepherd et al., 2006). Adolescents typically have busy schedules, with high demands from school, sport or recreational activities, and their social lives, often resulting in them preferring quick, easy-to-prepare foods that require little to no cooking (Ziegler et al., 2021; Fleming et al., 2020).

As adolescents mature, their independence grows, and time spent with peers becomes more significant. During this time, their peers and close relationships are the most commonly reported influences, along with friends and family, exerting the strongest impact on dietary behaviours (Fleming et al., 2020). As adolescents typically spend more time socialising away from their homes and schools, they have more opportunities to make poor dietary choices, often opting for ultra-processed foods high in sugar, salt and fat (Rauber et al., 2021; Kelly et al., 2019). Food choices vary for adolescents depending on their location, with around a third of their meals being consumed outside the home, making the external food environment a significant influence on their diets (Kelly, Callaghan & Gabhainn, 2021). When considering the home environment, adolescents typically have limited autonomy in food decisions, as their parents control food purchases. The home environment often aligns with their need for convenience, where family meals are common, and they are limited to the foods that have been bought for them (Ziegler et al., 2021). Adolescents often adopt their parents' eating habits, but many believe their parents lack nutritional knowledge, and impose strict rule restrictions on their dietary behaviours, which can ultimately have both positive and negative effects (Fleary & Ettienne, 2019). Finally, the online environment has the potential to influence food choices, with data to suggest this more often than not leads to poor practice (Klassen et al., 2018; Qutteina et al., 2019). Social media is a significant influence on the dietary behaviours of adolescents, yet the quality of the information is often poor (Pollard et al., 2015). Nevertheless, given the rising popularity of social media amongst adolescents, this could perhaps be used as a resource or tool for disseminating accurate information from credible sources.

2.3.3 Factors influencing the dietary behaviours of athletes

The physiological demands of athletes require specific nutritional requirements to optimise health, performance, recovery and adaptations (Jeukendrup, 2017; Impey et al., 2018;

Stellingwerff, Morton & Burke, 2019). Although there is an existing body of evidence indicating that adult athletes may possess adequate nutritional knowledge, translating this knowledge into their dietary behaviours and adherence remains problematic (Cole et al., 2005; Spronk et al., 2014; Tam et al., 2019). Rather, the dietary choices made by athletes have been suggested to be a dynamic, intricate, and perpetually evolving process (Birkenhead & Slater, 2015). Although it may be assumed that the factors influencing the nutritional behaviours of the general population are also pertinent to athletes (Stok et al., 2017; Pelly, Thurecht & Slater, 2022), it would seem appropriate to delve deeper into the unique intricacies associated with athletes' dietary behaviours. This understanding can enhance the precision of interventions aimed at improving their dietary practices (Bentley et al., 2019).

In a review conducted by Birkenhead and Slater (2015), it was indicated that athletes' nutritional behaviours can be shaped by various factors, including physiological (e.g., fat-free mass and resting metabolic rate), psychological (e.g., body image), social (e.g., marketing, peers), and economic (e.g., cost) influences, which can differ both within and among individuals. These factors have recently been expanded to encompass cultural background (e.g., food beliefs), health and nutrition perceptions (e.g., nutritional content), sport and competition stages (e.g., season/phase), as well as situational (e.g., routine) and interpersonal (e.g., peers) influences (Pelly, Thurecht & Slater, 2022). Despite this broadening of factors, research to date suggests that performance and competition remain some of the most significant influences of athletes' nutritional behaviours (Smart & Bisogni, 2001; Long et al., 2011; Pelly, Burkart & Dunn, 2018; Bentley et al., 2019). This has also been reported in professional academy soccer players, with players suggesting that adopting a good diet positively effects their performance which subsequently motivates them to adhere to nutritional recommendations (Carter et al., 2022). Additionally, sports nutritionists and coaches reported that linking nutrition to performance was beneficial for increasing players' interest and motivation, particularly when the potential benefits are supported with data (Carter et al., 2022). The authors also reported that players discussed the importance of practical skills (i.e., cooking, independence) as an enabler to their nutritional adherence. This notion has also been reported by athletes across a range of sports, who have indicated that practical resources, such as food plans, can positively influence their nutritional behaviours by promoting confidence, structure, and routine (Bentley et al., 2019), however the researchers also reported that athletes often lack the skills to create these resources themselves. This proclaimed lack of ability is attributed to insufficient opportunities to develop these competencies and a preference for having someone else provide support. Indeed, when plans come from a credible source, such as a sports nutritionist, they can positively influence individuals' attitudes and beliefs about the behaviour, thereby increasing their confidence (Human Behaviour Change Project, 2016). However, plans should be tailored to specific goals (Bailey, 2019), making the alignment of goal setting for an athlete an important factor that may positively influence athletes' nutritional behaviours.

2.3.3 Behaviour Change Theory and the COM-B Model

Providing educational support to athletes is a crucial aspect of sports nutrition (Birkenhead and Slater, 2015), as this can provide them with the ability to recognise the negative impact of suboptimal practises on their health and performance, as well as the benefits of maintaining consistent, optimal dietary habits. Additionally, education can enhance athletes' awareness of the factors that influence their food choices and facilitate the development of strategies to navigate these influences effectively. Nutrition education interventions in various sports have demonstrated positive outcomes, including enhanced knowledge and improved performance (Cholewa et al., 2015; Tester et al., 2012; Valliant et al., 2012; Doyle-Lucas and Davy, 2011). Despite these reports of improved dietary practices following education, two systematic reviews evaluating the effectiveness of nutrition education interventions, including those targeting athletic populations, have reported only a weak connection between knowledge and improved dietary behaviours (Heaney et al., 2011; Spronk et al., 2014). Previous research has demonstrated that despite possessing sufficient nutritional knowledge, athletes do not always apply this in practice (Walsh et al., 2011) and often prioritise their own beliefs regarding optimal performance over recommended best practice (Harrison et al., 1991). Both systematic reviews and a review paper on factors influencing athletes' food choices (Birkenhead and Slater, 2015) conclude that due to the loose methodologies of prior research, the impact of knowledge alone on eating behaviours remains unclear.

Acknowledging that education alone is not sufficient to promote significant changes in athletes' nutritional behaviours, sports nutritionists have emphasised the need for greater focus on behaviour change interventions in practical applications, hence the growing body of literature in this area (Costello et al., 2017; Bentley et al., 2019; Bentley, Mitchell & Backhouse, 2020; Dunne et al., 2022; Carter et al., 2022; Carter et al., 2024). Behaviour change interventions are defined as "a coordinated set of activities designed to change behaviour" (Michie et al., 2011), with education comprising just one of several possible activities. Due to the limited guidance on selecting the appropriate theory for specific intervention contexts, many interventions are designed without any theoretical foundation, leading to ineffectiveness or failure (Michie et al., 2011; Eccles et al., 2012).

There are various behaviour change theories on which interventions can be modelled. Many of these theories share similar and overlapping constructs but are labelled differently (Michie, Atkins & West, 2014). Researchers often find it challenging to select an appropriate and valid theory for their specific project due to the wide array of options available. As a result, many researchers opt for the most commonly used theories, leading to a smaller number dominating the evidence base (Painter et al., 2008). A scoping review by Davis and colleagues (2014) examined 276 research articles and reported that of the 82 identified theories, only four accounted for 63% of the articles. A well-established theory, which featured in 92 published articles in the referenced review, is the Transtheoretical Model of Change (Prochaska and Velicer, 1997). Despite its popularity, it has faced criticism for its rigidity in creating non-fluid stages and its lack of consideration for the automatic and impulsive nature of human relapse (West, 2005; Cahill et al., 2010). Other commonly used theories include the Theory of Planned Behaviour (Ajzen, 1991) and the Information-Motivation-Behavioural Skills Model (Fisher and Fisher, 1992). An alternative systematic review identified nineteen behaviour change frameworks (Michie et al., 2011) and similarly concluded each had its shortcomings. To address this, there were calls for a 'supra-theory model' that could be applied across various contexts (Barker et al., 2015). In response, Michie et al., (2011) developed the 'COM-B model' (Figure 1) based on the nineteen identified frameworks, aiming to create a model that is comprehensive and applicable to all behaviours (Jackson et al., 2014).

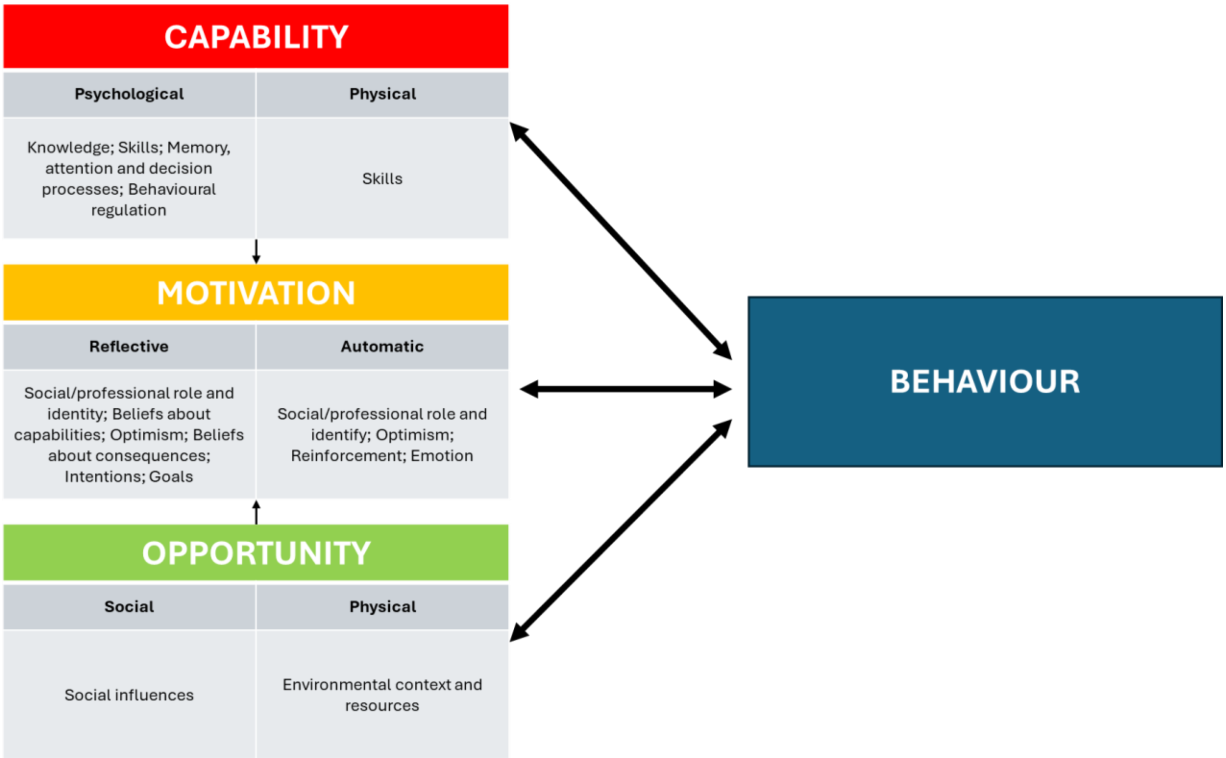

Figure 1. The COM-B model mapped to theoretical constructs of the TDF (Michie, van Stralen & West, 2011; Cane, O'Connor & Michie, 2012).

The COM-B model suggests that for an individual to engage in a desired behaviour, they need the capability (C), the opportunity (O) and be motivated (M) to perform the behaviour (B). Capability refers to an individual's psychological (e.g., knowing what to do) and physical (e.g., having the technical skills) capacity to perform the desired behaviour. Opportunity encompasses all external factors that enable or prompt the behaviour, including physical opportunity (e.g., access to necessary resource) and social opportunity (e.g., the surrounding environment, people and culture). Motivation involves the brain processes that energise and direct behaviour, which can be automatic (e.g., habitual processes and emotional responses) or reflective (e.g., analytical decision-making). These components of the COM-B model can be further detailed into specific constructs using the Theoretical Domains Framework (TDF) (Cane, O'Connor & Michie, 2012). Building on the COM-B model, the researchers integrated it into a broader theoretical behaviour system known as the Behaviour Change Wheel (BCW).

This tool is designed to aid in developing effective behaviour change interventions (Michie et al., 2011; 2014), as illustrated in Figure 2.

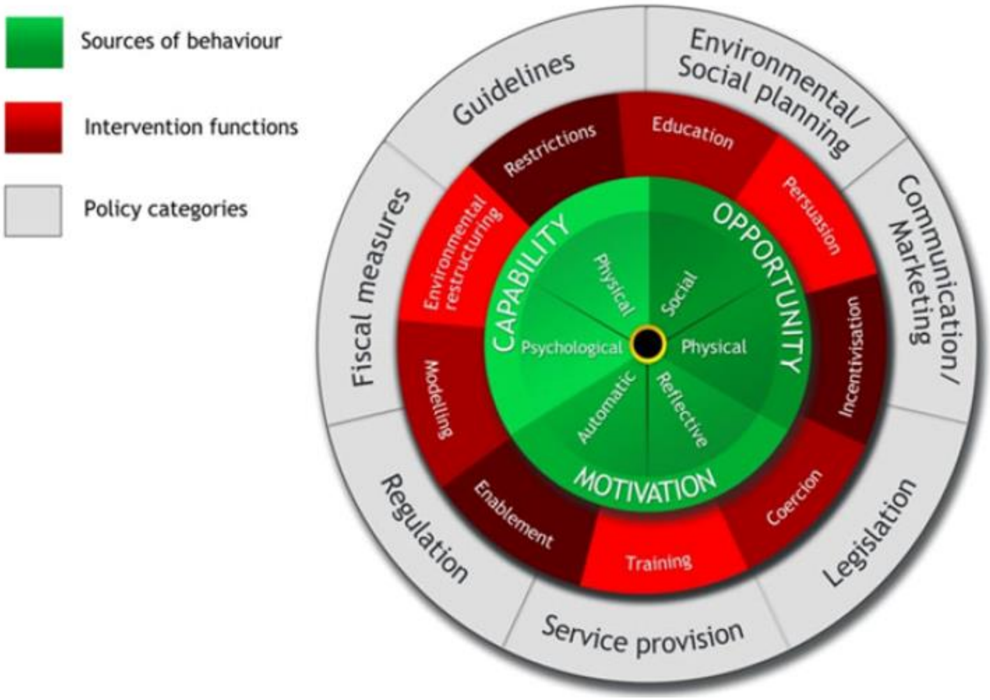

Figure 2. The Behaviour Change Wheel (BCW).

The BCW enables researchers and developers to systematically identify one or more of the nine ‘intervention functions’ and seven ‘policies’ that could induce behavioural changes when implemented. These intervention functions include Education, Persuasion, Incentivization, Coercion, Training, Enablement, Modelling, Environmental Restructuring, and Restrictions. The seven policies include; Legislation, Service Provision, Regulation, Fiscal Measures, Restrictions, Environmental / Social Planning, and Communication / Marketing. Definitions and examples of the interventions and policies are provided in Table 3.

The design and development of a theoretically informed behaviour intervention using the COM-B and BCW systems typically involves a three-stage process, each with additional sub-processes (Michie, van Stralen & West, 2011) as illustrated in Figure 3. This systematic approach is known as behavioural design (Voorheis et al., 2022). In stage one, intervention designers must “understand the behaviour”, and the COM-B model and the TDF are often used together in this stage to help designers understand the current behaviours and determine the necessary changes for the desired behaviour to occur. Stage two involves “identifying the intervention options” that could facilitate the desired behaviour change. This stage is supported by using the matric of explicit links between COM-B components and intervention functions before selecting policy categories. Stage three is the final stage, where intervention designers need to “identify implementation options” and specific resources to utilise within the intervention functions. In this stage, designers bring the intervention functions to life by using behaviour change techniques (BCTs), often referred to as the “active ingredients” of an intervention (Michie et al., 2013).

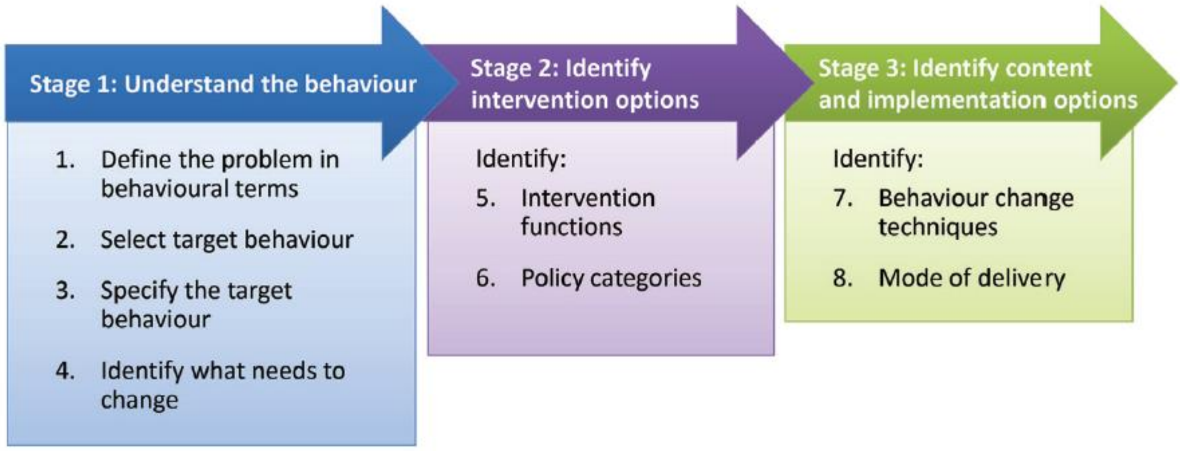

Figure 3. Three-stage process of behaviour intervention development (Michie et al., 2014).

Table 3. Definitions of BCW Interventions and Policies (*adopted from Michie et al., 2011)*

Intervention	Definition	Example
Education	Increasing knowledge or understanding	Educational workshops for players and parents highlighting the energy demands of youth soccer players and the implications on performance and development
Persuasion	Using communication to induce positive or negative feelings to stimulate action	Nutritionist present within mealtimes at the training ground and school
Incentivisation	Create expectation of reward	Recognition / reward for practicing desired behaviours
Coercion	Creating expectation of punishment or cost	Modifying training time in accordance with fuelling practices
Training	Imparting skills	Food / meal preparation skills
Restriction	Using rules to reduce the opportunity to engage in target behaviour to be changed (or vice-versa)	Removing vending machines in school that provide sub-optimal choices
Environmental Restructuring	Change the physical or social context	Provide performance chefs that provide foods conducive to optimal fuelling strategies at the training ground
Modelling	Providing an example for people to aspire to or imitate	Utilising first-team players
Enablement	Increasing means / reducing barriers to increase capability or opportunity	Provide food & drink items prior to training to optimise fuelling
Policies		
Communication/ Marketing	Using print, electronic, or broadcast media	Disseminating resources to parents via email or in-person workshops
Guidelines	Creating documents that recommend or mandate practice	Producing and disseminating protocols to stakeholders
Fiscal	Increasing or reducing the financial cost	Utilise training ground catering team to produce fuelling snacks rather than purchasing external items
Regulation	Establishing rules or principles of behaviour or practice	Establishing agreements with stakeholders on minimum standards of provision to facilitate player performance, development and health
Legislation	Making or changing laws	Compulsory mealtime attendance
Service Provision	Delivering a service	Establishing support services in the workplace / industry
Environmental / Social Planning	Controlling the physical or social environment	Better-informed planning of new industry buildings etc. from key decision makers

The COM-B model and the BCW have been successfully applied in various healthcare contexts, including promoting healthy eating in children (Alexander et al., 2014), ensuring medication adherence (Jackson et al., 2014), increasing compliance among new hearing-aid users (Barker et al., 2015), and improving attendance at National Health Service (NHS) stop-smoking services (Fulton et al., 2016). Despite its success in public health interventions, its use in professional sports is limited. A notable example is a case study on a professional rugby athlete, where the BCW was used to develop a nutrition intervention (Costello et al., 2017). The BCW could potentially address the challenges that academy soccer players face, by developing an intervention with various 'functions' such as education platforms, training, and enablement, supported by club and governing body policies.

In this regard, currently only one group has successfully developed an education and behaviour change intervention for professional academy soccer players, by conducting a series of studies to develop and implement the intervention (Carter et al., 2022; 2023; 2024). The researchers initially examined the barriers and enablers to nutritional adherence among professional male academy soccer players by exploring the perspectives of players (n = 13), nutritionists (n = 12), and coaches (n = 10) from 2, 12, and 10 professional UK clubs, respectively (Carter et al., 2022). To understand the factors influencing players' dietary behaviours, the authors applied the COM-B model, aiming to inform the development of evidence-based behaviour change strategies using the Behaviour Change Wheel (Michie et al., 2011). Participants identified nutritional knowledge, cooking skills, and food availability at training venues as key factors influencing adherence to nutritional guidelines. Following on from this, Carter et al., (2023) investigated the dietary intakes of professional players over the course of a week, reporting that players fail to periodise their CHO intake despite alterations in energy demands across the match week. Notably, a number of players failed to consume the recommended 6-8 $g \cdot kg^{-1}$

BM · day^{-1} across the crucial period pre and post-match, with some consuming < 2g · kg^{-1} BM · day^{-1}. The researchers concluded that perhaps the players do not fully understand the need to periodise their dietary intake or are unable to do so, whilst emphasising that practitioners should focus on knowledge and behaviour change strategies to promote effective fuelling and recovery practices. Taken together, these findings led to the researchers developing and implementing a nutrition education and behaviour change intervention targeting dietary practices around a match in professional soccer players (Carter et al., 2024). Following on from their previous findings (Carter et al., 2022), the researchers applied intervention functions (i.e., Training, Education, Modelling, Persuasion and Enablement) to successfully develop and implement an education and behaviour change intervention, with significantly higher mean energy and CHO intake reported in the intervention group when compared to a control group. The intervention group also demonstrated periodisation practices as CHO intake was significantly increased on MD-1 (7.0 ± 1.7 g · kg^{-1} BM · day^{-1}), MD (7.1 ± 1.4 g · kg^{-1} BM · day^{-1}) and MD + 1 (5.1 ± 0.8 g · kg^{-1} BM · day^{-1}).

Given the reported positive impact of utilising the COM-B model to develop an education and behaviour change intervention in professional male soccer players, in the context of this thesis, the COM-B model will be utilised to synthesise the results from Study 3, with the aim of understanding the enablers and barriers to the dietary behaviours of male academy soccer players from the YDP, to inform future research in developing behaviour change interventions for this population.

2.4 Framing the Research: Research Paradigms and Methodologies

After addressing the theoretical and conceptual issues underpinning this thesis, it is now appropriate to explore the paradigmatic foundation of the research. Accordingly, the next section is divided into two sections, the first of which provides an overview of the key paradigms in qualitative and quantitative research, as well as the concept of mixed-methods research.

2.4.1 Qualitative, Quantitative and Mixed Methods Research

Sports nutritionists often encounter complex questions within their practice that can be addressed through both qualitative and quantitative research methods. These two approaches differ in how they collect and analyse data (Gelo et al., 2008). Despite being distinct and well-established methodologies, there is currently no universally accepted definition for either (Sparkes & Smith, 2014). Quantitative research emphasises the measurement and analysis of causal relationships between variables, reducing phenomena to numerical values for statistical analysis (Denzin & Lincoln, 1994). On the other hand, qualitative research focuses on the close relationship between the researcher and the subject, considering the situational factors that influence the inquiry (Denzin & Lincoln, 1994), whilst relying on non-numerical data such as audio recordings and transcripts (Burnard et al., 2008). No single method can fully capture the complexity and dynamism of behaviour (Gill, 2011), therefore these methods are often viewed as opposites and defined by what they are not, rather than what they are (Sparkes & Smith, 2014). Recognising these differences along with the unique insights each method can offer is crucial for the fields of sports and exercise science (Martin, 2011).

Historically, research within the fields of sports and exercise sciences, has predominantly followed a positivist approach (Sparkes, 1998; Atkinson, 2012), focusing mainly on quantitative research to identify causal effects and provide reliable, evidence-based advice for athletes, coaches, and organisations (Ronkainen & Wiltshire, 2019). Positivists believe that phenomena like human behaviour have an objective reality, allowing for the measurements, analysis, and prediction of relationships between variables (Gelo et al., 2008; Park et al., 2020).

In contrast, constructivism views reality as socially and psychologically constructed (Given, 2012), and emphasises qualitative research to capture individual opinions, experiences, and perspectives in knowledge construction (Hammarberg et al., 2016). The importance of understanding the underlying reasons behind phenomena in a naturalistic, contextual, and holistic manner is increasingly recognised (Smith, 2003), leading to a significant rise in qualitative research within sports and exercise sciences, including sports nutrition (Gratton & Jones, 2004). However, this is no single way to conduct qualitative research (Denzin & Lincoln, 2008), rather, it serves as an "umbrella term" encompassing a broad range of research approaches (Greckhamer & Cilesiz, 2022). The selection of the most suitable qualitative approach depends on the researcher's preferences.

A relativist ontology and constructivist epistemology, which assumes that reality is relative according to how each individual experiences it (Sparkes & Smith, 2014), comprised the methodological research process to Study 2 (Chapter 4). This epistemological approach holds that reality is subjective (Ormston et al., 2014), acknowledging that personal experiences and social contexts shape individual perceptions. Consequently, my role as the researcher is to aid participants in expressing their subjective realities and then interpret and convey these insights accurately. This approach considers my role as a practitioner-researcher, acknowledging that my identity within the social context may influence what I observe and therefore impact upon conclusions. The practitioner-researcher role is further discussed in section 2.5 of this thesis.

Mixed methods research involves collecting and analysing both quantitative and qualitative data within a single study (Creswell & Clark, 2011; Bowers et al., 2013), leveraging the strengths of both approaches. This enables researchers to explore diverse perspectives and uncover relationships within complex research questions (Greene et al., 1989). The intentional integration of methods in data collection, analysis, and interpretation offers a more comprehensive view of the research landscape, as phenomena are examined through multiple research lenses (Shorten & Smith, 2017). However, this mixed-methods approach, often called the "third paradigm", is rooted in pragmatism (Denscombe, 2008). Pragmatism bypasses debates about truth and reality, recognising that there are both singular and multiple realities that can be explored empirically to address practical problems in the "real world" (Feilzer, 2010). Conducting research within a pragmatic paradigm allows researchers the flexibility to choose the most appropriate methods to answer their specific research questions. To date, there are a number of studies that have employed a mixed methods approach in the field of sports nutrition (Ono et al., 2012; Ryan et al., 2024; Mattar et al., 2024). Notably, Ono et al., (2012) utilised a similar study design to that of Study 3 (Chapter 5) in this thesis, as the researcher's combined an assessment of nutritional intake with semi-structured interviews, to ascertain what professional soccer players were consuming and the wider cultural factors that affect consumption. This approach allowed for the researchers to acquire more rich and meaningful data, hence why a similar approach will be employed in Study 3 (Chapter 5).

A pragmatic approach allows for the use of the most appropriate methods to be utilised when necessary throughout the thesis, ensuring that the research questions are effectively addressed and the objectives are achieved. Study 1 utilises a quantitative approach via a survey, to explore the performance nutrition service provision within soccer academies in English soccer. Study 2 will draw on qualitative methods to uncover the perspectives on the role of nutrition in influencing academy soccer player development and performance, from stakeholders of a Category One academy soccer club. Gathering data from a range of key stakeholders will provide a more in-depth analysis of the understandings of nutrition within a 'top-tier' academy soccer environment. Study 3 will employ a mixed-methods approach as it seeks to utilise a model of behaviour change to explore the barriers and enablers to the dietary behaviours of academy soccer players.

2.5 Practitioner-Researcher Role

The traditional research model establishes a distinct separation between the roles of the researcher and the practitioner. According to Bensimon et al. (2004), in this model, the researcher is responsible for identifying the problem, choosing the appropriate methods, gathering and analysing data, and presenting the results. The researcher is considered the expert, giving them the authority to propose solutions. However, despite the volume of research produced, it often has minimal impact on practitioners, who seldom access or apply the findings. This conventional approach is more suited to quantitative research that follows a scientific methodology (Bensimon et al., 2004). More recently, practitioner-researcher approaches have become more prevalent in the field of sports nutrition, with a growing body of research conducted by practitioners in recent years within male academy soccer nutrition (Hannon et al., 2020; Hannon et al., 2021, 2021b; Stables et al., 2022; Stables et al., 2023; Stables et al., 2024; Carter et al., 2022; Carter et al., 2024). McLeod (1999) defined practitioner-research as research conducted by practitioners with the aim of improving their own practice and enhancing the understanding of the social context in which the research takes place. The practitioner-researcher model helps to bridge the gap between theory and practice, creating a dynamic relationship where both inform and improve each other.

Practitioner-researchers are uniquely positioned to produce context-specific knowledge, which is directly relevant to their environment. As they operate within the settings they study, the knowledge generated is not only theoretically sound but also practically applicable. The findings from such studies are highly applicable to their specific context and can lead to immediate improvements in practice (Anderson & Herr, 2011). Practitioner-researchers are critical in bridging the gap between theory and practice. They apply theoretical models to real-world settings, testing and refining them based on practical realities. By contributing their findings to academic literature, practitioner-researchers ensure that theories evolve to meet practical needs (Cochran-Smith & Lytle, 2009). Practitioner-researchers also play a key role in promoting evidence-based practice (EBP), particularly in fields like healthcare, education, and social work. EBP involves using current best evidence to make decisions about patient care, teaching strategies, or social interventions (Sackett et al., 1996). By conducting research within their practice, practitioner-researchers provide empirical evidence that can guide others in the field. Moreover, the collaboration between academic researchers and practitioner-researchers blends practical insights with theoretical expertise. These collaborations are mutually beneficial, with practitioner-researchers providing real-world data and experience, and academic researchers contributing methodological rigor. This partnership leads to studies that are both theoretically sound and practically relevant, ensuring that the research has direct application in the field (Anderson & Herr, 2011).

Whilst the practitioner-researcher approach offers significant value, it also faces challenges. Balancing the demands of a professional role with the time and effort required for rigorous research can be difficult. Additionally, practitioner-researchers must navigate ethical considerations, particularly when researching within their own work environment (Cochran-Smith & Lytle, 2009). Maintaining objectivity and ensuring the validity of the research in such settings is crucial to avoid bias. Over the duration of my PhD journey, I have occupied a full-time role as a performance nutritionist within multiple soccer academies in England, delivering nutrition support to key stakeholders between the U9-U21 age-groups. I recognise that, because of my role, I will be engaged in both the generation and collection of data. However, this can be viewed advantageously, as my experiences as a practitioner allow for me to identify real-world problems and generate appropriate research questions and subsequent methodology. As a researcher-practitioner, my experiences in academy soccer settings have shaped and deepened my perspectives, impacting how I collaborate with participants in the co-creation of knowledge (Bourke, 2014). I acknowledge that my approach to generating and interpreting the research questions throughout this thesis may have been influenced by my background as a sports nutritionist in working in academy soccer, however this does provide me with insight into the culture and enable me to engage participants, to ultimately collect rich and meaningful data.

Chapter 3

An audit of performance nutrition services in English soccer academies: implications for optimising player development

The aim of this chapter was to audit the performance nutrition service provision with male soccer academies in England, to assess the impact of the current EPPP mandate.

This study was published in Science & Medicine in Football 2022.

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3.1 Abstract

Purpose: To audit the current provision of performance nutrition services provided to male adolescent players within academies from the English soccer leagues.

Methods: Practitioners from all eighty-nine academies (status categorised as one-four according to the Elite Player Performance Plan, EPPP) completed an online survey to audit: a) job role / professional accreditation status of persons delivering nutrition support, b) activities inherent to service provision, c) topics of education, d) on-site food, fluid and supplement provision and e) nutritional related data collected for objective monitoring.

Results: More full-time accredited nutritionists are employed within Category One (14/26) versus Category Two (0/18), Three (1/41) and Four (0/4). Respondents from Category One clubs report more hours of monthly service delivery (62 ± 57 h) than Category Two (12 ± 9 h), three (14 ± 26 h) and four (12 ± 14 h), inclusive of one-to-one player support and stakeholder education programmes. Category One practitioners reported a greater prevalence of on-site food, fluid and supplement provision on training and match days. Across all categories, players from the professional development phase receive more frequent support than players from the youth development phase, despite the latter corresponding to the most rapid phase of growth and maturation.

Conclusion: We report distinct differences in the extent of service provision provided between categories and phases of development. Additionally, players from all categories receive nutrition support from non-specialist staff. Data demonstrate that performance nutrition appears an under-resourced component of academy sport science and medicine programmes in England, despite being an integral component of player development.

3.2 Introduction

The purpose of a soccer academy is to develop players to represent the first team, thereby reducing the financial strain of having to buy players and/or potentially profiting from their sale (Elferink-Gemser et al., 2012). To develop more high-quality home-grown players, the English Premier League (EPL), the Football Association (FA) and representatives from the Football League, developed a strategic plan known as the 'Elite Player Performance Plan' (EPPP) (Premier League, 2011). According to the EPPP framework, clubs are audited and categorised from Category One (the best) to Four, largely dependent on the extent of support they provide to their players, taking into consideration factors such as productivity rates, training facilities, coaching, education, and welfare provisions. However, despite the mandate from the EPPP for interdisciplinary specialists in the sports science and medicine team, the employment of qualified staff with the specific remit of providing nutrition related services is only required on a part-time basis for Category One status. In contrast, lead sport scientists, lead strength and conditioning coaches, and academy psychologists must be employed full-time. Although clubs of Category One status are required to (at least) employ a nutritionist on a part-time basis (i.e., working <35 hours per week), those in Categories Two to Four do not require any formalised nutrition service provision. This is despite the fact that players from all categories are likely to experience the same energetic requirements to support both developmental (i.e., growth and maturation) and performance related goals (i.e., fuelling the demands associated with training and match play) (Hannon et al., 2021b).

In relation to training demands, male academy soccer players (U12-U23), albeit from a single Premier League club of Category One status, may experience similar absolute physical loading patterns to that of adult players within the English Premier League (EPL) (Anderson et al., 2016; Brownlee et al., 2018; Hannon et al., 2021a). Importantly, these training demands come at a time when players require sufficient energy to synthesize new tissues (Torun, 2005) during rapid biological growth and maturation (Malina et al., 2004). For example, Hannon et al., (2020) previously reported that the progressive increases in stature, body mass and fat free mass (FFM) that occurs in academy male players between the ages of 12-16 increases resting metabolic rate (RMR) by ~400 kcal·day^{-1}. Furthermore, in using the doubly labelled water (DLW) technique (Westerterp, 2017), Hannon et al., (2021b) also reported that individual players across the academy pathway (i.e., from U12 to U18) may present with an absolute total daily energy expenditure (i.e., 3000 – 5000 kcal·day^{-1}) that is comparable to (or exceeds) our previous observations from adult players of the EPL (Anderson et al., 2017). In this way, male academy soccer players present with a higher relative daily energy requirement compared to their adult counterparts (i.e., 60-80 kcal·kg^{-1} FFM versus 40-60 kcal·kg^{-1} FFM) (Hannon et al., 2021b). Where players do not consistently meet such daily energy requirements (Naughton et al., 2016; Briggs et al., 2015), they may present with chronically low energy availability (LEA, often defined as <30 kcal·kg FFM^{-1}·day^{-1}) (Mountjoy et al., 2018), the result of which could lead to negative symptoms associated with relative energy deficiency in sport (RED-S) syndrome. Such symptoms may present as reductions in skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks et al., 2011), all of which can be detrimental to long-term player development.

On this basis, there is a definitive need for clubs to educate and support players and key stakeholders (e.g., coaches, parents / guardians etc) on such fundamental principles of nutrition. However, notwithstanding differing methods of dietary assessment, data indicates distinct differences in daily energy intake in cohorts of male adolescent soccer players from two different Category One academies (Hannon et al., 2021b; Briggs et al., 2015), a finding that may be due in part to differences in the extent of service provision and education provided between clubs. Potential differences in service provision within and between category status could initially be underpinned by nature of practitioner employment (i.e., full versus part-time) and accreditation status (i.e., qualified versus non-qualified staff), the result of which can significantly affect the quality and extent of service provided. Although the EPPP have specified that Category One clubs should employ a professionally accredited sports nutritionist (or working under a line manager who is), it is not currently known how clubs in England are currently delivering their nutrition programme.

With this in mind, the aim of this study is to audit the performance nutrition services currently provided to male adolescent soccer players within academies from the English leagues. Using a specifically designed questionnaire, all 89 soccer clubs with an academy of category status (during the 2020-2021 season) in accordance with the EPPP framework (Premier League, 2011) were surveyed. It is hoped that data may prompt critical reflection of service delivery in an area of sport science and medicine which is of paramount importance to optimise player health, development, and performance.

3.3 Methods

3.3.1 Study Design

Practitioners working with academy soccer players from the English soccer leagues were invited to participate in this study. Data were collected during the 2020-2021 season, with all 89 clubs with category status (Categories One-Four) responding to the survey (Figure 4). A 100% response rate was achieved by contacting clubs and practitioners via email and professional and personal networks. Respondents were categorised in to three different roles: 1) Accredited nutritionists (AN), holding either graduate or practitioner status with the UK

Sport and Exercise Nutrition Register (SENr) or a relevant governing body (e.g., Association for Nutrition), 2) Sport Science and Medicine Staff (SSM), as comprised of Sports Scientists, Strength and Conditioning Coaches, Physiotherapists and Sports Therapists, 3) Interns and Volunteers (I/V), inclusive of individuals on internships, work placements or volunteers. Practitioners were provided a short anonymous survey to complete, consisting of 30 multiple choice and free text questions surrounding the nature of the nutrition service provided at the club. Consent was provided via a consent statement upon submission of the survey. Each club was provided a unique code known by the lead researcher only, to identify clubs for relevant feedback (where requested). The study was approved by Liverpool John Moores University Ethics Committee (20/SPS/046, 10/11/20).

3.3.2 Survey Design

The survey was developed using Online Surveys (formerly Bristol Online Survey, BOS. JISC Ltd) and designed by the research team, all with practical experience of the professional and academy soccer environment (authors DC and MH have provided nutrition support to academy and adult soccer players for 4 and 5 years, respectively, whilst authors GLC and JM have >10 years practitioner experience within professional soccer). The purpose was to establish the scope of current nutrition service provision for male youth soccer players across different categories of academies in English soccer. The survey was comprised of eight sections: (a) practitioner information (i.e., name, club, category of academy, and job role), (b) professional information (i.e., accreditation status and academic qualifications), (c) nature of service provision (i.e., one-to-one support, group education, parent education, host-family education, cooking workshops, staff education, and catering staff education; see Table 4 for an overview of what constitutes each of these activities), (d) topics of education provided (i.e., basics of macronutrients, basics of micronutrients, eating for growth, fuelling for training, fuelling for games, hydration, recovery, and supplements), (e) extent of on-site food and drink provision (i.e., breakfast, lunch, dinner, snacks, pre-match food, post-match food, fluids), (f) extent of on-site supplement provision and management and (g) objective monitoring of nutritional related data. To compare the differences in nutritional provision between age-groups, the under (U) 9-U11 age-groups were categorised as the Foundation Phase (FP), U12-U16 as the Youth Development Phase (YDP) and U18-U23 as the Professional Development Phase (PDP), all in accordance with the EPPP framework (Premier League, 2011). A preliminary focus group was conducted by members of the research team and nine qualified nutrition practitioners (currently working in both academy and senior professional soccer) before the survey was finalised. This focus group allowed for refinement of wording and focus of questioning to ensure clarity and suitability of questions.

3.3.3 Data Analysis

Descriptive statistics (i.e., mean, SD and frequency analysis) were used to display responses to all questions within the survey, due to the results being comprised of nominal and ordinal data. No data are reported for the FP and YDP in category four, as these phases are not part of clubs in this category.

Table 4. Overview of nature of service provision.

Nature of Service Provision	Examples
One-to-one player support	• Individualised support to players comprising formal (e.g., planned consultation) and informal (e.g., corridor or canteen conversation).
Group education	• Group presentation or workshop delivered to a squad/age-group.
Parent education	• Support delivered to parents/guardians of the players e.g., presentations, practical workshops and newsletters etc.
Host-family education	• Support delivered to individuals who provide board and lodging to players e.g., presentations, practical workshops and newsletters etc.
Player cooking workshops	• Group sessions related to practical cooking and food hygiene skills.
Staff education	• Support delivered to club staff e.g., presentations, practical workshops or individual educational support etc.
Catering staff education	• Support delivered to club catering staff e.g., group presentations, practical workshops or individual educational support etc.

3.4 Results

A respondent from all eighty-nine soccer academies from the English leagues completed the survey. Respondents were representative of Category One (n = 26, 29%), Two (n = 18, 20%), Three (n = 41, 46%) and Four (n = 4, 5%) and included clubs from the Premier League (n = 20, 22%), Championship (n = 22, 25%), League One (n = 24, 27%), League Two (n = 21, 24%) and National League (n = 2, 2%). Quantities and proportions (%) per category of practitioners who delivered the nutritional support are displayed in Figure 4.

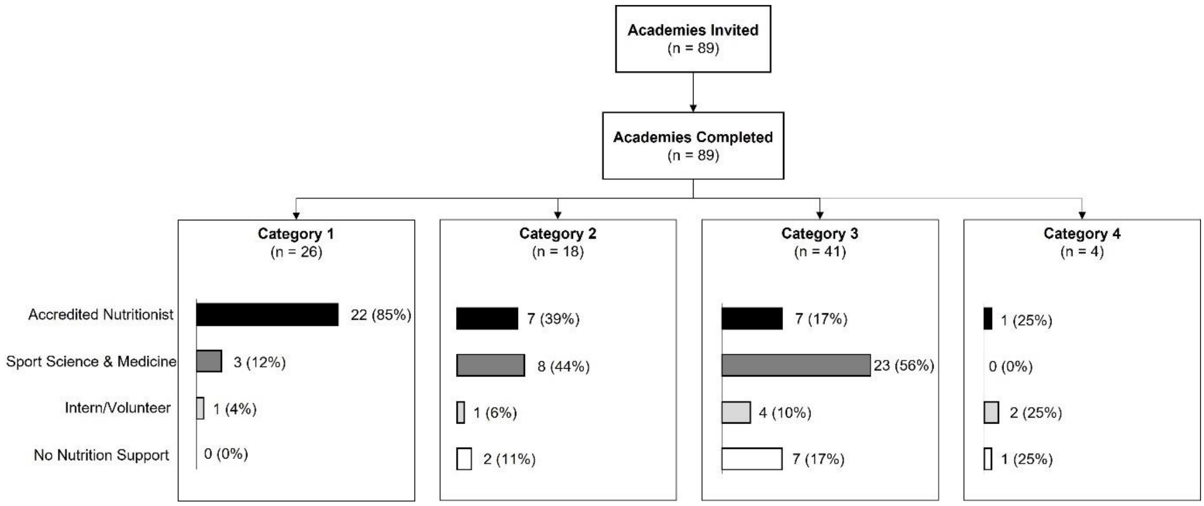

Figure 4. Overview of category status and role of practitioners providing the nutrition support in each respective academy.

3.4.1 Employment Status and Hours of Support Provided

An overview of practitioner employment status and hours of support provided is presented in Figure 5. In Category One clubs, 64% of ANs were employed full-time, whilst 0, 14, and 0% of ANs were employed full-time in Categories Two, Three and Four respectively. Across all categories, ANs provided more hours of support per month than those SSM staff and I/Vs who were required to provide nutritional support. Additionally, practitioners reported delivering more hours of support per month to players from the PDP when compared to players from the YDP and FP (see Figure 5).

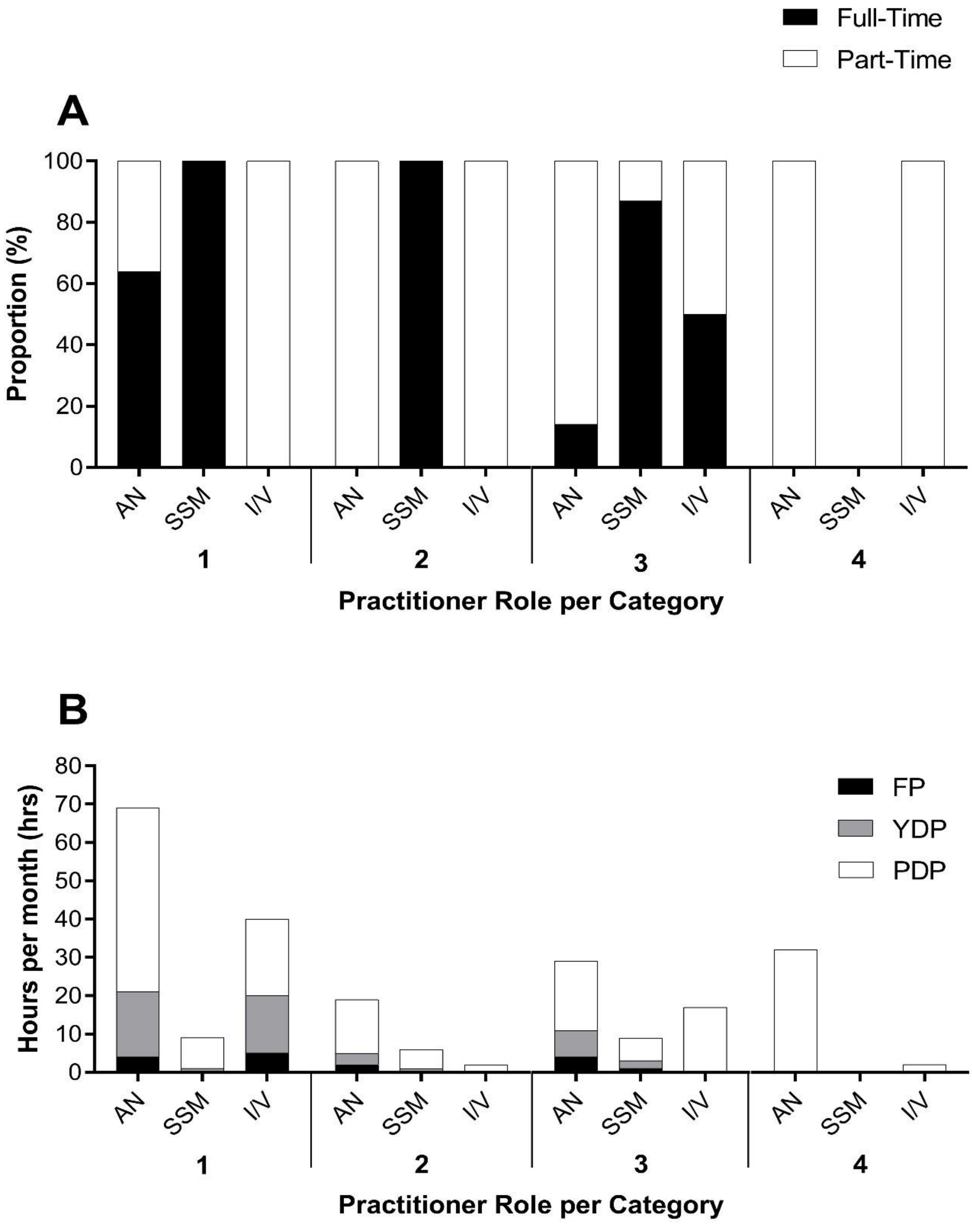

Figure 5. Comparison of (a) the employment status of the practitioners who provide the nutritional support at each respective academy, and (B) hours of nutrition provision provided per month to the foundation phase (FP), youth development phase (YDP) & professional development phase (PDP) by either an accredited nutritionist (AN), sport science and medicine staff (SSM), or an intern/volunteer (I/V).

3.4.2 Nature of Service Provision

An overview of the varying nature of service provision is presented in Figure 6. The proportion of practitioners providing one-to-one player support, staff education, group education and cooking workshops in Category One clubs was greater than that of clubs from Categories Two, Three and Four. Additionally, a greater proportion of clubs in each category provided these modes of support to the PDP when compared to the YDP and FP. Both parent and host-family education were provided by a greater proportion of practitioners working in Category One clubs than Categories Two, Three and Four. However, a greater proportion of Category One, Two and Three clubs delivered parent education to the FP and YDP, whilst the PDP was prioritised for host-family education. When compared to SSM staff and I/Vs, a greater proportion of AN's delivered catering staff education across all categories.

3.4.3 Topics of Education

An overview of topics of education is presented in Figure 7. In Category One clubs, a greater proportion of practitioners delivered the topic 'Basics of macronutrients' to the YDP than the FP and PDP. In contrast, a greater proportion of practitioners delivered this topic to the PDP in Categories Two and Three. Similar trends were reported for the topic 'Basics of micronutrients', as a greater proportion of practitioners delivered this topic to the YDP than the FP and PDP in Category One clubs, whilst a larger proportion delivered this topic to the PDP in Categories Two and Three. A greater proportion of practitioners delivered the topic 'Eating for growth' in Category One clubs, where a greater proportion of practitioners in Categories One and Two delivered this topic to the YDP when compared to the FP and PDP. The topics of 'Fuelling for games', 'Fuelling for training', 'Hydration', 'Recovery', and 'Supplements', were delivered by a larger proportion of practitioners working in Category One clubs than Categories Two, Three and Four, with a greater proportion of clubs delivering these topics of education to the PDP when compared to the YDP and FP.

3.4.4 Food and Drink Provision

An overview of on-site food and drink provision is presented in Figure 8. Players in the PDP were provided with breakfast, lunch, dinner, snacks, pre-match food, post-match food and fluids more frequently across all categories than players from the YDP who, in turn, were also provided with these more frequently than the FP. Clubs of Category One status provided these meals and fluids more frequently to all phases when compared to Category Two clubs, who also had a greater frequency of food and drink provision than clubs from Category Three and Four.

3.4.5 Supplement Provision

An overview of supplement provision is presented in Table 5. There was a greater supplement provision in Category One clubs when compared to all other categories. In all categories, a greater proportion of clubs provided supplements to players in the PDP than the YDP, who were also provided more supplements than the FP. The most common supplement provided was carbohydrates, (i.e., powder, gels), followed by protein, electrolytes, vitamin D, and caffeine.

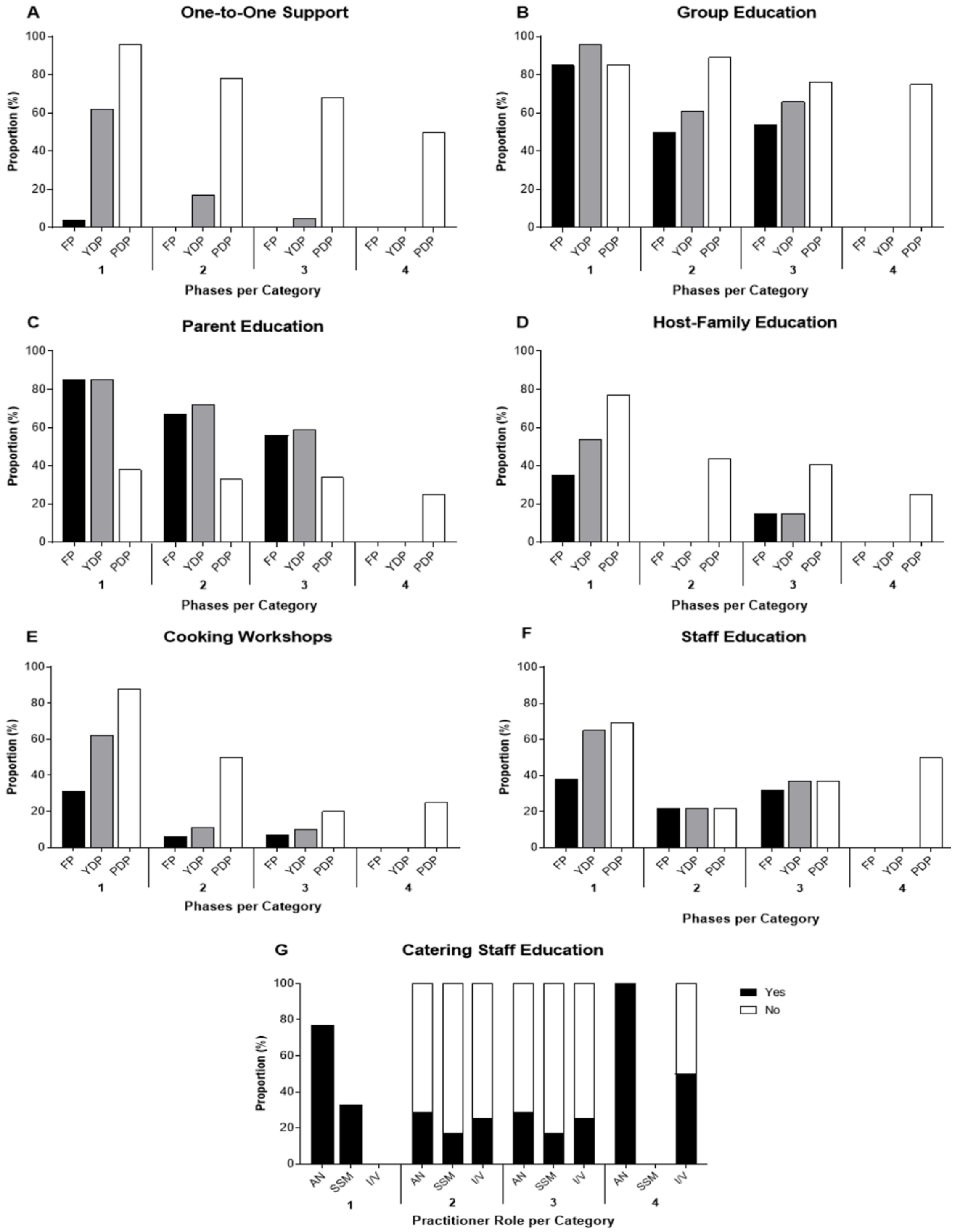

Figure 6. Proportion (%) of clubs in each category who provide nutrition provision in the form of (A) one-to-one support, (B) group education, (C) parent education, (D) host-family education, (E) cooking workshops, and (F) staff education to the foundation phase (FP), youth development phase (YDP) and professional development phase (PDP), as well as the proportion (%) of practitioners per role who provide (G) catering staff education.

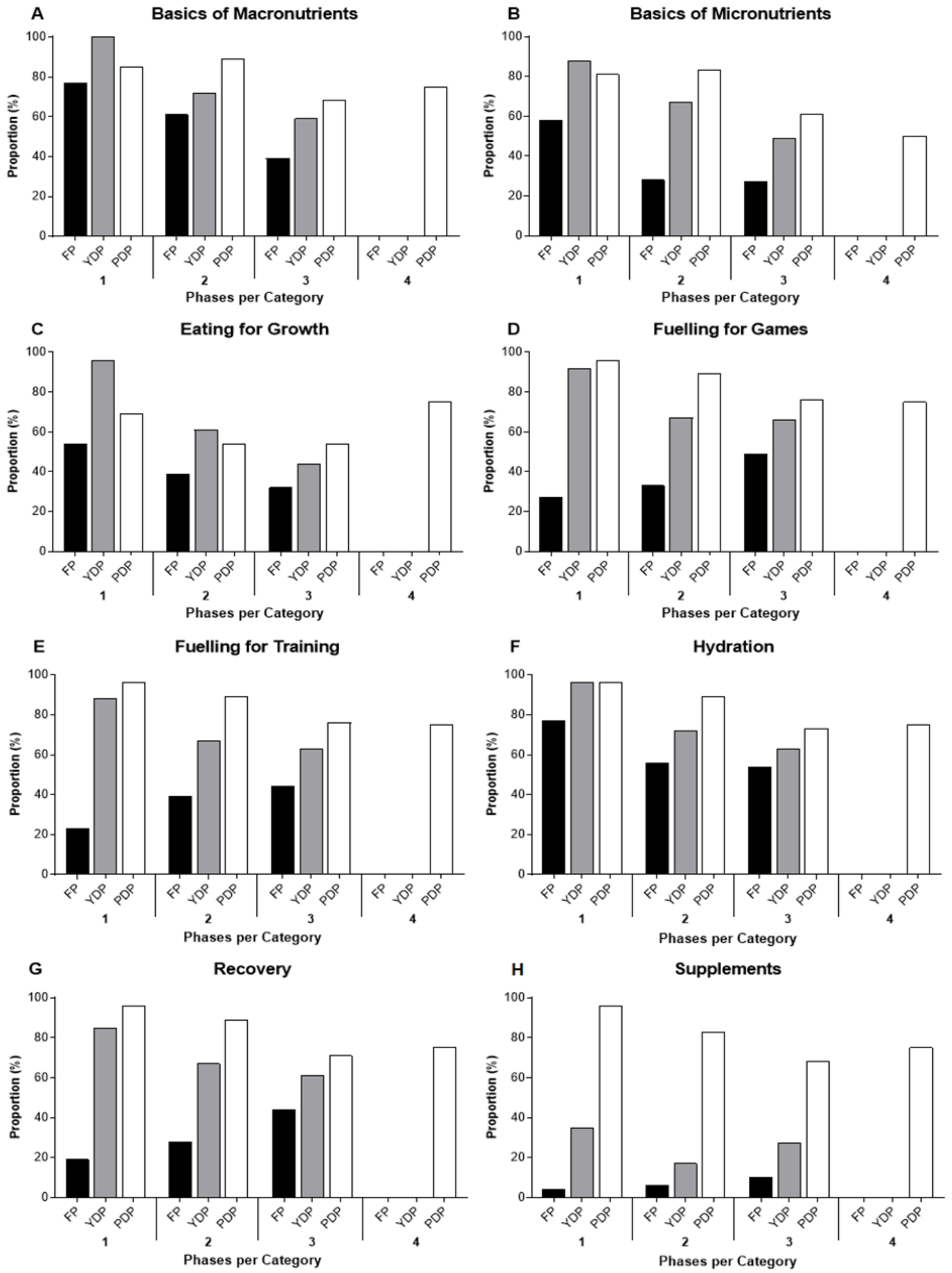

Figure 7. Proportion (%) of clubs in each category who deliver each theme of education content to the foundation phase (FP), youth development phase (YDP) and professional development phase (PDP).

Table 5. Total number and percentage (%) of clubs who provide each form of supplement to the foundation phase (FP), youth development phase (YDP) and professional development phase (PDP) between Categories One, Two, Three and Four.

	Category 1			Category 2			Category 3			Category 4		
	FP	**YDP**	**PDP**	**FP**	**YDP**	**PDP**	**FP**	**YDP**	**PDP**	**FP**	**YDP**	**PDP**
Carbohydrates	1 (4%)	9 (35%)	25 (96%)	0 (0%)	0 (0%)	14 (88%)	0 (0%)	1 (3%)	16 (47%)	n/a	n/a	1 (33%)
Protein	1 (4%)	4 (14%)	24 (92%)	0 (0%)	1 (6%)	14 (88%)	0 (0%)	2 (6%)	19 (56%)	n/a	n/a	1 (33%)
Electrolytes	1 (4%)	7 (27%)	24 (92%)	0 (0%)	0 (0%)	12 (75%)	1 (3%)	1 (3%)	14 (41%)	n/a	n/a	0 (0%)
Vitamin D	1 (4%)	8 (31%)	21 (81%)	0 (0%)	1 (6%)	7 (44%)	1 (3%)	1 (3%)	19 (56%)	n/a	n/a	1 (33%)
Caffeine	0 (0%)	0 (0%)	19 (73%)	0 (0%)	0 (0%)	7 (44%)	0 (0%)	0 (0%)	4 (12%)	n/a	n/a	0 (0%)
Creatine	0 (0%)	0 (0%)	15 (58%)	0 (0%)	1 (6%)	11 (69%)	0 (0%)	0 (0%)	4 (12%)	n/a	n/a	1 (33%)
Collagen	0 (0%)	2 (8%)	15 (58%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)	0 (0%)	2 (6%)	n/a	n/a	1 (33%)
Multi-Vitamin	0 (0%)	1 (4%)	12 (46%)	0 (0%)	0 (0%)	5 (31%)	1 (3%)	1 (3%)	4 (12%)	n/a	n/a	0 (0%)
Probiotic	0 (0%)	1 (4%)	10 (38%)	0 (0%)	1 (6%)	2 (13%)	1 (3%)	1 (3%)	2 (6%)	n/a	n/a	0 (0%)
Nitrate	0 (0%)	0 (0%)	4 (15%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)	1 (3%)	2 (6%)	n/a	n/a	0 (0%)
Beta-Alanine	0 (0%)	0 (0%)	3 (12%)	0 (0%)	0 (0%)	1 (6%)	0 (0%)	1 (3%)	2 (6%)	n/a	n/a	0 (0%)
Fish Oil	1 (4%)	2 (8%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	n/a	n/a	0 (0%)

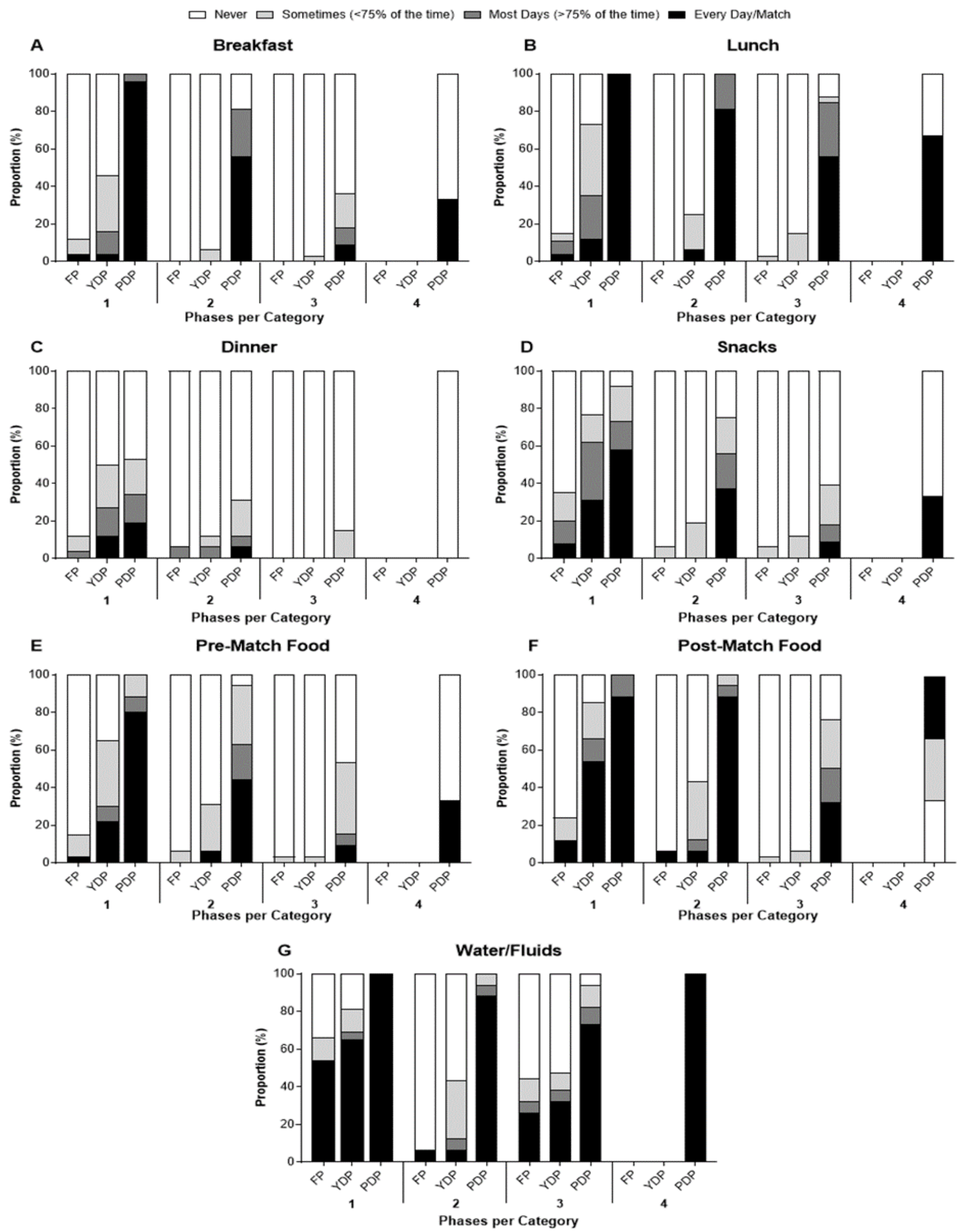

Figure 8. A comparison between categories 1–4, of the proportion (%) of clubs who provide (A) Breakfast, (B) Lunch, (C) Dinner, (D) Snacks, (E) Pre-match food, (F) Post-match food and (G) water/fluids, and the frequency at which they do so for the Foundation Phase (FP), Youth Development Phase (YDP and the Professional Development Phase (PDP).

3.4.6 Objective Monitoring of Nutritional Related Data

An overview of nutritional related monitoring is presented in Figure 9. Category One clubs monitor data related to anthropometric (i.e., stature and body mass) profiling more frequently across all phases when compared to all other categories, where once every 1-3 months was the most common frequency for this method of monitoring. Across all categories, players within the PDP are monitored more frequently than the YDP, who are also assessed more frequently than the FP. Practitioners from Category One clubs also partake in blood profiling more frequently across all phases when compared to the other categories, with once every 6-12 months being the most common frequency. Bloods are monitored more frequently in the PDP when compared to the FP and YDP, who are only monitored in Category One clubs. Body composition (i.e., skinfolds and/or dual-energy X-ray absorptiometry, DXA) is monitored more frequently in players from the PDP when compared to the FP and YDP across all categories, with once every 1-3 months being the most common frequency. Hydration status is also monitored more frequently in players from the PDP when compared to the FP and YDP across all categories, although it is more common to never monitor hydration status across all phases in each category.

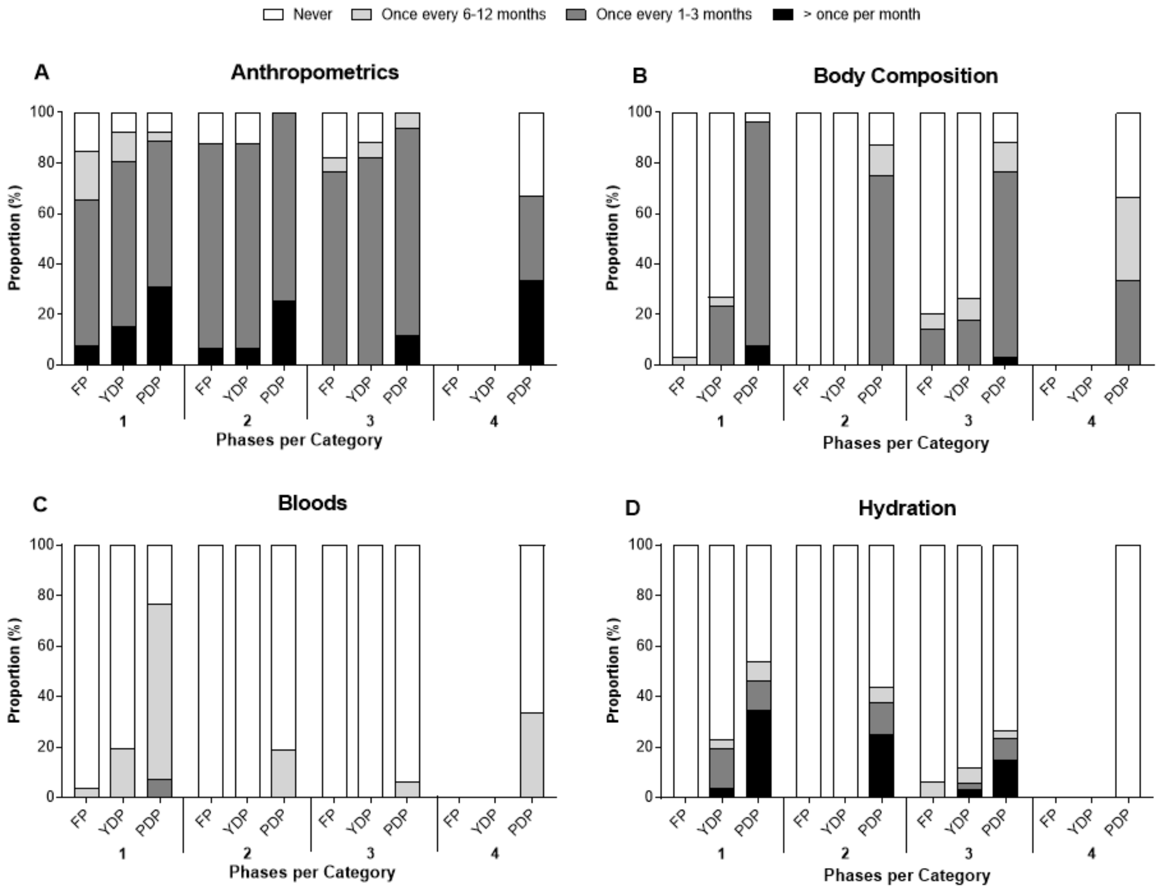

Figure 9. A comparison between categories one, two, three and four, of the proportion (%) of clubs who monitor (a) anthropometrics, (b) body composition, (c) bloods and (d) hydration, and the frequency at which they do so for the foundation phase (FP), youth development phase (YDP) and the professional development phase (PDP).

3.5 Discussion

The aim of the present study was to audit the performance nutrition services currently provided to male adolescent soccer players within soccer academies from the English leagues. Using a specifically designed questionnaire, all 89 academies with category status (during the 2020-2021 season), as determined in accordance with the EPPP framework, were surveyed. Data demonstrate distinct differences in the depth of service provision provided across categories, likely underpinned by the greater prevalence of employment of full-time professionally accredited staff within higher category academies. As such, practitioners from Category One clubs reported more total hours of service delivery per month, inclusive of both individualised and stakeholder education programmes. Practitioners also reported providing more specialist support to players from the PDP phase (e.g., one-to-one support, cooking workshops, food and supplement provision) when compared to players from the younger phases. The reduced prevalence of support within the YDP is suggested as an area of improvement, considering that this is the time when players typically undergo their most rapid phase of growth and maturation. When compared with other sub-disciplines of sport science, data demonstrate that performance nutrition is an under-resourced component of academy sport science and medicine programmes from Soccer clubs in English Soccer, despite being an integral component of long-term player development.

The greater proportion of accredited nutritionists working at Category One academies (i.e., 85%, albeit only 64% are full-time) is in accordance with the requirements of the EPPP (Premier League, 2011). To obtain Category One status, clubs must (at least) employ a part-time nutritionist, with the individual being appropriately accredited (e.g., via a professional body such as the UK Sport and Exercise Nutrition Register) or work under the direct management and supervision of an individual listed on the register (Premier League, 2011). It is noteworthy, however, that 15% of Category One clubs (n = 3) do not employ an accredited nutritionist to deliver their nutritional programme. On the basis that 64% of the accredited nutritionists working in Category One clubs are employed on a full-time basis, it is unsurprising that practitioners reported providing a greater number of total monthly hours service delivery when compared to Categories Two, Three and Four. Nonetheless, a considerable amount of service delivery across Category One, Two and Three remains delivered by sport science and medicine staff as well as students on internships and work placements (this was especially prevalent in category three clubs) (see Figures 4 and 5).

In considering phase of player development, practitioners reported a greater extent and range of services provided to players from the PDP when compared to younger players (see Figures 5B). This was the case for provision of specific activities (i.e., one-to-one player support and cooking workshops etc) (see Figure 6), as well as on-site provision of main meals (see Figure 8) and sports supplements (see Table 5). Additionally, PDP players also receive more targeted education on topics such as fuelling for match play and training, recovery and sports supplements (see Figure 7). The enhanced level of service provided to PDP players is, of course, in accordance with the requirement to support players as they potentially transition to first team football. However, the lower prevalence of support provided to YDP players could be a targeted area for specific improvement, especially when considering that this is the time when academy players typically experience their most rapid period of growth and maturation. In accordance, Hannon et al., (2021b) observed progressive increases in TEE as players progress from the U12/13 age group (2859 ± 265 kcal·day^{-1}, range: 2275-3903 kcal·day^{-1}) to U15 (3029 ± 262 kcal·day^{-1}, range: 2738-3726 kcal·day^{-1}) and to U18 status (3586 ± 487 kcal·day^{-1}, range: 2542-5172 kcal·day^{-1}). Additionally, given that younger players may lead "busier" lives with schooling activities and lengthy travel to and from training, there is a clear need to provide specific education support on the requirement to fuel correctly before (during school), during and after training (i.e., when travelling home after training). In this regard, it is noteworthy that players from the YDP of Category One clubs are reported to receive more education on "growth and maturation" when compared to the other phases of player development, as evident both within and between categories. Such data may be underpinned by the increased prevalence of support provided by accredited staff (as alluded to previously), suggesting that qualified and specialist staff may be more aware of how to tailor the necessary education to different phases of development.

In relation to on-site food and fluid provision, practitioners from Category One clubs reported a higher prevalence of provision when compared to the remaining categories. Additionally, players within the PDP also receive a greater frequency of food provision across all mealtimes when compared to the YDP and FP. Although it must be acknowledged that the pattern of meal provision is, of course, likely influenced by training schedule (i.e., players from differing phases of development and category status likely train at different times of the day), the enhanced provision at Category One level is most likely related to the significantly greater budgets that are available to practitioners working within those environments (unfortunately, disclosure of annual nutrition budgets was not collected within this study). Indeed, this is supported by the observation that distinct differences in food provision are still apparent on match day, as evident for food provided before and after games. In such scenarios, the need to sufficiently educate key stakeholders (e.g., parents/caregivers) on practical food strategies at home, such as cooking, shopping and batch cooking skills, to promote both fuelling and recovery becomes readily apparent.

In a similar manner to food provision, practitioners reported a greater prevalence of supplement provision to players from the PDP, a finding that was evident across all categories. Across all categories, the four most common supplements provided included carbohydrate and protein-based products, electrolytes and vitamin D. Such data demonstrate a provision of "evidence-based supplements" in accordance with fundamental principles of nutrition such as fuelling, recovery and hydration. Interestingly, vitamin D was the fourth most prevalent supplement provided. Although this has sound rationale (i.e., given its role in bone development and the lack of sunlight exposure in the UK), data regarding the typical dose provided was not collected. As expected, more “specialist” and ergogenic related based supplements (i.e., caffeine, creatine, nitrate, beta-alanine etc) were apparently reserved for players from the PDP of Category One and Two clubs, perhaps a reflection of the knowledge base of the qualified and accredited staffing base working at this level as well as the actual stage of player development.

In accordance with the requirement to monitor growth and maturation status (Towlson et al., 2021), the most prevalent form of data collection that could be perceived as “nutrition related” was assessment of parameters for anthropometric profile. The most prevalent frequency of assessment was once every three months, a pattern that was largely similar across all categories and phases of player development (see Figure 9A). In contrast, practitioners reported that the assessment of body composition was most frequently performed to players from the PDP (see Figure 9B) whereas younger players were rarely assessed for body composition. Whilst the rational for this finding was not uncovered in this study, this could be in part due to the assessment of fat mass (i.e.,skinfolds assessment) amongst academy players has obvious ethical issues and potential safeguarding concerns. As practitioners working with youth athletes, we first and foremost have a duty of care to these young individuals and should ensure best safeguarding practice is adhered to when conducting such assessments (i.e., in the presence of a chaperone). Another reason for the reduced assessment of body composition amongst players in the YDP could be an indication that the data this method of monitoring provides may be deemed unnecessary by practitioners, given the priority of this population should be to increase lean mass rather than reduce fat mass (Hannon et al., 2020). Indeed, it could be suggested that a more frequent assessment of fat free mass (e.g., DEXA), rather than body fat (e.g., skinfolds) may permit the development of more individualised athletic development and nutrition programmes (Hannon et al., 2020), assuming that such data collection is positioned and communicated correctly to all stakeholders.

Although sufficient hydration before, during and after exercise is an essential component of performance nutrition (Maughan et al., 2010), practitioners reported limited objective assessment of hydration status (see Figure 9D). Whilst the decision to engage with such data collection may be based on staff resourcing and cost-benefit analysis, it could be suggested that a more frequent assessment of hydration status could assist with promoting optimal drinking behaviours. As expected, there was a low prevalence of assessment for clinical blood profiles, perhaps due to the ethical issues with blood collection in an adolescent population.

From a practical perspective, our data suggest that the employment of a full-time accredited nutritionist may help to promote long-term player development, as based on the premise that practitioners from Category One clubs reported a greater extent of service provision. These findings may also allow practitioners working in academy soccer to highlight areas in which their provision is currently lacking and thereby enhance their future delivery. Nonetheless, this study did not undertake any formal assessment of the efficacy of the current models of service provision in terms of stakeholder knowledge, as well as quality of the practical nutrition services that are being delivered to players. Indeed, as with all survey reports, our data is based on self-reported responses, with the potential for response bias where the respondents may attempt to 'look good' with their responses (Rosenman et al., 2011). As such, future research would benefit from detailed qualitative inquiry to better understand the individual and organisational factors (e.g. philosophy, staffing resources, logistical issues, budget constraints etc.) that likely determine the nature of the performance services described here. It is also important to acknowledge that the present data is only inclusive of English soccer clubs and hence the present data may not be comparable to soccer academies from other countries.

In summary, Study 1 (Chapter 3) provides the first report to audit the performance nutrition services currently provided to male adolescent soccer players within soccer academies from the English leagues. Importantly, data indicates distinct differences in the depth of service provision across categories, as evidenced by total hours of service delivery, one-to-one player support, stakeholder education programmes and provision of foods and supplements. Such findings are likely underpinned by the greater prevalence of employment of full-time professionally accredited staff within higher category academies as well as the higher budgets that are typically available within these environments. Additionally, although a more detailed service provision to players of the PDP was observed, data suggest that players from the YDP would likely benefit from greater support considering that this is the time when players typically undergo their most rapid phase of growth and maturation. Future studies are now required to evaluate the efficacy and effectiveness of the current level of service delivery across all category status as well as qualitatively explore the factors underpinning the current level of service delivery. Such research could also lead to the co-creation of "best-practice" service models and organisational, stakeholder specific behaviour change strategies that strive to create a positive nutrition environment that supports player development.

Chapter 4

Perspectives on the role of nutrition in influencing academy soccer player development and performance: A qualitative case study of key stakeholders from an English Category One soccer academy

Having audited the performance nutrition service provision in academies in English Soccer in Study 1 (Chapter 3), the aim of this chapter were to explore the perspectives of a range of key stakeholders on the role of nutrition in influencing the performance and development of male academy soccer players. In this way, this Chapter aimed to explore the current understanding of the impact of performance nutrition in male academy soccer.

This study was published in the Journal of Sports Sciences 2024

Carney, D.J., Hannon, M.P., Murphy, R.C., Close, G.L. & Morton, J.P. (2024). Perspectives on the role of nutrition in influencing academy soccer player development and performance: A qualitative case study of key stakeholders from an English Category One soccer academy. *Journal of Sports Sciences*, 42(1), 61–72.

4.1 Abstract

This study aimed to explore stakeholder perceptions of the role of nutrition in influencing the development of male academy soccer players. Semi-structured interviews (28 ± 13 mins in length) were conducted with 31 participants from an English Category One academy, including players (Youth Development Phase, YDP: n = 6; Professional Development Phase, PDP: n = 4), parents / guardians (n = 10), coaches (n = 3), sport scientists (n = 3), physiotherapists (n = 3), and catering (n = 2). Via reflexive thematic analysis, data demonstrate an apparent lack of understanding and awareness on the role of nutrition in influencing player development, especially in relation to growth, maturation and reducing injury risk. Players highlighted the influence of their parents on their dietary behaviours, whilst parents also called for education to better support their sons. Notably, players and stakeholders perceived that the daily schedule of an academy soccer player presents as 'too busy to eat', especially in relation to before school, and before and after training. The results demonstrate the necessity for the co-creation of stakeholder specific nutrition education programmes as an initial step towards positively impacting the nutrition culture associated with the academy soccer environment.

4.2 Introduction

The purpose of a soccer academy is to develop the technical, tactical, physical and psychosocial capabilities of young players (Wrigley et al., 2012). The ultimate aim is to produce players to represent their respective first-team squad and/or to potentially profit from their sale (Elferink-Gemser et al. 2012). In this way, academy players are exposed to a formalised and structured coaching programme where players progress through distinct development phases as they transition through the academy pathway. Within the English academy system, such phases are referred to as the foundation phase (FP: under 9-11 years old), youth development phase (YDP: under 12-16 years old) and professional development phase (PDP: under 17-23 years old). In relation to physical development, Hannon et al., 2021a reported (across three different soccer academies) that the overall training load progressively increases as academy players transition through the academy pathway. Moreover, players may experience similar absolute loading patterns (e.g. total weekly duration of activity and distance covered) as adult players from the English Premier League (EPL), albeit at a time when they are not yet biologically mature (Anderson et al., 2016; Brownlee et al., 2018; Hannon et al., 2020).

To support such high training volumes alongside the energetic cost of growth and maturation, it is becoming increasingly recognised that nutrition should be a key component of an academy player's developmental programme. Indeed, in using the gold standard doubly water method, recent literature has reported that individual players across the academy pathway (i.e., from U12 to U18) may present with an absolute total daily energy expenditure (i.e., 3000 – 5000 kcal·day^{-1}) that is comparable to (or exceeds) (Hannon et al. 2020; Stables et al., 2023) previous observations from adult players of the EPL (Anderson et al., 2017). In addition, Stables et al., (2023) also demonstrated that academy players (within the U13 age group) typically expend 750 kcal·d^{-1} more than age matched soccer players playing at "grassroots" standard.

Despite such high training volumes and energetic demands, however, it is often reported that academy players "under-fuel" (Hannon et al., 2021; Naughton et al., 2016), especially in relation to the acute period before, during and after training sessions (Stables et al., 2022). Although the negative outcomes associated with "under-fuelling" are often considered from a performance perspective, a more concerning outcome for adolescent athletes is the potential impact upon growth and maturation with a specific risk to skeletal structures. Indeed, players who consistently present with chronically low energy availability (LEA, often defined as <30 kcal·kg $FFM^{-1}\cdot day^{-1}$) (Loucks & Thuma, 2003) may experience negative symptoms associated with relative energy deficiency in sport (RED-S) syndrome (Mountjoy et al., 2018). Symptoms may present as reductions in skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks et al., 2011), all of which can be detrimental to long-term player development. In this regard, Hall et al., (2022) reported that the most prevalent injury occurring in academy players from England, Europe and South America was growth related injuries in the anatomical location of the knee, lower back, sacrum and pelvis, the prevalence of which was most evident during periods of peak height velocity.

The exact reasons underpinning the prevalence of sub-optimal dietary practices in male academy soccer players are not yet clear. Across a variety of sports, Bentley et al., (2021) investigated the 'barriers and enablers of elite athletes' adherence to nutritional guidance, reporting the importance of food planning skills and a good working relationship between the athlete and nutritionists, as well as motivational factors such as the desire to enhance performance and maintain an appearance appropriate for the athletic persona. However, much of the existing literature on male youth soccer nutrition has been conducted via quantitative methods that do not necessarily examine contextually rich accounts of the lived experiences of adolescents in high-performance settings. This approach may be remiss given sport participation is a biopsychosocial activity (Armour & Chambers, 2014), and moreover, psychological and social factors may additionally influence the dietary behaviours of youth soccer players. In a recent qualitative investigation, Carter et al., (2022) explored the perspectives of the barriers and enablers to nutritional adherence in professional male academy soccer players, by interviewing players (n = 13), nutritionists (n = 12) and coaches (n = 10) from 2, 12 and 10 professional clubs in the UK, respectively. The authors used the COM-B model to understand the barriers and enablers of soccer players' dietary behaviours, to facilitate the development of evidence-based behaviour change strategies via the Behaviour Change Wheel (Michie et al., 2011). In doing so, they reported that participants perceived that nutritional knowledge, cooking skills and training venue food provision were key 'barriers' and enablers to facilitating adherence to nutritional guidelines. This study demonstrates the value of exploring nutritional practices from the perspectives of those with lived experiences (i.e., of players themselves) and those who work alongside them in the training facilities (i.e., support staff). In this regard, a recent study in Netball (O'Donnell et al., 2023) conducted a qualitative case study to explore the perspectives on RED-S of athletes, coaches and medical professionals. This mode of research demonstrates that nutritional experiences are not solely individuated, but reciprocally influenced by interactions with others across social contexts (Overdorf & Silgailis, 2005).

There is a need for further transdisciplinary understanding of how male youth soccer players experience nutritional practices, whereby this type of research approach allows for the interaction of in-depth and reflective personal insights between participants' perspectives, hence providing a greater understanding of the social context. To the authors' knowledge, the role of nutrition in influencing the performance and development of male academy soccer players across both the YDP and PDP has yet to be explored from the perspective of multiple stakeholders. Although the perspectives of the barriers and enablers to nutritional adherence have previously been qualitatively explored in players of the PDP (Carter et al., 2022), there is a need to explore the perspectives of stakeholders in the YDP given that this is when players experience their most rapid phase of growth and maturation (Hannon et al., 2020), their significant energy demands (Hannon et al., 2021b), and the apparent lack of support provided to this phase, as reported in Study 1 (Chapter 3).

With this in mind, the aim of Study 2 (Chapter 4) was to qualitatively explore player, caregiver (parent/guardian/host-family), and club staff perspectives on the role of nutrition in influencing the performance and development of male academy soccer players from the YDP and PDP. It is hoped that the present data may inform the creation of stakeholder specific education and behaviour change interventions which improve the nutritional practices of the male academy player.

4.3 Methods

4.3.1 Research philosophy and positionality

A relativist ontology and constructivist epistemology, which assumes that reality is relative according to how each individual experiences it (Sparkes & Smith, 2014), comprised the philosophical underpinnings to this paper. This epistemological approach assumes that reality is subjective (Ormston et al., 2014), whilst recognising that prior experience and current social contexts may influence one's perceptions. It is therefore the researcher's role to support the participant's understanding of their subjective realities, and subsequently interpret and communicate these appropriately. This approach considers my role as the performance nutritionist working at the club, acknowledging that my identity within the social context may influence what I observe and therefore impact upon conclusions.

4.3.2 Sample

To gain detailed insights into the multiple perspectives of nutrition in academy soccer, players, caregivers (i.e., parents, guardians, host-families), and staff from a variety of roles from one English soccer academy of Category One status were purposefully invited to take part in this study. This approach is comparable to previous qualitative explorations of nutrition practices in professional sport (Martin et al., 2017; Logue et al., 2021; McHaffie et al., 2022; Carter et al., 2022) and allow for a broad understanding of the soccer context in question. A single case study soccer academy was studied to develop a detailed and nuanced view within the context of the club, allowing for the development of new insights (Lobo et al., 2017), of which some may be generalisable to other soccer academies. Participants invited to take part in the study were contacted through a gatekeeper at the club via an email containing a participant information sheet. All players (n = 10) recruited were aged above 12 years old and played in either the YDP (n = 6; 13.8 ± 1.2 years) or the PDP (n = 4; 17.5 ± 0.6 years). Parents or guardians (n = 10) also took part, all of whom currently live with a player from the YDP (n = 7) or PDP (n = 3). Staff members invited to the study all currently work full-time at the club in varying roles. These roles included coaches (n = 3), sport scientists (n = 3), physiotherapists (n = 3), and catering staff (n = 2). This sample allowed for an in depth understanding of nutrition in academy soccer. Ethical approval was granted by the Liverpool John Moores University Ethics Committee (22/SPS/028) and, as condition of this, further details of the participants are not provided to avoid direct identification. All participants provided verbal and written informed consent before completing the interview, including child assent and carer consent forms for those under the age of 18 years. Consistent with qualitative research (Sparkes & Smith, 2014), the sample size was not decided a priori, but determined by the analysis, with recruitment stopping for each participant group when any additional data did not contribute to the identification of any new themes.

4.3.3 Procedures

To address our aims, we undertook a qualitative investigation as a means to understand the experiences and perceptions of individuals within complex social environments (Sparkes and Smith 2014). The sampling, data collection, and data analysis procedures outlined below sought to provide a credible and transparent account of the understanding of the role of nutrition for the development and performance of male academy soccer players. Semi-structured interviews were undertaken with all participants. An 'open-ended' (Gall et al., 2003) format was adopted. Questions were presented in a conversational and informal manner, to allow for maximal voluntary contribution and detail (Lincoln and Guba, 1985). For example, initial questions began with phrases such as 'What are your thoughts on…?' and 'In your opinion…?'. Subsequent 'probing' (Gratton and Jones, 2004) via naturally occurring follow-up questions allowed for further depth in responses to be acquired (Turner, 2010). This format of enquiry allowed participants the liberty to express their experiences and opinions with minimal constraints and to self-navigate towards areas they felt significant (Braun and Clarke, 2013). The interview was centred on exploring the participants' perceptions on the role of nutrition in influencing the development (e.g., growth and maturation) of academy soccer players. The questions outlined in Table 6 were devised with the study aims and findings of previous literature in mind (Hannon et al., 2020; Carney et al., 2022; Carter et al. 2022; McHaffie et al. 2022). Pilot interviews were conducted with two academy players and four staff members from the same club to determine the viability of the interview questions. The wording of some questions was subsequently reviewed and adjusted following feedback from these pilot interviews. Pilot interviews were not included as part of the analysis.

All participants were invited to take part in the interview at the club's training facility. If they were unable to attend the training facilities at the club, participants were offered the option of taking part in the interview via online software (Microsoft Teams) with cameras on.

All interviews were recorded and subsequently transcribed verbatim. The interviewer was acquainted with the academy soccer subculture having worked as a performance nutritionist in the industry for the previous five years and within the current club for two years. This could be viewed conversely due to the potential for them to lead the interview based on their own personal views and experiences, however this was deemed advantageous due to his fluency in their jargon and informal terminology (Cook et al., 2014).

4.3.4 Data Analysis

All interviews were recorded and transcribed verbatim into a word document. A reflexive thematic analysis approach was adopted (Braun and Clarke, 2019), with a six-stage process of thematic analysis (Braun and Clarke, 2006) employed: (1) familiarisation and immersion of the data was achieved by repeated reading and listening of the data during the transcription process; (2) a systematic process of initial coding allowed for any relevant content to be identified; (3) initial codes were re-examined to identify patterns in the data and generate initial themes; (4) identified themes were reviewed for their appropriateness by the research team by comparing them to the raw data; (5) following agreement of the themes, they were refined, defined and named; and finally, (6) data extracts from each theme were used to provide a concise, coherent, logical, nonrepetitive, and interesting account of the story the data tell, both within and across themes (Braun and Clarke, 2006).

4.3.5 Methodological trustworthiness and rigor

Several procedures were undertaken to ensure scientific rigour. This included the recruitment of a varied sample and by piloting the interview questions. Members of the research group independent of the primary author also acted as a critical friend to provide critique of the data analysis. In doing so, the team sought to provide credible and transparent perceptions of the role of nutrition in the development and performance of academy soccer players. The data analysis process demonstrates high rigor as all authors engaged in open and challenging discussions and were collaborative and reflexive throughout (Smith and McGannon, 2017). The worthiness of this research topic was justified given the gap in evidence and practice in this population (Naughton et al., 2016; Hannon et al., 2021b; Stables et al., 2022). The research team also acknowledged the need to take steps towards detachment during key stages of the study (Elias, 1956), particularly given the lead authors role as the nutritionist at the club. To support this, the final author was not familiar with the club or involved in the interview process and acted as a 'critical friend' to independently review the interview schedules and transcripts (Smith & McGannon, 2017). However, we do acknowledge a degree of involvement given the lead authors role within the club and their personal interest in this topic. This was deemed advantageous due to their 'insider knowledge' of this topic and social context. The findings and discussion section that follows presents four themes and relevant quotations from the data, allowing readers to interpret the data in their own way and consider the transferability of findings to their own context (Smith, 2017).

Table 6. Player interview guide and aims (wording was adjusted for parents and stakeholders).

Questions	Prompts	Aim
Domain 1. Participant background and demographic.		
Can you tell me about your journey playing football so far?	How long played for, number of academies, time at current club.	Understand their background and experiences.
Domain 2. Perceived academy specific performance nutrition priorities and their impact on player development and performance.		
Thinking about since you started playing football, what and/or who has influenced your understanding of nutrition for football?	Personal interest, experience working with nutritionists, player feedback, other members of staff (e.g., coaches, physios, sport scientists), parents, friends.	Ascertain where their understanding of nutrition has come from.
What are your thoughts on the role of nutrition for your performance and development. Is it important, and if so to what extent and what are the potential benefits?	Energy availability/fuelling significant energy requirements, fuelling training and games, recovering from training and games, growth and maturation, body composition, hydration, injury prevention and rehabilitation.	Understand their perceptions of the importance and role of nutrition.
Of the potential benefits of nutrition you mentioned, do you think any are more of a priority for you as an academy footballer?	Why do you think this/these are the priorities? Does this differ for *the other phase* (YDP/PDP).	Understand what areas of nutrition they perceive to be most important and why.
Are you aware of any potential negative implications related to players not following the appropriate nutritional advice?	Energy availability, growth & maturation, injuries, Lack of energy.	Understand their level of knowledge.
Domain 3: Nutrition associated challenges for academy soccer players.		
Do you think any of the priorities previously mentioned are more of a challenge to academy players?	In what areas do you struggle to optimise your nutrition, time/schedule demands, why?	Understand what nutritional challenges they face and why.
Do you think you need support to overcome these challenges?	From who? Why? How?	Understand what support they believe they need.
From your experience, has there been anything you have seen to be helpful and why?	Work with previous nutritionists, education sessions, food and drink provision.	Understand what they perceive to be helpful.
Do you think the phase you currently play in (YDP/PDP) receives sufficient nutrition support?	Differences in food and drink provision, individualised support, group education.	Understand their perceived nutritional support requirements for their stage of development.

4.4 Findings and Discussion

Via a reflexive thematic analysis of the interviews (mean: 28 min; range 11 – 37 min), four themes were established, that present a narrative of the understanding of the role of nutrition on player development and performance in male academy soccer. These themes are presented below, and stakeholder quotes are presented verbatim to support the narrative.

4.4.1 Theme 1: Food for thought! Lack of understanding on the role of nutrition in supporting player development

When participants were initially asked about their understanding as to how nutrition may impact player development, a range of perceived benefits were identified that included fuelling, body composition, hydration, and 'health'. Despite such sentiments, however, data suggested that participants typically presented with a lack of understanding of how nutrition can benefit player development, let alone the relevance of nutrition for the academy player. In this regard, there was a view that players "just eat" with no purpose or development goal in mind.

> **PDP Player 4:** I don't know because I used to just eat…. because I used to get fed at school, eat whatever that was there….and then eat whatever was here…and then just have a little bit at home often. Never really with a priority in mind, I wouldn't even know what it should have been.

Consistent with this insight, support staff also suggested that players do not eat with a purpose in mind and are unaware of the impact of nutrition on their performance and development as an academy soccer player. This was especially evident in relation to "fuelling" the energy demands of training.

> **Sport Scientist 3:** I think there's a lack of awareness from the players of why we give them food, so like the amount of food I see thrown in bins, or they have one bite, it's almost like a luxury to them. But what they don't view food as is fuel, it's just food to them.

This sentiment was echoed by a coach working in the YDP:

> **Coach 3:** I think the priority at say U13s or U14's is just getting the boys to actually eat, we have boys who just do not understand the importance of fuelling their bodies.

Meanwhile, a physiotherapist working in the PDP suggests that physical opportunity is not a challenge for the players in this phase, whilst continuing the notion that the players lack awareness and require educational support:

> **Physiotherapist 1:** I think there's a bigger problem throughout academy football where they're not eating enough and fuelling for the demands of the sport. Are they aware of how much they need to take on? Fuelling shouldn't be a problem because they're given enough opportunity. The players are almost the biggest problems themselves rather than what food is potentially offered. I think it's then educational and them wanting to buy in to it and do it properly, that's the biggest hinderance.

The discussion of 'fuelling' and 'under-fuelling' continued to the potential impact upon growth and maturation, a crucial component in the physical development of an academy player as they transition between development phases of the academy pathway. Despite the documentation of increasing energy demands during this time, however, when probed on the impact of nutrition on growth and maturation participants did not readily consider the concept that a player's daily energy intake should increase as they get older. For instance, YDP Player 3 stated *'I'm not sure about that. No idea. I guess maybe'* and when asked about the differences between the YDP and PDP, Catering 1 said *'I think it's the same yeah, from any age. I think the only difference I presume, was the difference between male and female. I'd say the same nutritional priorities for the 13s or 14s as I would the U23s'.* This lack of awareness was also present in a coach working in the YDP:

> **Coach 1:** I wouldn't know to be honest. But taking a guess, I'd say if you've got a player going through growth and he's not eating correctly then that is going to have some sort of impact.

Whilst a member of the medical department made suggestions but remained unclear as to exactly how growth and maturation impacts the nutritional requirements of this population:

> **Physiotherapist 3:** Yes, but I wouldn't know to what extent….my gut would say that you probably need more fuel in that group. Just because obviously you're gonna have like higher metabolic rate with growth and maturation and the turnover of cells. But that's a guess and putting two and two together there and it might be five.

In those cases where participants did acknowledge that players may "need to eat more" as they get older, there was an apparent lack of understanding as to the "how" and "what" may need to change in terms of practical nutrition strategies.

YDP Parent 2: I'm pretty sure it would impact his nutritional requirements, but I wouldn't have a Scooby Doo* how or what I should be doing about it. (* colloquial term for 'clue').

YDP Parent 7: I mean, I guess they're growing more when they're younger right, so maybe they'd need more then to fuel that growth. But I wouldn't know what.

The negative consequences of presenting with chronically low energy availability has recently been discussed in the literature using the RED-S model (Mountjoy et al., 2018) and may include: reductions in skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks et al., 2011). However, despite the fact that male academy soccer players are vulnerable to injury during the growth spurt (Monasterio et al., 2021; Hall et al., 2022; Hill et al., 2022; Johnson et al., 2020), the potential causative link between sub-optimal energy intake and injury (especially bone related injuries) had not been considered by the participants in this study. This is especially important when considering that a recent randomised control trial demonstrated that sub-optimal carbohydrate intake before, during and after training (comparable to the habitual practices of academy players) increases markers of bone resorption when compared with consuming carbohydrate intake according to the recommended guidelines (Stables et al., 2023). When asked if there are any potential negative implications to not following the appropriate nutritional advice on bone health, YDP player 2 simply stated *'I have no clue',* with this lack of awareness extending to a parent as well:

YDP Parent 2: I hadn't contemplated whether any of his growth-related injuries could possibly be related to his diet…kind of got alarm bells going in my head now.

A coach who works in the YDP, a time in which players are vulnerable to growth related injuries, was also unaware of the impact of nutrition in this context:

> **Coach 3:** I don't really know if there's any correlation to like injuries or anything like that from a lack of nutrition or under fuelling as such.

As was a member of the sport science department:

> **Sport Scientist 3:** I don't know if I think under fuelling is directly linked to growth and maturation related injuries, because they're mainly bony injuries. I genuinely don't know.

Overall, Theme one demonstrates that players, caregivers and members of staff within this study lack the awareness and understanding of how nutrition can impact player health, development and performance. With this in mind, practitioners working in male academy soccer clubs should consider delivering education to promote awareness and understanding. Future research is warranted to establish the appropriate content and format of delivery for the dissemination of educational content within academy soccer environments.

4.4.2 Theme 2: Who told you that? The influence of caregivers, the internet and unaccredited members of staff

When talking about who and/or what has influenced their understanding of nutrition for soccer players, players highlighted the influence their caregivers have in this regard. For instance, a PDP player mentioned the influence his parents had on his views of nutrition from a young age:

PDP Player 3: I guess the very first thing you find out about nutrition is from your parents telling you to eat the right stuff. So, I guess my parents influenced me when I was younger but now as I'm older I would say nutritionists.

A player from the YDP also reported that their mum has an impact on his understanding of nutrition from a monitoring standpoint:

YDP Player 3: Probably my mum, yeah, she's very big on that side of things. And she's always like, looking out for like, for what I eat and stuff. Yeah. Whenever I eat something bad she's like, "you shouldn't be eating that".

These insights support previous findings in which parental eating habits have been shown to influence nutrient intake in young children (Oliveria et al., 1992). For example, the availability and accessibility of fruit and vegetables have been reported to be significant predictors of fruit and vegetable consumption in children with low preference to these foods (Cullen et al., 2003; Kratt et al., 2000). When the players are not at the club's training facilities, parents typically provide their children with the physical opportunity to emulate their dietary preferences, given that they are responsible for selecting the food choices of the family diet (Savage et al., 2007). This notion was present from the perspective of YDP Parent 7, who when asked about where they had acquired their understanding of nutrition for soccer players replied, *'I guess I'm relying on what I would eat or what I want to eat myself'*. This was also reported by YDP player 1 who stated *'My mum cooks everything for me. I'll occasionally cook but very occasionally, but my mum cooks everything for me'*.

Given the significant influence parents have on the players' diets, it would seem appropriate that parents were able to acquire the sufficient nutritional knowledge from accredited sources (i.e., club nutritionist) to be able to positively influence their child's diet. However, the findings from Study 1 (Chapter 3) indicate that academies in England will typically only have one nutritionist responsible for providing a service to the entire academy, with only 64% of Category One clubs employing a nutritionist on a full-time basis (Carney et al., 2022), as was the case in the present club. This inevitably has implications for the level of service provided and can lead to caregivers acquiring information from elsewhere. For instance, YDP Parent 7 commented on the use of the internet for seeking nutritional support when talking about what influenced their nutritional understanding, stating that *'Influences are mostly just like Googling'.* In addition to caregivers, the use of the internet (or 'googling') has previously been reported amongst adult athletes across a range of sports to obtain sources of information regarding nutrition (Vazquez-Espino et al., 2022; Devlin & Belski, 2015; Trakman et al., 2019). Given the wide range of informational sources of nutrition available on the internet and the likelihood for misleading, inaccurate and potentially harmful information, this source of information should inevitably be used with caution. However, the academy players studied here also reported the use of the internet and social media to acquire nutrition knowledge, with PDP Player 2 stating *'So sometimes if I want to find something out I'll just Google it or I'll watch a video on YouTube',* whilst PDP player 1 suggested that this would be a good way to *'educate yourself and understand what is good for you and what's not good for you'*.

The practice of utilising sources of information that are not informed by an accredited nutritionist was also reported by club staff when reflecting on their time at previous clubs. For instance, a physiotherapist suggested that unaccredited members of staff are often required to deliver nutrition support in the absence of a nutritionist:

> **Physiotherapist 1:** Sometimes in the clubs that there wouldn't be a designated nutritionist then you kind of, you pick up, you pick up on the knowledge from like the

S&C (strength & conditioning) coach, for example, or they take it upon themselves because there wasn't a nutritionist.

This experience was also reported by a coach:

Coach 3: Well, I think sports science staff play a big role in it. Like not every club has an assigned nutritionist, so often the sports scientist takes over that role. And they're the one that's providing sort of the workshops, the communication around nutrition, both to the players and to parents.

Such insights agree with data reported in Study 1 (Chapter 3), in which it was reported that sport scientists (as a more 'generalist' practitioner) are often utilised to deliver nutrition support in the absence of an accredited nutritionist. Indeed, only 64% of clubs in England (with Category One status) employed nutritionists on a full-time basis, whilst 34 clubs from categories 1-4 relied on members of the sport science and medicine department to deliver nutrition support (Carney et al., 2022). Although the club within this study does employ a nutritionist on a full-time basis, these insights should be taken into consideration given that some of the practitioners working at the club may have prior experiences of having to deliver unaccredited nutrition support to academy players and may at times be tempted to continue to do so in an informal manner.

Theme two therefore highlights the influence of caregivers, the internet and members of staff who lack the necessary accreditation to provide nutritional advice, whilst perhaps providing reasoning for the lack of understanding and awareness previously reported in Theme one. These sources have the potential to provide limited and inaccurate nutritional information, whilst previous research has demonstrated the potential harm of disseminating erroneous nutritional advice (Cockburn et al., 2014). Nutrition education programmes should therefore consider delivering to all key stakeholders, with the aim of facilitating positive influences on the dietary behaviours of male academy soccer players.

4.4.3 Theme 3: Too busy to eat! The busy lives of academy players and the impact on their dietary behaviours

There was a general consensus amongst all participants that the biggest nutritional challenge for academy players, notably players in the YDP, is the intensity of their daily schedules such that they are 'too busy to eat'. When Physiotherapist 1 was asked about their perspective on the challenges male academy soccer players may face, they stated *'The YDP, who've got school and stuff, but then coming here, it's long days for them, do they even have time to think about food?'.* This was also expressed by a player currently in the YDP:

> **YDP Player 2:** One of the hardest things about being an academy footballer when it comes to diet is like the long days you have, or like you sometimes forget to eat. I forget sometimes to eat at school. So sometimes I don't eat from half seven in the morning until eight o'clock at night. I just… I just don't think of it unless I'm starving. When you're doing stuff you're not that hungry.

Another player in this phase reported the challenge of time in the context of pre-training:

> **YDP Player 3:** We arrive here from school and have to get changed and start training in half an hour and sometimes I'm starving because we haven't eaten since lunch at school.

When reflecting on their time in the YDP at this club, a current PDP player also highlighted this sentiment:

> **PDP Player 4:** Most days I was waking up at seven and getting back home at like eight. You don't really have time to think about food to be honest and there wasn't always time to eat.

A coach currently working with players in the YDP further suggests that not only is it a problem for players having the time to think about food, but also difficulties within their daily schedule in finding appropriate and sufficient time for the players to consume food:

> **Coach 3:** It is quite a big period of the day when we are expected to provide the food rather than the parents. So, I think some of the difficulties with that is there's so much going on in the day that you have to find time and enough time for them to eat.

The concept of 'too busy to eat' is especially relevant in relation to fuelling *before* and *after* training, a time when we have previously reported that players throughout the academy pathway report sub-optimal nutritional practices and specifically, that of carbohydrate intake (Stables et al., 2022). The reasons underpinning sub-optimal dietary practices at these specific times are likely due, in part, to the timing between school ending and the start of training. In this way, players may resort to consuming 'food on the go' where the travel schedule now presents as a 'habitual mealtime'. When reflecting on their time in the YDP, this concept was also suggested by a PDP player to be the case in the context of post-training too:

> **PDP Player 4:** I used to be starving on the way home, so where I used to change trams I'd go to Sainsburys there, I was still hungry when I left training as sometimes there wasn't enough time for me to grab food or eat as much as I'd have liked.

As an extension of the discussion regarding the perceived challenges of the demanding schedule of an academy soccer player in the YDP, all participants also commented that breakfast was a particularly hard meal to consume due to a perceived lack of time before the start of the school day:

> **YDP Player 3:** So I don't eat breakfast because I don't have a lot of time. Maybe I wake up at half seven and I've got to leave by quarter past eight so that's forty-five minutes. I've got to have a shower, get ready. It's busy, it's just non-stop. Sometimes people forget about food.

This notion was supported by a current PDP player when discussing the challenges they faced whilst being in the YDP:

> **PDP Player 1:** When I was in the YDP, some days I'll be in such a rush in the morning to get to school, I won't have breakfast.

When parents were asked to provide insights from their perspective on this apparent lack of time in the morning, YDP Parent 5 stated *'He (their son) doesn't seem to eat before he leaves in the morning…he always says he needs more time in the morning',* whilst another parent agreed with the players that time is a challenge when it comes to preparing and providing breakfast before school and in doing so suggests it is there responsibility:

YDP Parent 1: He leaves the house very early in the morning. So, it's like I have just such a short window for him to eat something so early that he doesn't really…. is not really hungry yet or something. So that's a little bit of a problem for us always because we want him to have a healthy breakfast like that. But it's more like a rush in the morning, you know.

These findings suggest that parents and players do not understand the importance of consuming breakfast and are unaware of time efficient breakfast options. This is consistent with previous data reported within elite male youth soccer players (Naughton et al., 2016), in which the researchers reported a skewed daily distribution of macronutrient intakes, with both absolute and relative energy intake at breakfast being significantly lower than at lunch and dinner. More specifically, a lower protein intake at breakfast was reported in the YDP when compared to the PDP, with protein intake at breakfast being derived from the addition of milk to a predominantly carbohydrate-based option (e.g., cereal, bread), a behaviour which is common in children of these ages in the general population (Alexy et al., 2010).

Overall, Theme three highlights the demands of an academy soccer player's typical day and the potential time constraints and their impact on players' dietary behaviours. The proclaims from players and parents that a lack of sufficient time in the morning to consume breakfast suggests that perhaps they 1) do not understand the importance of taking in nutrients at this time of day and 2) are unaware of practical, time-efficient solutions that are sufficient for the energy requirements of an academy soccer player. This would indicate the need for the provision of education to both parents and players to support them with this challenge.

4.4.4 Theme 4: Considerations for stakeholder specific support

In reviewing the findings from themes one, two and three, there appears to be an obvious requirement to educate not only players, but also caregivers and club staff, who in turn, can collectively impact the nutritional behaviours of academy players. Indeed, all stakeholder groups called for targeted education programmes that were bespoke to each stakeholder, and also customised to the requirements and challenges of the academy player. In this regard, key stakeholders advocated for more player education at a younger age, with Coach 3 stating *'I think the earlier that we can sort of educate the players around the importance of nutrition the better',* whilst Physiotherapist 3 suggested *'They need education in those formative years'.* A parent of a player in the YDP also proclaimed the need for players to receive educational support to promote understanding, whilst suggesting that this may provide a source of motivation to implement better dietary behaviours:

> **YDP Parent 5:** I'd also say a bit of education for him really, so he understands the importance of it and why he needs to do it. I guess that might encourage him a bit more.

The call for the delivery of educational support during the players' 'formative' years has been previously reported (Carter et al., 2022), though it is noteworthy that data form Study 1 (Chapter 3) indicate that academies in England often prioritise the delivery of performance nutrition services to players in the PDP (Carney et al., 2022). The reduced level of support provided to players of the YDP is a particular cause for concern, considering that this is the phase when players typically undergo their most rapid phase of biological growth and maturation (Hannon et al., 2020). The players themselves also appeared to recognise the increasing 'service provision' as they got older.

PDP Player 2: I'd say the difference from the PDP to the YDP is, I think it's just more talked about, like pushed on to you, if that makes sense? Like you've got more people telling you how important it is. When you're in the youth phase you don't think it's as important as it actually is.

Other players from the PDP also provided insights on their previous perceptions of nutrition when they were younger, suggesting that they were not aware of the importance of nutrition and the impact it may have on their performance:

PDP Player 3: Me, being in that phase (YDP) I would never have thought, right, I'll eat healthy and it'll be good. When you first start out you're kind of ignorant to it.

PDP Player 4: When I was younger I used to eat dead bad because like, you never used to think it affected you that much. It's bad to say but when I first started U18's that was when I started to take it more seriously.

Given the lack of support during a player's time in the YDP previously reported in Study 1 (Chapter 3), the need to provide educational support to caregivers becomes especially evident, particularly as YDP Parent 1 states *'I think it's a very important part of the parent of a footballer to make sure that this is right, because giving the right or wrong food could have an impact on his performance at the end of the day here'.* Another parent of the YDP reiterates this view whilst advocating the need for educational support:

YDP Parent 6: Education for the parents, not just the child, because adults do the cooking at home. I know they want them to be independent and stuff, but I've got two children. It's me that does the cooking so it's me that needs to be educated as well. So I think parents need to be educated, the child, yes, for the future, but the parent as well for the now.

The influence of caregivers on the players' diets was previously reported in Theme two, and as an extension of this concept, providing educational support to the caregivers may in turn translate to improving the dietary behaviours of the players. For instance, Physiotherapist 3 states *'They like the foods their parents do and they give them and they form their habits like that'.* A member of staff who coaches players in the YDP concurs with the need for parental support, whilst providing insights from a different perspective in suggesting that positioning the nutrition support as a means to enhance growth may serve as a means of motivation:

Coach 1: I think you need to educate parents on this, how can you maximise growth through nutrition. If you can get that into them from a young age the buy-in would go through the roof. Everyone's obsessed with it.

In addition to caregivers, the requirement to educate the support staff who may ultimately present as a 'club gatekeeper' towards nutrition is also readily apparent. In this regard, Physiotherapist 2 suggested that '*You've almost got to try and influence the system to help the lads'*. Given the presence of multiple stakeholders in 'the system', it would seem appropriate that they too were aware of the nutritional requirements of the players:

Physiotherapist 2: I think a lot of it has been learning on the job, but we don't…. our teaching isn't as good for physios, we don't get taught about paediatric stuff very well at all. It's probably covered in like one or two weeks too, in terms of like anatomical and physiological development and stuff. I think we're limited there and then we're even more limited on our educational nutrition. So a lot of it has been like learning on the job.

As well as club staff admittedly possessing limited knowledge of nutrition, the players themselves also suggested that club staff may benefit from educational support too:

PDP Player 2: I’m sure the catering team already have a basic understanding of what we need, but I guess a bit more nutrition education for them wouldn’t hurt too.

In relation to the content of educational support, participants suggested that the support needs to promote a general understanding of the role of nutrition for player development (i.e. theoretical knowledge) but also provide practical insights as to ‘what to eat, when’ and also adopt an ‘individualised’ approach.

YDP Parent 5: Maybe some different ideas for certain foods you know where I’d probably say oh eat cereal or toast or something. Maybe you might say actually he might enjoy this or something that other boys eat? Just maybe some ideas.

PDP Player 3: I just think from what I experienced if it was maybe a more individualised programme for me I think I would have wanted to do it more because I would have thought right well that's specific to what I need to do rather than just like general advice that everybody gets.

Theme four highlights the need for stakeholder nutrition education, that is specific to their roles and responsibilities in influencing the dietary behaviours of academy soccer players. Although participants made suggestions for the content of such educational support, further research is warranted to design and develop an academy soccer nutrition education program that provides stakeholder specific support, with the aim of increasing awareness and providing practical solutions to positively influence the dietary behaviours of academy soccer players.

4.5 Summary of Findings and Future Research Directions

In conducting a qualitative exploration of player, caregiver and club staff understanding of the role of nutrition for player development, several connected themes emerged that have clear implications for practice. In this regard, there is a readily apparent need for targeted stakeholder education to initially equip such individuals with a sufficient knowledge base. It is noteworthy, however, that education alone is unlikely to change nutrition behaviours (Spronk et al., 2014; Alaunyte et al., 2015), and hence stakeholder specific behaviour change interventions should also be developed to positively affect players' nutritional behaviours given that food choices are multifaceted, situational, and complex (Sobal and Bisogni, 2009). For instance, factors influencing food choice have previously been categorised in to 1) Food-related features: intrinsic features (i.e., colour and aroma), extrinsic features (i.e., information and packaging) (Eertmans et al., 2001; Wang et al., 2019); 2) Individual differences: biological (e.g., hunger, appetite, taste), physical (e.g., access, cooking skills, time), psychological (e.g., mood and stress), cognitive (e.g., attitudes, preferences, knowledge), and social (e.g., family and friends) (Bellisle, 2003; Rozin, 2006), or 3) society-related features: culture and economic variables (e.g., price and income) (Rayner and Lang, 2015). Future research is warranted to identify the specific nutritional related behaviours that are likely to have the most beneficial impact, before establishing the appropriate content and format of delivery for the dissemination of subsequent educational content within academy soccer environments. Given the benefits of co-creation approaches to develop education curricula (Bovill et al., 2009; Jensen & Bennett, 2016;

Murphy et al., 2017), it is suggested that a similar approach be considered here. Indeed, this approach has previously been used to create nutritional change within the horseracing industry (Martin, 2019) at athlete, stakeholder, and organisational level. Given the present limitation of sampling one club only, it is also suggested that a co-creation approach to education design should involve multiple soccer academies with varying category status. Such a co-ordinated approach that involves multiple clubs, stakeholders and the relevant governing bodies is likely to lead to the greatest change and impact. The use of a case study design may be a potential limitation as findings may only reflect the culture and procedures at one club as well as those who were willing to participate. Future research is warranted to develop a better understanding of the prevalence of such findings within other academy settings. Nevertheless, the present study allows readers to reflect on the case under study and assess if the findings bear familiar resemblances to the readers' experiences, setting they move in, events they have observed or heard about, and people they have talked to (Smith, 2017), prior to forming 'naturalistic generalisations' (Stake, 2005).

4.6 Conclusions

The present study used a qualitative case study methodology to explore player and stakeholder perspectives on the role of nutrition in supporting the development of academy soccer players. Data demonstrate that participants across all stakeholder groups display a limited knowledge as to how nutrition can impact player development, especially in relation to promoting growth and maturation. Additionally, participants did not readily appreciate that the negative aspects of under-fuelling extend to increased injury risk. Players also report that parents have a strong influence on their dietary choices and behaviours, some of which have been formed from an early age. Parents, in turn, report that they are not equipped with the necessary theoretical or practical skills (i.e., awareness of which foods to cook) to provide the relevant meals for their sons. Notwithstanding an apparent lack of knowledge and stakeholder influences (that also extend to club support staff), it is noteworthy that the ‘busy lives’ of an academy player (as due to schooling and training schedules) is perceived as a challenge to enable the execution of behaviours that are conducive to optimal nutritional intake. When considered together, it is clear that educating all stakeholders should now be a strategic goal for practitioners, clubs and governing bodies as an initial step towards improving the dietary behaviours of academy boys. This would of course need to take into consideration key contextual information such as category status, facilities, staffing and finances, all of which will have implications for the content of educational support required for each club.

Chapter 5

A mixed methods approach to exploring the dietary behaviours of male academy soccer players and the underlying barriers and enablers informed by the COM-B model

Having audited the current landscape of performance nutrition service provision (Study 1, Chapter 3) and explored stakeholder perspectives on the role of nutrition in influencing male academy soccer player development and performance (Study 2, Chapter 4), this chapter aimed to quantify the energy and macronutrient intake and distribution across meals and explore the barriers and enablers to positive dietary behaviours in male academy soccer players in the YDP.

5.1 Abstract

Purpose: To quantify the energy and macronutrient intake and distribution across meals in male academy soccer players in the YDP and explore the barriers and enablers to their dietary behaviours.

Methods: Fourteen (n = 14) male soccer players from the U13 and U14 age-groups of a Category One English soccer academy volunteered to take part in this study. The remote food photography method (RFPM) was employed to assess energy and macronutrient intake over a 3-day in-season period, including two training days and one rest day, followed by a physical activity and dietary recall on the fourth day, which also included a structured interview to explore the players' perspectives on factors influencing their dietary behaviours over the three days. The COM-B model was utilised to determine the barriers and enablers to dietary behaviours at each mealtime, from the perspective of the players, with their responses categorised into a component of the COM-B model and deemed a barrier or enabler to positive behaviour. In total, 191 meals were analysed to generate a frequency analysis of COM-B components for each mealtime.

Results: Mean total energy intake on the first training day (2476 ± 416 kcal·d^{-1}), rest day (2168 ± 465 kcal·d^{-1}), and the second training day (2440 ± 619 kcal·d^{-1}) were lower than energy expenditures previously reported in this population (Hannon et al., 2020; Stables et al., 2023). Physical opportunity (food availability/options and time) and automatic motivation (food desirability and hunger) transpired as the most frequently cited influencing components on dietary behaviours by the players. It is noteworthy that across all mealtimes psychological and physical capability rarely emerged as an enabler to the players' dietary behaviours.

Conclusion: Clubs should aim to provide their academy players with sufficient physical opportunity to optimally fuel for and refuel/recover from training, that includes desirable options for the players, should they have the resources to do so. Practitioners aiming to develop behaviour change interventions should firstly aim to understand the behaviour they want to change and consider the varying barriers and enablers at each of the different mealtimes.

5.2 Introduction

The nutritional requirements of male academy soccer players have been well documented, with data highlighting their training load (Hannon et al., 2021a), increases in RMR and FFM (Hannon et al., 2020) and the subsequent energy demands (Hannon et al., 2021b; Stables et al., 2023) as players progress though the academy pathway. Indeed, significant increases in total daily energy expenditure (750 kcal·d^{-1}) between U12 and U18 players (Hannon et al. 2021b) has been observed, with some players energy expenditure comparable to or exceeding that previously reported from adult EPL players (Anderson et al., 2017). Despite the high training demands and energy requirements of this group, "under-fuelling" is frequently observed (Hannon et al., 2021b; Naughton et al., 2016), with research also reporting inadequate dietary practices during key periods before, during, and after training sessions (Stables et al., 2022). This is of particular concern for adolescent athletes, as insufficient energy intake can impact growth and development, especially skeletal health, as athletes with consistently low energy availability (LEA, typically defined as <30 kcal/kg FFM/day) (Loucks & Thuma, 2003) are at risk of experiencing symptoms of relative energy deficiency in sport (RED-S) (Mountjoy et al., 2018), which can hinder performance and development. This concern is exacerbated by the lack of accredited nutritionists providing support to these players and the reduced level of service provision for the YDP, as reported in Study 1 (Chapter 3) (Carney et al., 2022).

Whilst the energy and macronutrient intake and distribution of this population have previously been reported, there remains limited research exploring the influential factors underpinning the dietary behaviours of male academy soccer players. As reported in Study 2 (Chapter 4), it was apparent that; stakeholders (players, parents, coaches, catering staff, sport scientists and physiotherapists) lack understanding of the role of nutrition, players acquire nutritional information from unaccredited or misinformed sources, and the busy lives of male academy soccer players due to scheduling demands, all influence the dietary behaviours of this population (Carney et al., 2024). Taken together, it is evident that stakeholder specific support is required to better support the dietary practices of male academy soccer players, however, it is crucial to understand their specific behaviours before this can occur.

In this regard, the COM-B model (Michie et al., 2011) has previously been employed in other sporting contexts (Costello et al., 2018; Bentley et al., 2019; Carter et al., 2022; Carter et al., 2024) to facilitate the understanding of dietary behaviours of athletes and develop behaviour change interventions. The COM-B model is a meta-theory that shifts the focus from placing blame on individuals to emphasising shared responsibility for behaviour change, unlike earlier behaviour change theories such as Social Cognitive Theory and the Health Belief Model, which primarily target the individual. COM-B is considered the most suitable model for evaluating the key factors influencing an athlete's behaviour, as it is argued that other models fail to adequately account for the complexities and variations in human behaviour (Coulson et al., 2012). It is suggested by Michie et al., (2014) that the first step to designing a behaviour change intervention is to ‘understand the behaviour’. This model considers the psychological (i.e., knowledge) and physical (i.e., skills) capability, physical (what the environment allows or facilitates in terms of time, triggers, resources, locations, physical barriers, etc.) and social (including interpersonal influences, social cues and cultural norms) opportunity, and reflective (beliefs about what is ‘good’ or ‘bad’) and automatic (wants, needs, desires and impulses) motivation, in the context of a given behaviour. This model will be employed in this study as a framework to facilitate the understanding of the dietary behaviours of male academy soccer players. If additional detail is needed to understand the behaviour, the Theoretical Domains Framework (TDF) can be applied to expand on the COM-B components. This framework includes 14 domains, derived from 128 theoretical constructs across 33 behaviour change theories (Cane et al., 2012).

Currently, only two studies have investigated the underlying reasons for the dietary behaviours of male professional soccer players. Ono et al., (2012) utilised a mixed methods approach to establish the nutritional intake of players and explore the nutrition culture in professional soccer via a sociological theory (Bourdieu, 2001), highlighting 'tradition within the world of professional football' influencing the players' approach to nutrition. More recently, Carter et al., (2022) explored the barriers and enablers to nutritional adherence from the perspectives of players (n = 13), nutritionists (n = 12) and coaches (n = 10) from 2, 12 and 10 professional clubs in the UK, respectively. In doing so, the researchers reported seven key factors influencing players' nutritional adherence; nutritional knowledge, cooking skills, food availability at training venues, accessibility and approachability of nutritionists, living arrangements, performance impact, and role modelling, aligning with challenges previously observed in other sport populations (Bentley et al., 2021; Heaney et al., 2008; Birkenhead and Slater, 2015; Shepherd, 2005). Despite this, research has yet to establish the barriers and enablers to male academy soccer players dietary behaviours by capturing their dietary practices and subsequently investigating the reasons and influencing factors behind such behaviours. Given that this thesis has previously reported in Study 1 (Chapter 3) that players in the YDP (i.e., U12-U16) receive less support than players from the PDP (i.e., U18- U21) and that peak rates of growth and maturation occur during this phase, the lack of provision to these age-groups is especially concerning and there is a clear need to better understand the dietary behaviours of players during this period of development.

With this in mind, the aims of the present study were two-fold: 1) quantify the energy and macronutrient intake and distribution across meals, and 2) utilise the COM-B model as a framework to explore the barriers and enablers to the dietary behaviours of male academy soccer players in the YDP.

5.3 Methods

5.3.1 Participants

Fourteen (*n* = 14) male soccer players from the U13 and U14 age-groups of a Category one (i.e., top tier) English soccer academy volunteered to take part in this study. Participants were recruited from these age-groups given the apparent lack of support delivered to players of the YDP as reported in Study 1 (Chapter 3) (Carney et al., 2022) and that peak rates of growth and maturation typically occur during this phase (Hannon et al., 2020). All experimental procedures and associated risks were explained to both the players and their parents/guardians. Written informed parental/guardian consent and player assent were obtained for all participants. Ethical approval was granted by the Liverpool John Mores University Ethics Committee, UK (REC approval number: 23/SPS/042).

5.3.2 Study Design

In a cross-sectional design, we assessed energy and macronutrient intake over a 3-day in-season period, including two training days and one rest day, followed by a physical activity and dietary recall on the fourth day, which also included a structured interview to explore the players' perspectives on factors influencing their dietary behaviours over the three days. During this time, all players continued with their usual education and training schedules. An example daily schedule is displayed in Table 7. A mixed-methods approach was employed as this was deemed necessary to comprehensively answer the research question and has been employed previously in similar research in this area (Ono et al., 2012).

Table 7. Example daily schedule of an academy soccer player on a training day.

Time	Activity
06:00	Wake-up; shower; brush teeth; breakfast
07:15	Get on the school bus
08:40	Arrive at school
09:00	Form time
09:20	Lesson 1
10:20	Lesson 2
11:10	Lunch
11:30	Lesson 3
12:20	Lesson 4
13:10	Bus to the Training Ground
13:30	Arrive at the Training Ground
13:45	Pre-Training Snack
14:00	Gym
14:45	Pitch Session
16:30	Analysis
17:00	Post-Training Meal
18:30	Leave the training ground; picked-up by parent
19:15	Arrive Home; do homework
19:45	Dinner
20:15	Relax
21:30	Evening Snack
22:30	Brush teeth; bedtime

5.3.3 Quantification of energy and macronutrient intake

Self-reported energy and macronutrient intakes were assessed over a 3-day period via the remote food photography method (RFPM), which has been previously validated in adolescent team sport athletes (Costello et al., 2017) and previously used in this population (Hannon et al., 2021b; Stables et al., 2022; Stables et al., 2023).

Before data collection, all participants and parents/guardians were invited to a workshop in which the study methodology was outlined. They were initially informed on the rationale for collecting energy and macronutrient intake data and how these analyses can be used to positively impact player performance and development. Participants were shown a video detailing 'step by step' how to use the RFPM and instructed on additional details to include (i.e., branding, weights and cooking methods), as well as common problems (i.e., difficulty to identify food items or a loss of phone signal) when collecting this data and how to rectify them (i.e., provide ingredients and individual weights or record the time of consumption which could be sent as soon as possible once signal had returned). The workshop was pre-recorded and sent to each parent/guardian accompanied with a written step-by-step guide should they need to refer back to it throughout data collection.

Participants were instructed to take two images of any food or drink consumed using their smart phone; one at 45 degrees and one at 90 degrees, allowing for a better estimation of portion size than one image alone, and send both images to the principal investigator. Participants were instructed to include a detailed description of each eating occasion encompassing all ingredients (where possible), branding, weights, cooking methods and pre-existing nutritional information from food labels. Post-consumption, participants were required to send a final image detailing any food or drink remaining. All images were sent via Threema (Threema GmbH, Pfäffikon, Switzerland). In those instances where food was consumed on-site, the principal investigator was also present at the host club training ground to assist with data collection on behalf of the participant (i.e., self-record images and weights at mealtimes) and make written records of energy and macronutrient intakes, specifically for food and drink provided by the club. The principal investigator was also present at all meals consumed at school to avoid the participants using their phone whilst at school.

At the end of the three days, each player completed a dietary recall to highlight any missed data and cross reference data collected by the principal investigator (Capling et al. 2017). During this process, the principal investigator clarified all timings, quantities and brandings provided by the participant and prompted the participant to recall any missed items. Energy and macronutrient intake was analysed by a Sport and Exercise Nutrition register (SENr) accredited nutritionist using dietary analysis software Nutritics (Nutritics, v5, Dublin, Ireland). Energy, carbohydrate, protein and fat intake were quantified as kilocalories and grams, respectively, in both absolute and relative (to each player's body mass) terms. To ensure reliability of energy and macronutrient intake data, a second SENr nutritionist also analysed a sample of food diaries chosen at random (n = 7, equating to 21 days of entries in total). Energy and macronutrient intake analysed by the two researchers was compared for systematic bias via an independent t-test. No significant difference was observed between researchers for energy (p = 0.93), CHO (p = 0.74), protein (p = 0.82) and fat (p = 0.71) intake. Intra-rater reliability was assessed by the lead researcher performing the dietary analysis two weeks later. Intra-class correlation coefficients (IDD) were used to assess the test–retest reliability of repeated energy and macronutrient content derived from the RFPM and 24-hour recall. Coefficients of variation (CV%; typical error expressed as a percentage of the subject's mean score) and LoA (mean bias ± 1.96 standard deviation: SD) were calculated and provided that no significant differences existed. Variables were deemed to have acceptable reliability if both CV% was ≤10% and ICC was ≥0.8 (Aben et al., 2020). Acceptable re-test reliability was observed for all variables.

Time of consumption was used to distinguish between meals and aligned to previous research in this population (Naughton et al., 2016); breakfast (main meal consumed between waking and 09:00) lunch (main meal consumed between 11:00-13:30), pre-training (food and beverages consumed between 13:30-14:00), post-training (consumed in the 1hr period post-training) dinner (main meal consumed between 17:00-20:00) and evening snacks (consumed after 20:00).

5.3.4 Physical Activity and Dietary Behaviours Interview

All participants took part in a structured interview the day after completing the RFPM. The purpose of this interview was to record the daily physical activity of participants, as well as to better understand the dietary behaviours observed during the previous 3 days. Participants were asked to describe what activities they were doing across all 3 days and what time they were doing them, as well as the location and any travel involved. Participants were then shown pictures of the data collected from the 3-day RFPM and asked to provide reasoning for their dietary behaviours and who prepared the food/drink or influenced their behaviour.

5.3.5 Data Analysis

All dietary analysis data were initially assessed for normality using the Shapiro-Wilk test. To determine differences in absolute and relative energy and macronutrients intake between days and also meals, data were also assessed using a one-way between groups analysis of variance (ANOVA). Where significant effects were present, LSD post-hoc analysis was conducted to locate specific differences (level of significance set at $P < 0.05$). Ninety-five percent confidence intervals for the difference are also presented. All statistical analyses were completed using SPSS (version 26; SPSS, Chicago, IL) where $P < 0.05$ is indicative of statistical significance. All data are presented as mean ± SD. Energy intake was reported as kilocalories in both absolute and relative terms, and macronutrient intake was reported in grams for both absolute and relative terms.

All interviews were recorded so that responses could be cross-checked with members of the research team. Data were subsequently analysed using the COM-B model as a framework for analysis, with participant responses attributed to each component of the COM-B model, whilst also determining whether the response was deemed an enabler or barrier to recommended nutritional strategies. To further understand the behaviour, the TDF was applied to expand on the COM-B components. To achieve this, for each player at each mealtime we identified; 1) what did they eat/drink, 2) where did this occur, 3) who was involved in/influenced the provision, and 4) reason for dietary choice. This was performed on a meal-by-meal basis given the varying contexts and influential factors at each meal.

Data are presented as a proportion (%) of the frequency of responses per meal over the 3 days that were attributable to each component of the COM-B and whether it was deemed a barrier or enabler.

5.4 Results

5.4.1 Self-reported energy and macronutrient intake

There was no significant effect of day of the week on both absolute and relative energy, carbohydrate and protein intake, as well as relative fat intake, however there was a significant effect on absolute fat intake ($p < 0.05$), with a significant difference between Wednesday (70.6 ± 24.4 g.day^{-1}) and Thursday (95.0 ± 28.6 g.day^{-1}). The 95% confidence intervals of the mean difference were 4.1 to 44.8 g.day^{-1} (see Figure 10).

5.4.2 Self-reported relative energy and macronutrient distribution across meals on training days

There was a significant effect of mealtime on reported relative energy and macronutrient intake on training days ($p < 0.01$ for all variables; see Figure 11). Specifically, when compared to the evening snack (2.8 ± 3.5 kcal·kg^{-1}), greater relative energy was consumed at breakfast (8.2 ± 4.5 kcal·kg^{-1}, 95% CI: 1.3 to 9.5, P < 0.01), lunch (13.5 ± 3.0 kcal·kg^{-1}, 95% CI: 6.2 to 15.3, P < 0.001), post-training (12.7 ± 3.1 kcal·kg^{-1}, 95% CI: 6.3 to 13.6, P < 0.001) and dinner (10.2 ± 5.6 kcal·kg^{-1}, 95% CI: 0.6 to 14.2, P = 0.03). There was also a greater relative energy intake at lunch and post-training than at pre-training (5.4 ± 2.3 kcal·kg^{-1}, 95% CI: 5.3 to 11.0, P <

0.001; 95% CI: 3.4 to 11.3, $P < 0.001$, respectively) (see Figure 3a). Relative carbohydrate intake was lower at the evening snack (0.4 ± 0.6 g·kg^{-1}) than at breakfast (1.3 ± 0.7 g·kg^{-1}, 95% CI: 0.1 to 1.7, $P = 0.03$), lunch (1.3 ± 0.4 g·kg^{-1}, 95% CI: 0.2 to 1.6, $P < 001$) and post-training (1.5 ± 0.4 g·kg^{-1}, 95% CI: 0.5 to 1.7, $P < 0.001$), yet greater at lunch and post-training than at

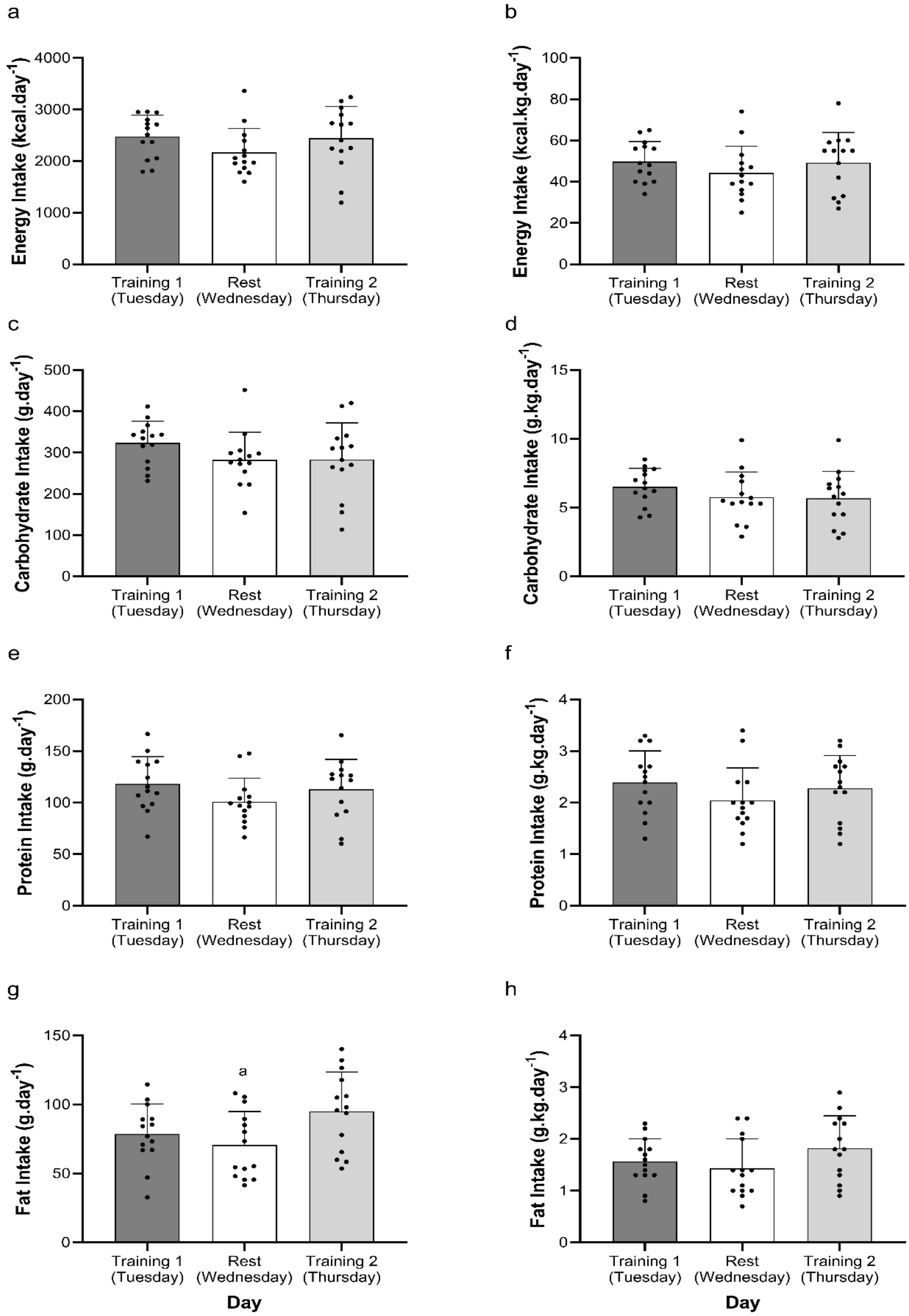

Figure 10. Overview of the mean daily absolute energy (a), carbohydrate (c), protein (e) and fat (g) intake, and their relative values (b), (d), (f) and (g) respectively on training days (grey bars) and a rest day (white bar). [a] Denotes significant difference from Training day 2 ($P < 0.05$).

pre-training (0.8 ± 0.4 g·kg^{-1}, 95% CI: 0.1 to 0.9, $P < 0.01$; 95% CI: 0.1 to 0.2, $P = 0.01$, respectively) (see Figure 11c). Relative protein intake was lower at the evening snack (0.1 g·kg^{-1}) than at breakfast (0.3 ± 0.2, 95% CI: 0.1 to 0.4, $P < 0.01$), lunch (0.6 ± 0.2 g·kg^{-1}, 95% CI: 0.2 to 0.7, $P < 0.001$), post-training (0.8 ± 0.2 g·kg^{-1}, 95% CI: 0.5 to 1, $P < 0.001$) and dinner (0.5 ± 0.3 g·kg^{-1}, 95% CI: 0.07 to 0.08, $P < 0.001$). Relative protein intake at post-training was also greater than at breakfast (95% CI: 0.2 to 0.8, $P < 0.001$), lunch (0.0 to 0.5, $P = 0.02$) and pre-training (0.2 ± 0.1 g·kg^{-1}, 95% CI: 0.4 to 0.9, $P < 0.001$), whilst pre-training was less than lunch (95% CI: 0.1 to 0.5, $P < 0.001$) and dinner (95% CI: 0.2 to 0.6, $P < 0.05$) (see Figure 11e). Relative to body mass, fat intake at the evening snack (0.1 ± 0.1 g·kg^{-1}) was lower than at breakfast (0.2 ± 0.2 g·kg^{-1}, 95% CI: 0.0 to 0.2, $P < 0.05$), lunch (0.6 ± 0.1 g·kg^{-1}, 95% CI: 0.3 to 0.6, $P < 0.001$), post-training (0.5 ± 0.2 g·kg^{-1}, 95% CI: 0.2 to 0.6, $P < 0.001$) and dinner (0.4 ± 0.2 g·kg^{-1}, 95% CI: 0.1 to 0.6, $P = 0.01$), and greater at lunch than breakfast (95% CI: 0.1 to 0.6, $P = 0.001$) (see Figure 11g).

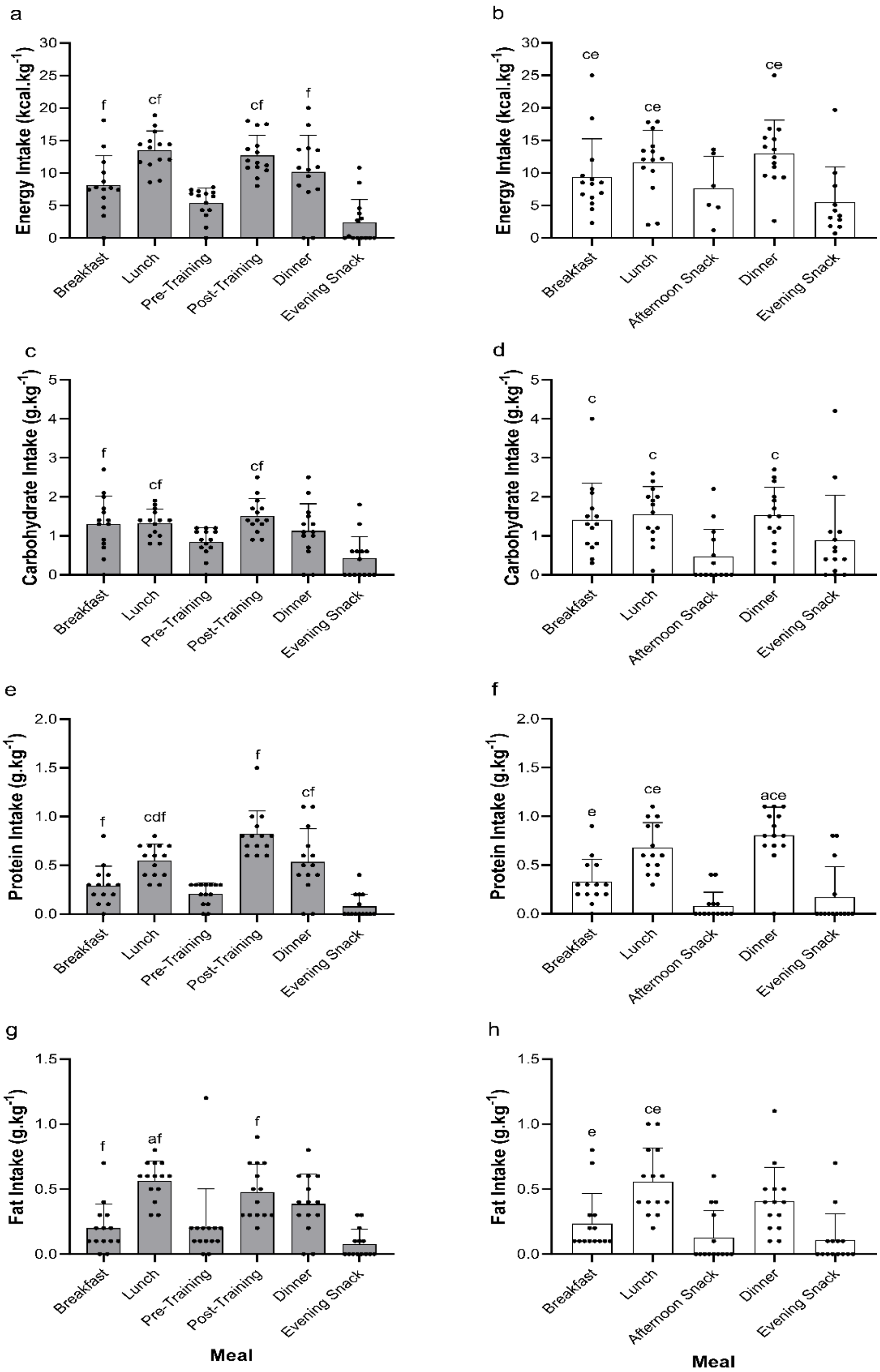

Figure 11. The distribution of mean relative (a) energy, (c) carbohydrate, (e) protein and (g) fat intake on training days (grey bars) and rest day (white bars) (b,d,f,h) respectively. Mean values are represented by solid bars, black circles represent each player's mean intake. On training days, a denotes significant difference from Breakfast, c denotes significant difference from Pre-Training, and d denotes significant difference from Post-Training (all P < 0.05). On the rest day, a denotes significant difference from Breakfast, c denotes significant difference from Afternoon Snack, and e denotes significant difference from Evening Snack (all P < 0.05).

5.4.3 Self-reported relative energy and macronutrient distribution across meals on a rest day

There was a significant effect of mealtime on reported relative energy and macronutrient intake on the rest day (p < 0.01 for all variables; see Figure 11). Specifically, relative energy intake was significantly greater at breakfast (9.4 ± 5.9 kcal·kg^{-1}), lunch (11.6 ± 4.9 kcal·kg^{-1}) and dinner (13.0 ± 5.1 kcal·kg^{-1}), when compared to the afternoon snack (3.3 ± 5.0 kcal·kg^{-1}, 95% CI: 0.9 to 11.3, P = 0.02; 95% CI: 2.9 to 13.9, P < 0.01; 95% CI: 3.3 to 16.2, P < 0.01, respectively) and the evening snack (4.3 ± 5.3 kcal·kg^{-1}, 95% CI: 1.0 to 9.1, P = 0.01; 95% CI: 0.4 to 14.2, P = 0.04; 95% CI: 1.7 to 15.7, P = 0.01, respectively) (see Figure 11b). Relative carbohydrate intake was significantly greater at breakfast (1.4 ± 0.9 g·kg^{-1}), lunch (1.6 ± 0.7 g·kg^{-1}) and dinner (1.5 ± 0.7 g·kg^{-1}) than the afternoon snack (0.5 ± 0.7 g.kg^{-1}, 95% CI: 0.0 to 1.9, P < 0.05; 95% CI: 0.3 to 1.9, P < 0.01; 95% CI: 0.2 to 2.0, P < 0.05, respectively) (see Figure 11d). Relative protein intake was significantly greater at dinner (0.8 ± 0.3 g·kg^{-1}) than at breakfast (0.3 ± 0.2 g·kg^{-1}, 95% CI: 0.2 to 0.8, P < 0.01), afternoon snack (0.1 ± 0.1 g·kg^{-1}, 95% CI: 0.5 to 1.0, P < 0.001) and evening snack (0.2 ± 0.3 g·kg^{-1}, 95% CI: 0.2 to 1.1, P < 0.01). Relative protein intake was also significantly greater at lunch than at the afternoon snack (95% CI: 0.3 to 0.9, P < 0.001) and evening snack (95% CI: 0.1 to 0.9, P < 0.01), and significantly greater at breakfast compared to the afternoon snack (95% CI: 0.0 to 0.5, P = 0.02) (see Figure 11f). Relative fat intake was significantly greater at breakfast (0.2 ± 0.2 g·kg^{-1}) and lunch (0.6 ± 0.2 g·kg^{-1}) than at the evening snack (0.1 ± 0.2 g·kg^{-1}, 95% CI: 0.0 to 0.2, P < 0.02; 95% CI: 0.1 to 0.8, P < 0.01, respectively), whilst relative fat intake was also significantly greater at lunch compared to the afternoon snack (0.1 ± 0.2 g·kg^{-1}, 95% CI: 0.1 to 0.8, P = 0.01) (see Figure 11h).

5.4.4 COM-B Analysis of each mealtime

The COM-B analysis of each mealtime from the perspective of the players is displayed in Tables 8-14. In total, 191 meals were analysed, with the subsequent frequency analysis of COM-B components for each mealtime displayed in Figure 12.

Table 8. COM-B analysis of Breakfast. Table shows data for how many meals analysed were at each location (n =), as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Home (n = 36)	Capability	Psychological	Knowledge	Barrier 2%	**Player 9: "**I just eat cereal because it give me everything I need in the morning".
Home (n = 36)	Capability	Psychological	Knowledge	Enabler 19%	**Player 13:** "I have that every morning really, just to make sure I've got some energy in me for the day ahead".
Home (n = 36)	Opportunity	Social	Social Influences	Enabler 43%	**Player 2:** "I normally just eat whatever my digs parents make for me to be honest"
Home (n = 36)	Opportunity	Physical	Environmental Context	Barrier 48%	**Player 12:** "In the morning it's just such a rush, like, I've got to shower, get ready…sometimes I wake up late then there's no time to eat or I grab something quick"
Home (n = 36)	Opportunity	Physical	Environmental Context	Enabler 10%	**Player 3:** "I wake up pretty early in the morning and they (parents) prepare it for me whilst I'm getting ready, so time isn't really an issue".
Home (n = 36)	Motivation	Reflective	Beliefs about consequences	Barrier 17%	**Player 6:** "I don't eat breakfast at home because I know I will grab something when I get to school and if I eat both it might make me fat, maybe".
Home (n = 36)	Motivation	Reflective	Beliefs about consequences	Enabler 5%	**Player 3:** "They (parents) choose it for my benefit. They wanted to give me the energy to train and at school".
Home (n = 36)	Motivation	Automatic	Emotion	Barrier 12%	**Player 11:** "I don't ever feel like eating breakfast. I'm never hungry in the morning".
Home (n = 36)	Motivation	Automatic	Emotion	Enabler 2%	**Player 5:** "I always have that for breakfast, whether I'm in digs or at home. I really like it".
School (n = 2)	Opportunity	Physical	Environmental Context	Barrier 79%	**Player 4:** "I don't eat then as the bus gets me to school too late for that".
School (n = 2)	Opportunity	Physical	Environmental Resources	Barrier 24%	**Player 14:** "I'd prefer to have something like toast or a bagel with maybe egg or beans, but they don't do that".
School (n = 2)	Opportunity	Physical	Environmental Resources	Enabler 5%	**Player 8:** "Well because you know it's there and made available to us I just go in a grab something. If it wasn't there I probably wouldn't eat otherwise".
School (n = 2)	Motivation	Automatic	Emotion	Barrier 21%	**Player 1:** "I'm not really a fan of what they have available, so I don't really bother with that".
School (n = 2)	Motivation	Automatic	Emotion	Enabler 5%	**Player 7:** "I really like the pain au chocolat and stuff like that".

Table 9. COM-B analysis of Lunch. Table shows data for how many meals analysed were at each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
School (n = 41)	Capability	Psychological	Knowledge	Enabler 10%	**Player 9:** "Well, we have training around 3 hours later, so, you know, I guess it's important to start fuelling for that training session at lunch really, isn't it?"
	Opportunity	Physical	Environmental Context	Barrier 67%	**Player 2:** "The queue was massive and I didn't have time to wait for it". **Player 11:** "We don't get much time to eat lunch at all. You have to try and eat it so quickly or if you're at the back of the queue by the time you sit down you have to eat as much as you can before the next lesson starts".
			Environmental Resources	Barrier 19%	**Player 5:** "I have to, it is my only option".
				Enabler 19%	**Player 10:** "On this day there was options, so it made it easier for me to pick something I like".
	Motivation	Reflective	Beliefs about consequences	Enabler 14%	**Player 3:** "We have to eat it because it gives you energy."

Table 10. COM-B analysis of pre-training. Table shows data for how many meals analysed were at each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Training Ground (n = 24)	Capability	Psychological	Knowledge	Barrier 13%	**Player 1:** "I just thought that because I have had lunch 2 hours ago that would be plenty of carbs to give me energy for training".
				Enabler 25%	**Player 2:** "To get my body fuelled up before training, just as a little snack"
	Opportunity	Social	Social Influences	Enabler 58%	**Player 9:** "To be fair, on that day I wasn't particularly hungry but when you see everyone else having something and the coaches encouraging you to take it, I just thought okay then I'll have something". **Player 7:** "The sport scientist always has them available for us when we arrive from school".
		Physical	Environmental Resources	Barrier 13%	**Player 11:** "Sometimes they're the same options every day and you can get fed up of them".
				Enabler 50%	**Player 4:** "Because it's provided for us, so it makes it easy to get something in you before training".
	Motivation	Reflective	Beliefs about consequences	Barrier 21%	**Player 14:** "I didn't have anything then because I wanted to feel light and not full when I went out to train".
		Automatic	Emotion	Enabler 88%	**Player 13:** "I love them chocolate milkshakes. I always try to get one of them".

Table 11. COM-B analysis of post-training. Table shows data for how many meals analysed were at each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Training Ground (n = 26)	Capability	Psychological	Knowledge	Enabler 18%	**Player 6:** "I knew as well that we'd just had a big training session and been in the gym, so, I was thinking I needed to get some energy back in me after that".
	Opportunity	Social	Social Influences	Enabler 14%	**Player 11:** "We all go up to eat after we've finished. Sometimes I'm not even hungry but you just go up and eat because that's just what we do".
		Physical	Environmental Resources	Barrier 8%	**Player 3:** "There wasn't any options, just a chicken and cheese pasta bake I think it was. So that make's it difficult sometimes when you've got nothing to choose between".
				Enabler 86%	**Player 4:** "Because it's the only thing I can have and I was hungry". **Player 1:** "There is always food available for us to have after training so I always use that opportunity to eat".
	Motivation	Reflective	Beliefs about consequences	Barrier 18%	**Player 13:** "Well I knew I was going to eat when I go home so I thought I don't really need to eat anything then, do I?".
		Automatic	Emotion	Barrier 18%	**Player 14:** "I didn't have anything because I didn't like what was there". **Player 2:** "I know I should have eaten then to recover my muscles and replace my energy, but I just wanted to go home rather than stay to eat".
				Enabler 54%	**Player 7:** "Because I was just very, very hungry on that day. It was after training and I had lost a lot of calories".

Table 12. COM-B analysis of afternoon snack (rest day). Table shows data for how many meals analysed were each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Travelling (n = 6)	Opportunity	Social	Social Influences	Enabler 33%	**Player 2:** "My digs parents just offered it me and I was a bit hungry, so I said yeah".
		Physical	Environmental Resources	Barrier 66%	**Player 11:** "I don't have any food or snacks with me to have anything at this time when I'm travelling home from school". **Player 14:** "If there's nothing for me to grab when I get in from school then I would just wait for dinner".
				Enabler 33%	**Player 8:** "It just depends if there's any food in the car for me to have, but normally there is".
	Motivation	Automatic	Emotion	Barrier 50%	**Player 1:** "I just didn't want anything then, I wasn't hungry". **Player 7:** "I wasn't too hungry after school. I normally just wait until the evening for dinner".
				Enabler 50%	**Player 5:** "I got that from *supermarket* with my dad. Yeah, it's because I was hungry and I prefer sushi than the sandwich".

Table 13. COM-B analysis of dinner. Table shows data for how many meals analysed were at each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Home (n = 36)	Opportunity	Social	Social Influences	Enabler 64%	**Player 14:** "My mum and my parents, yeah, because she makes it. Most of the time she just says, this is what you're having, and I just eat it".
		Physical	Environmental Context	Barrier 10%	**Player 13:** "It took us so long to get home, so there wasn't enough time for dinner then so I just had a little snack".
			Environmental Resources	Enabler 64%	**Player 2:** "That was what my mum had made for me so it was the only option really". **Player 7:** "It really depends on what my options are, but normally there's always something that I will have".
	Motivation	Reflective	Beliefs about consequences	Barrier 14%	**Player 12:** "I didn't have anything to eat because I ate the meal after training and I don't think I need to again otherwise it might make me heavy".
		Automatic	Emotion	Enabler 36%	**Player 5:** "Well, my house parents had cooked it for me. And to be fair, I was hungry as well". **Player 6:** "I was starving and I really like that meal. I'm always so hungry when I get home at the end of the day".

Table 14. COM-B analysis of evening snack. Table shows data for how many meals analysed were at each location, as well as sample quotations that were attributed to each component of the COM-B model and TDF construct. The frequency (%) of responses that were deemed a barrier or enabler for each component are also displayed.

Location	COM-B	COM-B Construct	TDF Construct	Frequency of Barrier or Enabler	Sample Quotations
Home n = 21	Opportunity	Physical	Environmental Resources	Barrier 12%	**Player 14:** "It just depends what's in really. We didn't have much in that I fancied that day so I didn't bother".
				Enabler 7%	**Player 12:** "I was really hungry and that was just what I could find in the kitchen so I thought I'd just have that".
	Motivation	Automatic	Emotion	Barrier 50%	**Player 7:** "I wasn't hungry at that time". **Player 10:** "I just didn't really want anything, so I didn't have anything to eat".
				Enabler 50%	**Player 3:** "I was very hungry and I do like cornflakes". **Player 7:** "I always get hungry before going to bed, so I have some cereal just because that's what I like".

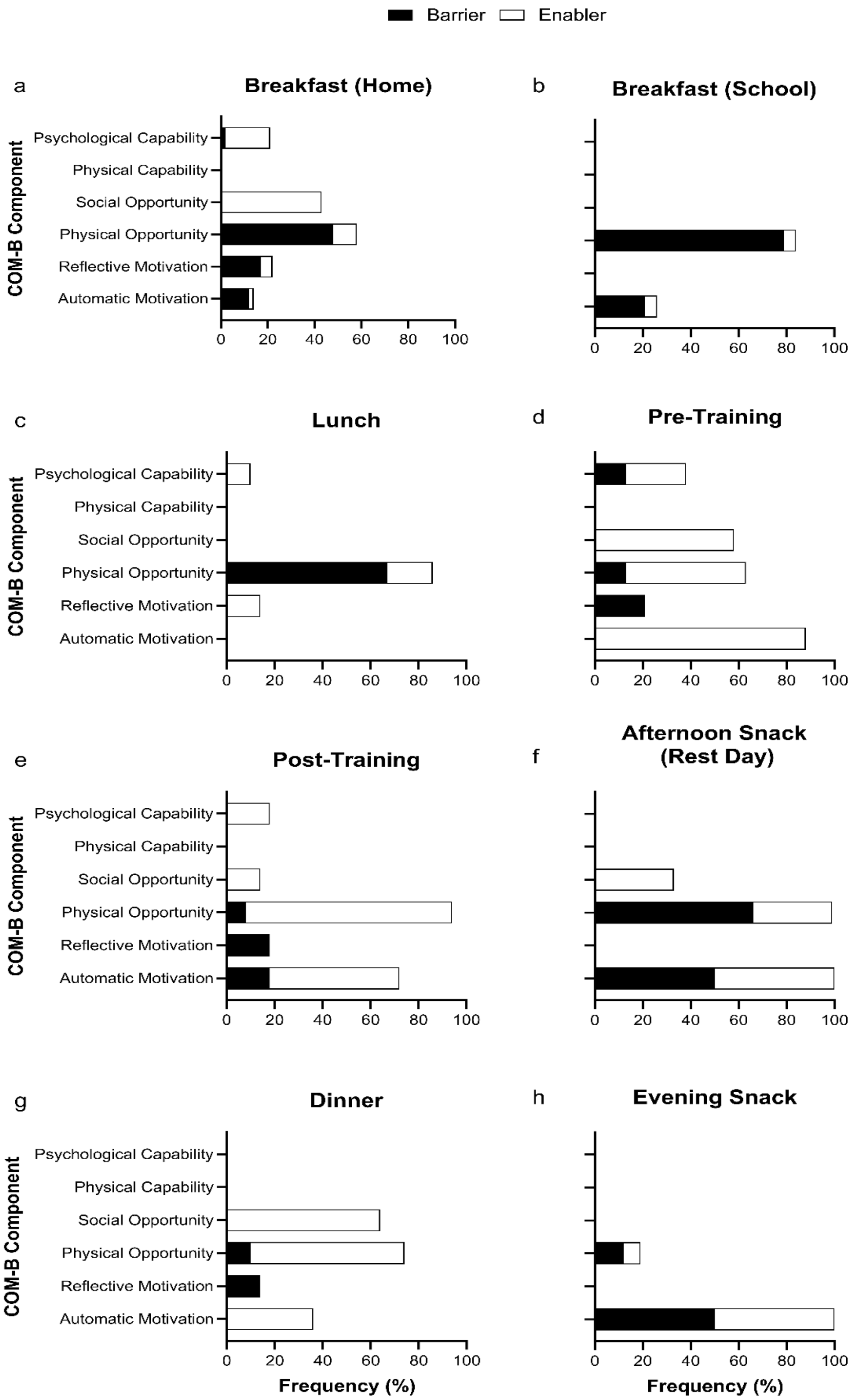

Figure 12. Frequency analysis of each component of COM-B at each mealtime from the perspective of players.

5.5 Discussion

The purpose of the present study was to develop an understanding of the dietary behaviours of academy soccer players. A mixed methods approach was employed to do so, by using the RFPM to quantify energy and macronutrient intake and distribution, whilst the players' dietary behaviours were further explored through structured interviews and subsequent analysis of all 191 meals via the COM-B model.

To address our aims, we recruited players from the U13 and U14 age-groups of a Category One academy. When considering total energy intake, on the first training day (2476 ± 416 $kcal \cdot d^{-1}$), rest day (2168 ± 465 $kcal \cdot d^{-1}$), and the second training day (2440 ± 619 $kcal \cdot d^{-1}$), we observed mean absolute energy intakes comparable to data previously reported in these age-groups (2178 ± 319 $kcal \cdot d^{-1}$) at another Category One academy (Stables et al., 2023). Although the present study did not assess the total energy expenditure of participants, research has previously assessed mean total energy expenditure over a 14-day period using the gold-standard DLW method in two separate Category One academies, reporting an average total energy expenditure of 2859 ± 265 $kcal \cdot d^{-1}$; range 2275-3903 in a group of U12/U13 players (Hannon et al., 2021b) and 3380 ± 517 $kcal \cdot d^{-1}$; range, 2811 – 4013 in a group of U13 players (Stables et al., 2023). Notwithstanding the error associated with dietary assessment (Stables et al. 2021) and difficulties when comparing methodologies between studies, data suggest that players in the present study are potentially 'under-fuelling' by consuming fewer total calories per day than their total energy expenditure. Moreover, our data indicate that only seven players reported an average daily CHO intake > 6 $g \cdot kg^{-1}$ per day, an intake that is recommended to support the typical volume of exercise that is completed by these players (Collins et al. 2021).

The exact reasons underpinning the reported sub-optimal dietary practices of male academy soccer players in the YDP have yet to be explored. When exploring the barriers and enablers to nutritional adherence in professional academy players (those playing in the PDP), players, coaches and nutritionists highlighted the importance of players possessing sufficient nutritional knowledge to achieve behaviour change (Carter et al., 2022), with further evidence highlighting the need for improving the nutritional knowledge of male professional soccer players (Andrews and Itsiopoulos 2015; Devlin et al., 2017). Study 2 (Chapter 4) also qualitatively reported the lack of knowledge and understanding of how nutrition can impact the development and performance of academy soccer players across a range of stakeholders (players, parents, coaches, sport scientists, physiotherapists, and catering staff) from the YDP and PDP (Carney et al., 2024). Accordingly, Study 1 (Chapter 3) reported that practitioners working in clubs deliver educational workshops to players, staff, parents and host-families, covering topics such as the basics of macro and micronutrients, fuelling for training and games, eating for growth, hydration and nutrition for recovery (Carney et al., 2022). However, there remains conflicting evidence on the association between nutrition knowledge and dietary practices of athletes across a range of sports, with evidence to suggest a positive association (Andrews and Itsiopoulos 2015; Jenner et al., 2018), whilst others have reported a weak or no association between these variables (Argolo et al., 2018; Devlin et al., 2017; Murphy and O'Reilly 2020).

When considering this in terms of the COM-B model, nutritional knowledge is attributable to the psychological capability component. Data in the present study would suggest that this component is often not considered by players in the YDP as an enabler to their dietary behaviours when compared to other components of the COM-B model (see Figure 4). It is therefore important to consider other components of the COM-B model when developing dietary behaviour change interventions. Indeed, to develop a behaviour change intervention one must first understand the behaviour (Michie et al., 2014). To do this, for each player at each mealtime we identified; 1) what did they eat/drink, 2) where did this occur, 3) who was involved in/influenced the provision, and 4) reason for dietary choice. This was performed on a meal-by-meal basis given the varying contexts and influential factors at each meal.

Regarding breakfast, data indicates that players consume less relative energy, protein and fat intake at breakfast than at lunch and dinner. These findings concur with previously reported data in this population, in which players consumed significantly less absolute and relative energy and protein intake at breakfast when compared to lunch and dinner time (Naughton et al., 2016). Moreover, in reviewing the breakfast trends of children and adolescents, Alexy et al., (2010) reported that 62% of all breakfast meals include bread and 21% were ready-to-eat cereal meals. Data from the COM-B analysis of our dietary assessment indicates that physical opportunity, more specifically ‘time’, is a commonly cited barrier to dietary behaviours during this mealtime, with 48% of players suggesting ‘time’ as a barrier during breakfast at home, and 79% during breakfast at school. This notion was also qualitatively reported in Study 2 (Chapter 4) by players and parents of male academy soccer players (Carney et al., 2024), with one parent stating that *“He (their son) doesn’t seem to eat before he leaves in the morning . . . he always says he needs more time”.* Interestingly, we also report that on 43% of occasions at breakfast time, players suggested social opportunity in the form of parental influence to be an enabler to their dietary behaviours. The influence of parents on the dietary behaviours of male academy soccer players has previously been highlighted in Study 2 (Chapter 4) (Carney et al., 2024) and in another Category 1 male soccer academy (Carter et al., 2022) with suggestions that they require educational support. Taken together, our data would suggest that in order to increase the total energy and protein intake of male academy soccer players at breakfast, parents should be educated on time efficient solutions that are appropriate at this mealtime, as well as player and parent education on the potential performance and developmental benefits that recommended nutritional strategies can foster at this mealtime.

Many academies in England operate on a ‘full-time model’, which often involves a large number of their players attending the same school, which has implications for the scheduling demands and balance between education and training. Inevitably, this often results in players in the YDP being subjected to demanding schedules (see Table 7) which can have an impact on their dietary behaviours. For instance, despite lunch being the mealtime with the highest average relative energy intake, on 67% of occasions players continued to report ‘time’ as a barrier to their dietary behaviours, with one player suggesting on one occasion he did not eat lunch because he “did not have time to wait for it”. Indeed, this notion was previously reported in Study 2 (Chapter 4), with a coach working in a Category One academy stating that *“It is quite a big period of the day when we are expected to provide the food rather than the parents. So, I think some of the difficulties with that is there’s so much going on in the day that you have to find time and enough time for them to eat”* (Carney et al., 2024). It is worth acknowledging however, that this proclaimed barrier may in part be due to a lack of understanding on the need to eat at this time and/or a lack of motivation to do so. Physical opportunity also posed as a barrier (19%) and enabler (19%) at lunch time in the form of ‘food availability/options’, as players indicated that sometimes their dietary behaviours were the product of their choice being the only option available, whilst on other occasions there were options, with one player stating it *“made it easier for me to pick something I like”*.

Physical opportunity in the form of ‘food availability/options’ continued to transpire as a prominent influencing factor on the player’s dietary behaviours during the pre-training period. In contrast to lunch, this was proclaimed to be an enabler (50%), with one player suggesting

“Because it’s provided for us, so it makes it easy to get something in you before training”. Moreover, players also reported on 58% of occasions that the presence of members of staff as they arrive at the training ground positively influences their dietary behaviours via social opportunity, a finding we have previously reported in this population earlier in this thesis (Carney et al., 2024). Notably, on 88% of occasions players reported automatic motivation to be an enabler to their dietary behaviours at this time, as they were driven by their desire for the food/drink available to them. The positive influence of desirable food provision at the training ground has also been reported as an enabler in professional academy players (Carter et al., 2022). Collectively, these influencing factors resulted in players consuming an average relative carbohydrate intake of 0.8 ± 0.4 g.kg^{-1} in the 30 minutes prior to training, which alongside the relative carbohydrate intake at lunch (1.3 ± 0.4 g.kg^{-1}), which was consumed 3 hours before training, is in-line with the recommended intake 1-3 g.kg^{-1} in the 3-4 hours prior to soccer-specific activity (Collins et al., 2021). The influence of physical opportunity and automatic motivation continued to be the case in the post-training meal, with players reporting food availability/options to be an enabler to their dietary behaviours on 88% of occasions, whilst the desirability of the food available was again reported to be an enabler on 54% of occasions. Although our group have previously reported sub-optimal dietary practices in the acute period pre- and post-training (Stables et al., 2022), the authors did not ascertain the potential reasons underpinning the prevalence of under-fuelling. Findings from the present study would suggest that clubs should aim to provide their players with sufficient physical opportunity to optimally fuel for and refuel/recover from training, that includes availability of food and drink items that are desirable for the players, should they have the resources to do so. Considering it was reported in Study 1 (Chapter 3) that 74% of Category One academies either never or only sometimes (<75% of occasions) provide their YDP players with evening food provision after training (Carney et al., 2022), it would seem appropriate that clubs reconsider their training

ground food provision for this phase, or if unable to do so, provide appropriate educational support to the relevant stakeholders that includes practical solutions.

Once the players have left the training ground, their dietary behaviours are typically influenced by their caregivers (Carter et al., 2022; Carney et al., 2024). This was apparent in the present study with players highlighting the role of their caregiver as an enabler in influencing their dietary behaviours via social opportunity on 64% of occasions at this mealtime (Evening meal). Likewise, physical opportunity transpired as an enabler on 64% of occasions at this mealtime with players suggesting that the availability and options of food made available to them by their caregivers positively influenced their dietary behaviours. Given the influence of caregivers at this time, it would be beneficial for clubs to provide educational support to this stakeholder group on the potential benefits of optimal dietary practices at this time, whilst providing practical solutions that consider the context of this mealtime. The players themselves may also require educational input here, given that on 14% of occasions reflective motivation emerged as a barrier, with one player believing that they *"didn't have anything to eat (at this time) because I ate the meal after training and I don't think I need to (eat) again otherwise it might make me heavy"*. This statement would suggest that the player is unaware of their energy demands and subsequent nutritional requirements to optimise recovery from the current day and to fuel appropriately for the following day. Motivation continued to be key in influencing dietary behaviours during the evening snack time, with players suggesting on 50% of occasions that their hunger, or lack of (automatic motivation) was both a barrier and enabler to their dietary behaviours at this time.

When considering the different layers of the COM-B model, the findings in the present study have explored the 'sources of behaviour' and indicate that the varying enablers and barriers at each of the different mealtimes and their given contexts, should be considered by practitioners when aiming to develop behaviour change interventions. Indeed, there is an evident need for future research to develop stakeholder specific dietary behaviour change interventions for male academy soccer players in the YDP, potentially considering the use of the COM-B model and expanding on the present findings, by considering the appropriate intervention functions to positively influence dietary behaviours. In utilising the COM-B model to evaluate stakeholder perceptions of the nutrition culture with elite female soccer, personal beliefs about the effects of carbohydrates on body composition and body image (i.e., reflective motivation), along with external pressures from social media and coaches' emphasis on body composition assessments (i.e., social opportunity), were all recognised as contributing factors to a culture of under-fuelling (McHaffie et al., 2022). At present, there is currently only one study to have considered this approach with male academy soccer players (Carter et al., 2024), albeit with a group of players from the PDP (n = 20) of a Category One English Premier League club. As a follow-on from their previous research in this population, in which the researchers explored the perspectives on the enablers and barriers to nutritional adherence in the PDP (Carter et al., 2022), the researchers specifically targeted dietary behaviours around match day and applied intervention functions (i.e., Training, Education, Modelling, Persuasion and Enablement) as part of an education and behaviour change intervention. This approach was successfully implemented, with significantly higher mean energy and CHO intake reported in the intervention group when compared to a control group, with the intervention group also demonstrating periodisation practices as CHO intake was significantly increased on MD-1 (7.0 ± 1.7 g · kg^{-1} BM · day^{-1}), MD (7.1 ± 1.4 g · kg^{-1} BM · day^{-1}) and MD + 1 (5.1 ± 0.8 g · kg^{-1} BM · day^{-1}), having previously identified this as an issue in this population (Carter et al., 2023). Given the reported positive impact of utilising the COM-B model to develop an education and behaviour change intervention in professional male and academy soccer players, future research should consider utilising this approach with players in the YDP, expanding on the data reported in the present study.

The present study is not without its limitations. As with any dietary assessment study, the present data set has the potential for under-reporting from participants, as well as the measurement error associated with researcher assessment when using the RFPM. Indeed, we recently observed underestimations of total 'daily' CHO intake by 54 and 66 g, respectively, by both experienced and inexperienced nutrition practitioners, as obtained from 2-days of dietary assessment comprising 4 meals per day (Stables et al., 2021). Nonetheless, our assessments were strengthened by the use of known 'in-house' dietary databases, prior training on data collection and the onsite presence of the researcher at the training ground and school, to assist participants where required. The inclusion of only two age-groups from one academy could be perceived as a limitation to the present study, however this was deemed necessary for transferability, with regards to the methods utilised to establish the enablers and barriers to dietary behaviours in the present study. It is also noteworthy that the present study has not assessed the energy expenditure of the participants, therefore it is difficult to fully ascertain that under-fuelling is present, despite the existing data within this population (Hannon et al., 2021b; Stables et al., 2023).

In summary, in using the COM-B model, we report for the first time the sources of dietary behaviours of male academy soccer players in the YDP. It is apparent that for practitioners aiming to change a player's dietary behaviours, they must first aim to understand the player's behaviours and do so on a meal-by-meal basis, given the varying contexts and influential factors at each mealtime. It is noteworthy that across all mealtimes psychological and physical capability rarely emerged as an enabler or barrier to the players' dietary behaviours, indicating that clubs should be providing their YDP players with the physical opportunity to consume the food and drink necessary for their energy requirements, should they have the capacity and financial resources to do so, or at the very least consider employing an accredited nutritionist to deliver the appropriate educational support to all key stakeholders.

Chapter 6

Synthesis of findings

The aim of this chapter is to provide a summary of the findings from this thesis in relation to the original aims and objectives outlined in Chapter 1. A general discussion is then presented, which focuses on how the data derived from this thesis has furthered our understanding of the performance nutrition service provision in academy soccer environments. Finally, the practical implications, limitations and recommendations for future research will be outlined.

6.1 Achievement of thesis aims and objectives

The overall aim of this thesis was to explore the performance nutrition service provision within male academy soccer environments in English Soccer. The data derived from this thesis support the need for enhanced nutrition service provision within soccer academies and provides an understanding of the factors underpinning the dietary behaviours of this population. These aims were achieved through a series of field-based studies conducted in Chapters 3, 4 and 5. An overview of each specific objective is provided below.

Objective 1: **To audit the performance nutrition services in English soccer academies. This objective was achieved through the completion of Study 1 (Chapter 3).**

To audit the current provision of performance nutrition services provided to male adolescent players within academies from the English soccer leagues, practitioners from all 89 academies (as of 2021) completed an online survey to audit: a) job role/ professional accreditation status of persons delivering nutrition support, b) activities inherent to service provision, c) topics of education, d) on-site food, fluid and supplement provision and e) nutritional related data collected for objective monitoring. The findings of Study 1 indicate distinct differences in the extent of service provision provided between categories, as well as an apparent prioritisation of support for players in the PDP when compared to the YDP and FP. Additionally, players from all categories receive nutrition support from non-specialist staff. Data demonstrate that performance nutrition appears an under-resourced component of academy sport science and medicine programmes in England, despite being an integral component of player development.

Objective 2: **To explore stakeholder perspectives on the role of nutrition in influencing the development and performance of male academy soccer players. This objective was achieved through the completion of Study 2 (Chapter 4).**

Via reflexive thematic analysis of 31 semi-structured interviews with a range of key stakeholders (players, parents/guardians, coaches, sport scientists, physiotherapists and catering staff) from a single Category One academy, 4 key themes emerged. Data demonstrate an apparent lack of understanding and awareness on the role of nutrition in influencing player development, especially in relation to growth, maturation and reducing injury risk. Players highlighted the influence of their parents on their dietary behaviours, whilst parents also called for education to better support their sons. Notably, all stakeholder groups perceived that the daily schedule of a male academy soccer player presents as “too busy to eat”, especially in relation to before school, and before and after training. The results demonstrate the necessity for the co-creation of player and stakeholder specific nutrition education programmes as an initial step towards positively influencing the dietary behaviours of male academy soccer players.

Objective 3: **To quantify the energy and macronutrient intake and distribution across meals and explore the barriers and enablers to positive dietary behaviours in male academy soccer players in the YDP. This objective was achieved through the completion of Study 3 (Chapter 5).**

A mixed-method approach was employed using the remote food photography method to observe and quantify dietary practices, whilst post-dietary assessment interviews were used to provide an understanding of the players’ dietary behaviours. To this end, the COM-B model was used to qualitatively explore the perceived barriers and enablers to the players dietary practices on a meal-by-meal basis. Findings from this study demonstrate that players are under fuelling, when considering the energy expenditure data previously reported in this population (Hannon et al., 2020; Stables et al., 2023). The subsequent COM-B analysis of each of the 191 meals recorded suggests that there are a variety of barriers and enablers at each mealtime given the different contexts. Notably, physical opportunity (food availability/options and time) and automatic motivation (food desirability and hunger) transpired as the most frequently cited influencing components on dietary behaviours by the players. It is noteworthy that across all mealtimes psychological and physical capability rarely emerged as an enabler to the players' dietary behaviours.

6.2 General discussion of findings

Despite the EPPP mandate for academies to employ interdisciplinary specialists in the sports science and medicine team, to achieve Category One status academies are required to employ a nutritionist on only a part-time basis (Premier League, 2011). With this in mind, Study 1 (Chapter 3) sought to audit the performance nutrition services in English soccer academies, to investigate what impact this requirement was having on service delivery. A practitioner from all 89 academies with category status (at the time of data collection) completed an online survey to determine; if nutritional support was provided at their club, who was responsible for delivering the support and what were their credentials, hours of support provided, nature of service provision, topics of education, food and drink provision, supplement provision, and objective monitoring of nutritional related data.

The first key finding from Study 1 was the greater prevalence of accredited nutritionists employed by Category One academies, albeit only 64% on a full-time basis. Additionally, there was a considerable amount of service delivery across Categories One-Three delivered by sports science and medicine staff, as well as students on internships or work placements, which was particularly prevalent in Category Three clubs. This is unsurprising given that the EPPP does not mandate Category Two-Four clubs to employ a nutritionist, despite their players likely experiencing the similar energetic requirements as players at Category One academies, to support their performance and development (Hannon et al., 2021b). The dietary intake and energy expenditure of male academy soccer players and the subsequent likelihood of low energy availability have been highlighted throughout this thesis. Chronic periods of low energy availability may present as reductions in skeletal bone accrual, increased risk of stress fractures, delayed sexual maturation, impaired growth and maturation of tissues and organs, and suppression of the immune system (Loucks, Kiens and Wright, 2011), all of which can be detrimental to long-term player development. Indeed, there is some evidence that more severe injuries are recorded around 14 years old (Hall et al., 2020) coinciding with the time period in which most males undergo their most rapid phase of growth and require sufficient energy and nutrient intake to support this. Taking this into consideration, this further amplifies the magnitude of concern for the reduced requirements for nutritional support when compared to other disciplines in the sport science and medicine department, and the subsequent lack of support from accredited personnel across all categories, as identified in Study 1 (Chapter 3).

A further key finding within Study 1 (Chapter 3) was the apparent prioritisation of support to players in the PDP, when compared to the YDP. This transpired as more total hours of support per month, greater delivery of specific activities (i.e., one-to-one support and cooking workshops) and greater provision of on-site meals and supplements. This enhanced level of service for PDP players understandably aligns with the need to support them as they transition to first-team football, or perhaps are reaching the end of their journey at the club, who then may be hoping to achieve as greater transfer fee as possible for these players. However, data within this thesis indicate room for improvement in the service provided to those in the YDP, and justifiably so. Research in this population has reported progressive increases in TEE as players advance from the U12/13 age-group (2859 ± 265 kcal·day^{-1}, range: 2275-3903 kcal·day^{-1}) to U15 (3029 ± 262 kcal·day^{-1}, range: 2738-3726 kcal·day^{-1}) and to U18 status (3586 ± 487 kcal·day^{-1}, range: 2542-5172 kcal·day^{-1}). Additionally, younger players often have busy lives with school and long travel times to training, so there is a need for specific educational support and practical solutions for fuelling before, during, and after training, with sub-optimal practices previously reported in YDP players during these times (Stables et al., 2022). In this regard, further data from Study 1 (Chapter 3) demonstrates that players in the YDP of Category One clubs receive more education on 'growth and maturation' compared to other phases of player development, both within and across categories. This is perhaps due to the high prevalence of support from accredited staff, indicating that qualified specialists are more adept at tailoring education to different development phases.

To further investigate the performance nutrition services in male academy soccer, the aim of Study 2 (Chapter 4) was to explore stakeholder perspectives on the role of nutrition in influencing the development and performance of male academy soccer players. A qualitative approach was employed to acquire insights from a range of key stakeholders (n = 31) in a single male soccer academy, including coaches, sports scientists, physiotherapists, catering staff, players, and parents/caregivers, who were involved in either the YDP and/or PDP. The interview questions were devised to gather insights on the participants understanding of how nutrition can influence player development and performance, as well as perceived challenges that may impact dietary behaviours. This study purposefully gathered perspectives from a variety of key stakeholders who play a direct role in the daily lives of male academy soccer players and may indirectly influence their dietary practices or, at the very least, have significant insights into the key factors affecting their dietary behaviours.

The main finding from Study 2 was the apparent lack of understanding from all stakeholders on the role of nutrition in supporting player development. Whilst this study was the first to qualitatively report this finding, research has previously quantitatively reported a lack of nutrition knowledge in a number of the stakeholder groups involved in this study. In this regard, in a recent assessment of sports nutrition knowledge of parents and caregivers of male academy soccer players, the researchers utilised an 88-item validated Nutrition for Sport Knowledge Questionnaire (Trakman et al., 2017) and nutrition knowledge scores were classified as 'poor' (43 ± 13%) (Callis et al., 2023). A lack of nutrition knowledge among caregivers has been reported as a barrier to adolescents eating behaviours (Liu et al., 2021) with adolescents viewing their family members as important sources of nutrition information and are influential when it comes to changing dietary behaviours (Shepherd et al., 2006). Additionally, academy players in the PDP have suggested that caregivers would be better at facilitating positive dietary behaviours if they possessed adequate nutrition knowledge (Carter et al., 2022). This notion of parental influence was also reported in Theme 2 of Study 2, in which all stakeholders highlighted the influence of parents and caregivers on their child's dietary habits, whilst Theme 4 also reported the need for education amongst this stakeholder group. However, it is worth noting that dietary habits are multifactorial and are often influenced by more than knowledge alone. For instance, Theme 3 highlighted the influence of their busy schedule on the dietary behaviours of male academy soccer players. In this instance, it is perhaps the responsibility of the lead coach to ensure the schedule facilitates and considers the dietary requirements of the players. Although, as data from Study 2 would suggest, this stakeholder group lack the awareness and understanding of the nutritional requirements of the players, whilst research has previously demonstrated the lack of nutritional knowledge that soccer coaches possess (Aka, 2020).

Taken together, practitioners working in academies should aim to provide stakeholder specific nutrition education, with the aim of positively influencing the dietary behaviours of the players through the input and support of each stakeholder. It is important to note, however, that education alone is unlikely to change nutrition related behaviours (Alaunyte et al., 2015; Spronk et al., 2014). Therefore, stakeholder-specific behaviour change interventions should also be developed to positively influence players' nutritional behaviours, given that food choices are multifaceted, situational, and complex (Sobal & Bisogni, 2009).

The design and development of a theoretically informed behaviour change intervention using the COM-B and BCW systems typically involves a three-stage process, each with additional sub-processes (Michie, van Stralen & West, 2011). In stage one, intervention designers must "understand the behaviour", and the COM-B model and the TDF are often used together in this stage to help designers understand the current behaviours and determine the necessary changes for the desired behaviour to occur. With this in mind, Study 3 aimed to uncover the factors underpinning the dietary behaviours of academy soccer players, whilst providing a methodological framework to do so, as an initial step towards understanding the barriers and enablers to positive dietary behaviours in this population. The mixed-method approach firstly allowed for dietary analysis to take place over a 3-day, in-season period, via the RFPM, followed by a structured interview with each participant. The purpose of this interview was to record the daily physical activity of participants, as well as to better understand the dietary behaviours observed during the previous 3 days. Participants were asked to describe what activities they were doing across all 3 days and what time they were doing them, as well as the location and any travel involved. Participants were then shown pictures of the data collected from the 3-day RFPM and asked to provide reasoning for their dietary behaviours and who prepared the food/drink or influenced their behaviour. Players from the YDP were deliberately recruited to take part in Study 3 (Chapter 5), given the findings from Study 1 (Chapter 3) and Study 2 (Chapter 4), which both highlighted the lack of support to this phase and the influence that stakeholders and their busy schedules have on their dietary behaviours.

When looking at mean absolute energy intake on the first training day (2476 ± 416 $kcal \cdot day^{-1}$), rest day (2168 ± 465 $kcal \cdot day^{-1}$), and the second training day (2440 ± 619 $kcal \cdot day^{-1}$), data were similar to what has previously been reported in these age-groups (2178 ± 319 $kcal \cdot day^{-1}$) at a different academy of Category One status (Stables et al., 2023). Whilst Study 3 did not assess total energy expenditure, data from existing literature in this population would suggest that the players were potentially 'under-fuelling' by consuming fewer total calories per day than their likely total energy expenditure. Indeed, the total energy expenditure of male academy soccer players has previously been assessed over a 14-day in-season period via the gold-standard DLW method in two separate academies of Category One status, with the researchers reporting an average total energy expenditure of 2859 ± 265 $kcal \cdot d^{-1}$; range 2275-3903 in a group of U12/U13 players (Hannon et al., 2021b) and 3380 ± 517 $kcal \cdot d^{-1}$; range, 2811 – 4013 in a group of U13 players (Stables et al., 2023). Further data from the dietary analysis indicated that only seven players reported an average daily carbohydrate intake exceeding 6 $g \cdot kg^{-1}$, which is the recommended intake to support the demands of the players (Collins et al., 2021).

The factors underpinning the reported sub-optimal dietary behaviours were yet to be reported for players in the YDP. In this regard, the key findings from Study 3 were derived from the structured interviews and subsequent COM-B analysis of the data. The frequency analysis performed on this data for each meal provided insights into the barriers and enablers to the players' dietary behaviours. Indeed, psychological capability was rarely reported as an enabler to their dietary behaviours, as the players seldom suggested that their nutritional knowledge influenced their dietary habits. This finding would therefore align with data from Study 2, in which a lack of awareness and understanding was highlighted amongst all stakeholders. Also highlighted in Study 2 was the influence of parents and caregivers, which is supported by data from the COM-B analysis in Study 3. For instance, on 43% of meals at breakfast time the players reported social opportunity, in the form of parental influence, as an enabler to their dietary behaviours, a notion which has also previously been reported in players from the PDP (Carter et al., 2022). This further highlights the requirement for stakeholder specific education programmes to be developed and delivered in academies, given the positive impact previously reported in male professional soccer players (Carter et al., 2024).

In this regard, having previously explored the barriers and enablers to nutritional adherence in male professional academy soccer players (Carter et al., 2022) and reported sub-optimal CHO intake for a match (Carter et al., 2023), the researchers suggested that players might lack a complete understanding of the importance of periodising their dietary intake or may face challenges in doing so. They highlighted the need for practitioners to prioritise strategies that enhance knowledge and encourage behaviour change to support effective fuelling and recovery practices. Based on these insights, the researchers successfully developed and implemented a nutrition education and behaviour change intervention aimed at improving dietary practices around match days for professional soccer players (Carter et al., 2024). The researchers applied intervention functions (i.e., Training, Education, Modelling, Persuasion and Enablement) as part of an education and behaviour change intervention, and in doing so reported significantly higher mean energy and CHO intake in the intervention group when compared to a control group. The intervention group also demonstrated periodisation practices as CHO intake was significantly increased on MD-1 (7.0 ± 1.7 g · kg^{-1} BM · day^{-1}), MD (7.1 ± 1.4 g · kg^{-1} BM · day^{-1}) and MD + 1 (5.1 ± 0.8 g · kg^{-1} BM · day^{-1}). These findings demonstrate the potential positive impact of developing education and behaviour change interventions for soccer players, and should be considered as a future research direction for stakeholders within the YDP.

Study 3 (Chapter 5) also demonstrated the knock-on effects of the busy schedule of academy players previously highlighted in Study 2. For instance, physical opportunity in the form of 'time' continuously transpired as a perceived barrier from breakfast through to the evening meal. This is perhaps no surprise given that data from the physical activity recall within the interview uncovered that some players can be out the house for up to 13 hours on a training day, consisting of over travel to school where they take part in up to 4 lessons, before travelling to the training ground for numerous developmental related activities, before travelling home. Physical opportunity in the form of 'food availability/options' also continuously transpired as a prominent enabler to the players' dietary behaviours, particularly at the training ground during the pre- and post-training period. Moreover, on 88% of pre-training occasions, players reported automatic motivation to be an enabler to their dietary behaviours, as they were driven by their desire for the food/drink available to them. The positive influence of desirable food provision at the training ground has also been reported as an enabler in professional academy players (Carter et al., 2022). Collectively, these influencing factors resulted in players consuming an average relative carbohydrate intake of 0.8 ± 0.4 $g.kg^{-1}$ in the 30 minutes prior to training, which alongside the relative carbohydrate intake at lunch (1.3 ± 0.4 $g.kg^{-1}$), which was consumed 3 hours before training, is in-line with the recommended intake 1-3 $g.kg^{-1}$ in the 3-4 hours prior to soccer-specific activity (Collins et al., 2021). Taken together, these findings would suggest that clubs should aim to provide their players with sufficient physical opportunity to optimally fuel for and refuel/recover from training, that includes availability of food and drink items that are desirable for the players, should they have the resources to do so. Given that data from Study 1 identified that 74% of Category One academies either never or only sometimes (<75% of occasions) provide post-training food for their YDP players, clubs should perhaps reevaluate their training ground food provision, although in recognising that this may not be feasible for all clubs, employing an accredited nutritionist to provide educational support would be an appropriate alternative.

6.3 Limitations

Each of the studies undertaken within this thesis has yielded novel data that contributes to the advancement of knowledge and understanding regarding performance nutrition services in male academy soccer. The findings deepen our comprehension of the current landscape and its effects on the dietary behaviours of this population. Nevertheless, these studies are not without their limitations, some of which are relevant to all three studies. Firstly, this research was exclusively carried out among male participants, thus it would be inappropriate to generalise the findings of this thesis to young female soccer players. Additionally, the data from Study 2 (Chapter 5) and Study 3 (Chapter 6) were obtained from players and staff from a single Category One soccer academy, which may not be representative of other academies of varying category status in England, or of other soccer academies worldwide. In this regard, it is also worth acknowledging the differing philosophies (coaching, training, player development etc.,), infrastructure and staffing, resources and cultures that exist between different clubs, and the impact this may have had on the findings within this thesis. Additionally, each study within this thesis had its own set of limitations unique to its design and methodology.

Study 1 (Chapter 3)

As with all survey reports, our data is based on self-reported responses, with the potential for response bias, whereby the respondents may attempt to ‘look good’ with their responses (Rosenman et al. 2011). This study also did not undertake any formal assessment of the efficacy of the current models of service provision in terms of stakeholder knowledge as well as the quality of the practical nutrition services that are being delivered to stakeholders. Finally, the cross-sectional design of this study must be acknowledged when considering the findings, given that personnel employed by clubs and the subsequent delivery of nutrition services is ever changing and will have inevitably changed since this study was conducted.

Study 2 (Chapter 4)

Employing a case study design could be perceived as a limitation, as findings may only be representative of the culture and procedures of the club involved in this study, as well as the participants who were willing to take part. Nonetheless, this study enables practitioners to reflect on the data and determine if the findings resonate with their own experiences, settings, observed events, and conversations (Smith, 2017), before forming 'naturalistic generalisation' (Stake, 2005).

Study 3 (Chapter 5)

It is recognised that under-reporting is a common issue when it comes to assessing the self-reported dietary intake of adolescent athletes (Russell and Pennock, 2011; Silva et al., 2013; Briggs et al., 2015; Hannon et al., 2020; Stables et al., 2023). To mitigate this, two different prospective (RFPM) and retrospective (dietary recall) methods were employed (Capling et al., 2017). The accuracy of data was also enhanced by utilising established in-house databases, providing prior training on data collection, and having the researcher present at the training ground and school to assist participants as needed. The inclusion of only two age-groups from just one academy could be perceived as a limitation too. However, this was deemed necessary for transferability as practitioners may employ similar methodology in their own contexts when attempting to understand the dietary behaviours of the players they work with.

6.4 Recommendations for future research

Based on the insights gained from this thesis, there is a need for further research to deepen our understanding of how to enhance the nutritional support a development of male academy soccer players. Addressing some of the unanswered questions can be achieved through the following research recommendations:

1. Replicating all three studies in a cohort of female academy soccer players given the differences in the resources, infrastructure and staffing.
2. Conduct Study 2 (Chapter 5) with the inclusion of multiple clubs, particularly in Categories Two-Four, to obtain a broader range of perspectives.
3. Conduct Study 3 (Chapter 6) within a different academy, particularly in Categories Two-Four, to observe the impact of different infrastructures, staffing, resources and programme on the barriers and enablers of the dietary behaviours of male academy soccer players.
4. Develop a nutrition education and dietary behaviour change intervention for players in the YDP, that considers the roles of all stakeholders as influencers in the dietary behaviours of male academy soccer players.
5. Replicating Study 2 (Chapter 5) and Study 3 (Chapter 6) with the Foundation Phase, given that dietary behaviours are often instilled from a young age.

6.5 Practical Implications

The findings reported and discussed within this thesis have practical implications for practitioners working in academy soccer environments and the relevant governing bodies:

1. Clubs should invest in nutrition support by employing a SENr accredited nutritionist, preferably on a full-time basis, to deliver support to their players and key stakeholders

at the club. The beneficial impact this has on service provision is highlighted in Study 1 (Chapter 3).

2. Given the growing body of literature highlighting the importance of nutrition for the performance, development, and well-being of academy soccer players, governing bodies may wish to reconsider the EPPP requirements for the employment of an academy nutritionist.
3. Practitioners working within academies should invest sufficient time in players in the YDP (U12-U16) and provide the appropriate support to fuel their energy demands to enhance performance, optimise growth and maturation, and minimise time lost through injury, to ultimately support their development as a young soccer player.
4. Practitioners should deliver stakeholder specific education in an attempt to positively influence players' dietary behaviours via wider club staff and parents/guardians.
5. When attempting to positively influence the dietary behaviours of academy soccer players, practitioners should consider utilising models of behaviour change to enhance their practice and increase the likelihood of a change in behaviour occurring.
6. Institutions delivering Nutrition qualification courses (i.e., MSc, ANutr, IOC Diploma) should consider incorporating content on behaviour change within their course delivery, that provides aspiring nutritionists with an appreciation for and understanding of how to development and implement behaviour change interventions with athletes.

6.6 Summary

In summary, the research undertaken in this thesis provides novel data on the current landscape of performance nutrition services in English Soccer academies, the perspectives of the role of nutrition in influencing player development and performance and provides an understanding of the factors underpinning the dietary practices and behaviours of this population. More full-time accredited nutritionists are employed within Category One clubs versus Category Two, Three and Four, as well as more hours of monthly service delivery, inclusive of one-to-one player support and stakeholder education programmes, and a greater prevalence of on-site food, fluid and supplement provision on training and match days. Across all categories, players from the professional development phase receive more frequent support than players from the youth development phase. There is an apparent lack of understanding and awareness on the role of nutrition in influencing player development, whilst players highlighted the influence of their parents on their dietary behaviours, whilst parents also called for education to better support the players. It is also apparent that the busy daily schedule of an academy soccer player poses a challenge to the dietary behaviours of this population. Notably, the dietary practices and behaviours of male academy soccer players are influenced by several key factors, such as time (scheduling demands), food/drink availability, preferences, and social influencers. When taken together, these findings enhance our understanding of the performance nutrition service provision for male academy soccer players and the subsequent impact on dietary behaviours, whilst also providing a foundation for practitioners to develop behaviour change interventions to enable the recommended dietary behaviours for male academy soccer players, to optimise their performance and development.

6.7 Reflections on the Academic Journey: Nothing worth having comes easy

The idea of completing a PhD and conducting research was not one that I had considered throughout my time as an undergraduate. Throughout my schooling journey I was never the cleverest person in the class, but one thing I have always had is a strong curiosity for gathering new information about topics I am truly interested in. Perhaps the problem during my childhood was that I was only interested in Football, whether that was playing (anytime, anywhere) or watching Liverpool Football Club, neither of which really translate to good grades in Maths, Science or English, I suppose. However, when I was introduced to the area of Sport and Exercise Science at the age of 16, the future career prospect of working with Elite athletes had finally opened up the possibility for my passion and curiosity to perhaps lead to greater academic success.

Upon completing my undergraduate studies, my decision to undertake an MSc in Sports Nutrition resulted in the opportunity to gain experience at Everton Football Club's Academy, working alongside Dr. Marcus Hannon, who was conducting his PhD research at the time. Being involved in his research and witnessing the impact the findings were having on his applied work ignited my desire to also pursue an applied PhD beyond my MSc, so when the opportunity presented itself to start an applied PhD with a Category 1 academy, I was eager to get started. However, 1 year in and I was feeling unfulfilled and dissatisfied with my work and in my role. My thoughts at the time were that I viewed myself as a more of a researcher, whilst the environment I was present in on a day-to-day basis perceived me as a practitioner, and at this stage of my journey I very much struggled with this. This led to me making the difficult yet brave decision to end my PhD journey and take on a full-time position at a different academy as their performance nutritionist. Whilst at this point I was downhearted by having to come to terms with a 'failed' attempt at conducting a PhD, I was excited to fully commence my career as a practitioner. Yet despite feeling somewhat liberated for the first 6 months, there remained a burning desire to conduct research, and now I had more 'real-word' experience to enhance my research questions, and suddenly I found myself as a PhD student once more. I was now a full-time practitioner and a PhD student, the same position I was in 6 months prior and struggled to come to terms with. However, this time my perspective on my role changed, as I now viewed myself as a practitioner-researcher, as opposed to previously feeling like being a practitioner was getting in the way of me being a researcher.

The practitioner-researcher model facilitated me in bridging the gap between theory and practice, creating a dynamic relationship where both informed and improved each other. In considering this model throughout my journey, I continuously believed that patience would be my ally, by allowing my lived experiences in the applied setting to inform my research questions, as ultimately, I wanted my findings to inform my practice and solve problems. In this regard, I was aware of the literature highlighting the energy requirements of the population I was working with, as well as plenty of data reporting failures to meet such energy demands, therefore design my first study to explore why this might be the case, by auditing academies of all category status. This proved to be a comprehensive audit in which I received responses from 100% of academies in English soccer, achieved by utilising every avenue possible, whether that be my personal network, connections of the research team and also those I worked with. Patience was key for me here, as I wanted to collect data from as many clubs as possible to portray a fair and accurate assessment of the current landscape of performance nutrition service provision, and the only way to do that was to be patient in my pursuit of practitioner responses from each club. Following the completion of publishing this study, I had actually moved clubs (again). This was very different to my previous move, as I was very happy at this club, but knew the opportunity to further progress my career was too good to pass up. I also believed that this would strengthen my research, as gaining experience of working at another club would further expand my insights into the ways in which performance nutrition is practiced and understood at different clubs.

Whilst this was of course an exciting time for me, it inevitably stalled the PhD as I now needed to settle into my new role and build relationships, before I started to formulate my next research question. Within a year of working at this club, I was presented with the opportunity to present my research to date and ideas for future research, to the academy director and a group of additional key stakeholders. Given that the key findings from my first study highlighted the enhanced service provision with full-time support, as well as the prioritisation of the PDP, I emphasised the importance of nutrition for the younger age-groups and the impact this would have on their health, performance and development. The outcome of this presentation led to the club employing an additional full-time nutritionist with the academy to enhance service provision.

From my 5 years of experience working within 3 different clubs at this time, it stood out to me just how much we as academy nutritionists rely on stakeholder support to successfully deliver our messages and have an impact on the players' dietary practices. I was also aware that most stakeholders didn't fully understand exactly how nutrition could influence the performance and development of the players, which led me to my next study in which I explored stakeholder perspectives on the influence of nutrition for academy soccer player performance and development. Data from this study affirmed what I had experienced in practice, in that there was a clear need for stakeholder education. However, before jumping in to delivering theoretical and practical workshops to staff, parents and players, I wanted to explore what impact this was having on the dietary behaviours of the players. In doing so, study 3 required support from parents, players, coaches, sport scientists, chefs and teachers at the players' schools, to assess the dietary habits of the players. Utilising a mixed methods approach here allowed me to collect the necessary data to quantify energy and macronutrient intake, whilst also understanding the reasons for the players' dietary practices from their perspectives.

My long-term vision on completing my research was always to take my findings and translate them in to enhancing my practice and inevitably improving the dietary behaviours of the academy players I work with. However, upon completion of writing this thesis, I was presented with the opportunity to progress into a first-team role. Whilst I am no longer delivering support to the academy players, the findings of this thesis have had a significant impact on the nutrition service delivery of the club's academy. To date, as well as the club increasing their academy nutritionist head count, the findings of this thesis have led to; stakeholder specific educational support that targets the nutrition related behaviours they are able to influence, increased energy intake opportunities for players in the YDP (i.e., pre and post-training food & drink provision), a full canteen refurbishment to improve the experience for players and staff, and a 'bone health' project which incorporates the medical department, physical performance staff and nutritionist. Finally, I believe the role of the academy nutritionist is perceived to be more important now than it ever has done before, and I am excited to see how this field continues to progress in the future.

Chapter 7

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