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Abstract

In response to the ongoing sex data gap, the present study provides a qualitative exploration of females' nutritional experiences in elite sporting environments. Semi-structured interviews were conducted with multiple participant groups ($n = 18$), including athletes ($n = 7$), practitioners ($n = 6$) and researchers ($n = 5$) across differing sporting disciplines within professional sporting organisations and/or sport national governing bodies. Combined content and thematic analysis provided an insight into the specific factors influencing current sport nutrition practices. A common theme highlighted among all participant groups was the paradoxical struggle between adequate fuelling for training and competition demands and the fear this may impact body mass and body composition goals. This tension was identified as being rooted within athletes' perceptions of body image and driven by other participant groups and wider societal ideals. Each participant group also highlighted influences on cravings and approaches to food and dietary supplementation, centred around individual perceptions and challenges driven by symptomology associated with the female menstrual cycle and contraceptive use. To address these challenges, all participant groups called for more research to inform future change and continuing education pathways. In summary, this study contributes to providing a more complete understanding of elite female athlete sport nutrition experiences than currently exists. Multiple perspectives highlight the complexity of providing sport nutrition support to elite female athlete populations and directs future research and practice to reconsider *one size fits all* approaches and acknowledge unique individual contexts which may influence these areas.

Keywords: menstrual cycle, hormonal contraception, body image, nutrition, education, research

Introduction

Female participation in high performance sport has become consistently more prevalent, with women comprising 49 percent of the events at the 2020 Tokyo Olympic Games (Pegoraro & Arndt, 2021). Despite this increased representation, a recent review highlighted that between 2014-2020, only 6% of studies within sport and exercise science focused solely on women, with 63% of studies using mixed sex cohorts (Cowley et al., 2021). Whilst this *sex data gap* may be attributed to long standing social practices that lead to the marginalisation of women in academia and sport, another proposed contributing factor is the challenge of conducting high quality research in female demographics, due to the diversity in ovarian hormone status across the lifespan (Elliott-Sale et al., 2021). Within this context, the sport nutrition practices of female athletes is one of several under researched areas where current understanding is constrained (Holtzman & Ackerman, 2021). This is problematic given ovarian hormones

have been highlighted to affect metabolic, physiological and performance based outcomes, demonstrating that sportswomen may require alternate nutritional support than their male counterparts (Areta & Elliott-Sale, 2022). However, the overview of this evidence is often equivocal, which has been primarily attributed to a lack of research quality and quantity (Elliott-Sale et al., 2021).

Within the aforementioned research base, much of the existing evidence on female sport nutrition has been explored via quantitative assessments that do not necessarily examine contextually rich accounts of the lived experiences of females participating in high performance settings. This approach may be remiss given sport participation is a bio-psycho-social activity (Armour & Chambers, 2014) and moreover, psychological and social factors may additionally influence female athletes' everyday sport nutrition practices. Recent investigations have illustrated the relevance of these types of enquiries, by highlighting the bio-psycho-social influences on body image and eating behaviours in female athletes (Heaney et al., 2008), whilst recognising that those who operate as support staff within elite athlete networks are key drivers for this context and often influence these types of behaviours (Coppola et al., 2014). In doing so, these studies demonstrate the value of exploring sport nutritional practices from the perspectives of those with lived experiences (i.e., of athletes themselves) and those who work alongside them in situated sporting contexts (i.e., support staff). Furthermore, this type of research also illustrates that nutritional experiences are not solely individuated, but reciprocally influenced by interactions with others across social contexts (Overdorf & Silgailis, 2005). Notwithstanding this observation, there is a need for further transdisciplinary understanding of how females in elite sport experience nutritional practices, whereby this type of research approach allows for interaction of in depth and reflective personal insights between participants perspectives, therefore providing a greater understanding of the social context.

Whilst examining complex bio-psycho-social processes will always be an ongoing endeavour, the present research is currently inadequate as a means of understanding female sport nutrition practices. In particular, investigations on female sport nutritional experiences and how these are influenced by menstruation and hormonal contraception use remains absent. Accordingly, the aim of the present study was to gain specific insight into the sport nutritional experiences that females may face during training and competition and examine if this may be influenced by any associated symptomology driven by the menstrual cycle or hormonal contraceptive use. On this basis, the study explores the perceptions of sport nutrition practices by athletes, practitioners and researcher participant groups within elite high performance sporting environments. In doing so, this study strives to provide a more complete overview of the sport nutritional practices of female athletes, the results of which may aid in addressing the sex data gap by directing future research towards topics that require further scientific investigation.

Methods

Informed by an appreciation for the perceptions of those involved in everyday practice, this study adopted a qualitative approach. Specifically, a relativist position was undertaken alongside a subjectivist epistemology, both of which recognise that diverse experiences can contribute to personal knowledge and understanding (Smith & McGannon, 2018). Consistent with this philosophical position, the study sought to explore multiple perspectives of a social activity that may be missed with other types of research approaches and allows for deeper more reflective conversations with participants potentially leading to discovery of new insights that were not previously considered (Ellis et al., 2018; Roberts et al., 2019). On this basis, the methods described below were employed to provide varied accounts of sport nutritional practices from multiple practitioners involved in elite female sport.

Participants

To gain the greatest insight into the perceptions of differing participants within female elite sport, a purposeful sampling approach was utilised, inclusive of variation in type (endurance, team, weight restricted, multisport disciplines) and previous experience/involvement in sport, to provide a more balanced perspective of the research question (Patton, 2015). Inclusion criteria stipulated that all participants must be recognised and/or licensed as a member of a professional sporting organisation (PSO) or national governing body (NGB). Furthermore, athletes' inclusion criteria stated: (a) aged between 18-40 years old and (b) at least 5 years' international competition experience. Additionally, practitioner inclusion criteria dictated: (a) minimum of MSc level education and (b) employment with a PSO or NGB. Finally, researcher inclusion criteria stipulated: (a) minimum of Ph.D. level education, (b) employment with a PSO or NGB, (c) employment and/or affiliation with an academic institution and (d) published research within the area of female high performance sport. Therefore, researchers had experience of both research and applied practice, which enabled them to provide joint insight into both paradigms. Ethical approval was granted by the Liverpool John Moores University research ethics committee and all potential participants were contacted via e-mail requesting their involvement in the study, of which 100% agreed to engagement. Participants provided informed consent by return of e-mail after disclosure of the study's aims in a participant information sheet and were sectioned into three groups inclusive of 7 athletes (age: $M = 28.7$, $SD = 2.2$ years; body mass: $M = 60.1$, $SD = 9.7$ kg; stature: $M = 163.1$, $SD = 7.9$ cm; contraceptive status: 3 hormonal contraceptive & 4 non users), 6 sport nutrition practitioners (sex: 5 females & 1 male; experience: $M = 15.2$, $SD = 4.1$ years) and 5 sport nutrition researchers (sex: 3 males & 2 females; experience: $M = 22.4$, $SD = 11.5$ years). Anonymity was guaranteed for all participants and only limited details are provided throughout the manuscript

i.e., Endurance Sport Athlete 1 - Hormonal Contraceptive User, Team Sport Practitioner 2 - Female, Multi-Sport Researcher 3 - Male.

Data Collection

Semi-structured interviews were conducted with all participants, with questions informed by previous quantitative and qualitative investigations (Brown et al., 2021; Findlay et al., 2020; Kolić et al., 2021). This approach was chosen to allow investigation into each participants personal thoughts, feelings and beliefs, with an open-ended question format adopted to allow voluntary contribution and detail in an informal conversation (DeJonckheere & Vaughn, 2019). This afforded each participant the opportunity to express their insights and emotions with minimal constraint, so to navigate towards areas of significance. Probing was employed when required, to obtain more depth to specific answers (Turner, 2010). Question structure was arranged to cover a broad range of domains including background demographics, the role of nutrition in determining sporting performance and any sport nutritional challenges specific to the female athlete as highlighted in Table 1. Prior to the beginning of the study, a pilot interview was conducted with an athlete and practitioner, in order to refine the questions and address the research aim. Interviews were administered and recorded audio only via the Zoom online video conferencing application (Zoom Video Communications, California, USA) and subsequently transcribed, with an average interview length of 58 minutes (range 38 – 85 minutes). The interviewer was acquainted with the differing participant types, having (a) previously competed as an international level athlete for >10 years, (b) recognised and licensed with a PSO, (c) accredited with an NGB, (d) educated to Ph.D. level and (e) employed within an academic institution. Whilst this can be viewed to negatively impact data collection in terms of leading participants' responses based on personal views and experiences (Creswell & Creswell, 2018), conversely these experiences were considered to facilitate the process. Specifically, the interviewer's experience with the sporting jargon and informal terminology, enabled them to be viewed somewhat as an insider by the participants and to elicit more meaningful responses (Cook et al., 2014).

Data Analysis

All interviews were transcribed verbatim generating 305 pages of text (120 Athletes; 103 Practitioners; 82 Researchers). Utilising parallel procedures from both content and thematic analysis approaches (Vaismoradi et al., 2013), multiple readings of the data were conducted to allow immersion in the detail. For the initial domain of identifying background information, deductive qualitative content analysis was employed (Elo & Kyngas, 2008), with analysed categories including sex, sport, background and role, in order to quantify and describe participants' demographics and positions. For all subsequent sections, a reflexive thematic analysis was utilised

(Braun & Clarke, 2019), given this provides opportunities to describe recurrent and distinctive patterns across participants' responses. To do this, the lead researcher inductively identified meaningful segments of text and organised this data into a series of data matrices (Miles et al., 2014), therefore allowing a more practical view from across each of the participant groups. Subsequently, the lead author then coded the data and proposed initial themes (relationship with body image & body mass; managing fuelling; approaches to food supplementation; nutritional challenges specific to females; factors to affect positive change etc.). and were well placed to do so given their prior experiences as an athlete, practitioner and researcher, alongside being immersed in the data by completing and transcribing the interviews. When reflecting, a key reflexive conception of thematic analysis (Braun & Clarke, 2019), the second author therefore sought to build on the initial analysis by re-examining the data, codes and initial *bucket* themes. To do so, the second author who has experience as a coaching practitioner and a qualitative researcher, began by examining the athlete data prior to using formative thematic maps to then navigate across the practitioner and researcher data. This led to the construction of latent themes, which were then presented to the first author and following discussion, a more refined thematic story was developed for each theme (Braun et al., 2022). These themes were then shared with the wider authorial team who also had sight of the data and were able to critically challenge and further refine each theme. Acknowledging the subjectivity of researchers (Braun & Clarke, 2021b), both theory and previous research formed part of these discussions and are represented within the subsequent written findings and discussion.

Rigour

To ensure rigour throughout the study several procedures were undertaken (Braun & Clarke, 2019, 2021a). As previously described, these included purposefully selecting a varied sample and piloting the interview questions. Additionally, members of the research group independent from the primary author acted as a critical friend, in order to provide critique of the data analysis. In doing so, the team sought to provide a rounded insight into nutritional practices within elite female sport. In order to facilitate this, the findings and discussion section that follows presents three themes and relevant quotations from the data. This should enable readers to characterise and interpret this information in their own way and then consider the transferability of findings to their own context (Smith, 2018).

Findings & Discussion

The following findings and discussion have been developed by the individual engagements between each of the participants and the interviewer. As such, each prevailing theme serves to highlight a number of observations as

characterised by a commonly cited *performance narrative*, which is underpinned by a number of diverse cultural and bio-psycho-social perspectives of each participant group.

Theme 1: A tension between fuelling strategies for performance versus body mass management: practices influenced by individuals within the social context

Across the corpus of data, many of the athletes reported understanding the benefits of employing intentional fuelling strategies. These athletes appreciated the importance of fuelling as a means to enhance performance, specifically for training sessions and at least 24 hours prior to competition. Practitioners and researchers similarly considered fuelling as a key aspect of meeting the training and competition demands placed upon athletes:

I think one of the biggest areas is in terms of fuelling because of the volume of training I do. (Team Sport Athlete 3 – Non User)

I guess fuelling is quite a huge part of competition nutrition for us and a real key driver for success. (Endurance Sport Practitioner 1 – Female)

I think just general daily nutritional total intake is really important for us. So, fuelling and I mean competition as well, fuelling for competition is paramount. (Multi-Sport Researcher 1 – Female)

In doing so, participants espoused a performance narrative, whereby athletes' daily practices are focused on sport performance such that "the person and the job become inseparable" (Douglas & Carless, 2006, p. 20), which is well established in high performance sport settings and encourages a singular focus on achieving optimal sporting success (Carless & Douglas, 2013). Over time, such a focus indicates that many aspects of an individual's life, i.e., their nutritional intake, are co-ordinated in an attempt to succeed in a competitive sport context. Whilst this may enable sporting success, some athletes may also experience identity foreclosure, as their sense of self predominantly relates to their sporting practices (Champ et al., 2020). Nonetheless, the performance narrative described by the participants here is ubiquitous in high performance settings and as demonstrated, further influences the importance of female athletes' nutritional practices. However, it should be noted that despite the apparent importance of fuelling within the performance narrative, many athlete and practitioner participants highlighted a paradoxical approach to the *periodisation* of this nutritional strategy, indicating they didn't readily employ this within practice:

I've never measured any foods, as I think over thinking it is too much. I mean, it could be helpful in terms of me getting more food in, but most of the time I think I do a good job. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

I've worked with athletes who've won world championship titles in highly competitive sports, I mean the sports I work in are some of the most popular in the world and they've won world and Olympic medals and they've never really deliberately periodised their nutrition. (Multi-Sport Practitioner 1 – Female)

Every time I read a literature article it gives me a ridiculous range athletes should be having, for example, 3-8 grams per kilogram of body weight in carbohydrates. You can't get athletes to eat like that in the real world, because you can't write a meal plan for 5 days' training like that, it's just ridiculous. (Weight Restricted Sport Practitioner 1 – Female)

However, this view was not shared by the researcher group, who described nutritional periodisation as a cornerstone of practice:

Its looking at carbohydrate requirements during training based on my experience with substrate oxidation rates and having looked at that we would analyse based on the approximate oxidation rates and work back from that for fuelling. (Multi-Sport Researcher 1 – Female)

We're working on fuelling practice for the first time they're going to make up their bottles and go through this tracking tool that I have for fuelling the work outs. We sit down and I'm 'this is a label, this is how you get percent carbs, this is how you weigh out your carbs, here's a little weigh scale or you can use your weigh scale at home, here's how you do your pre-post weight, here's how you put your data into this little tracking form', so it's very defined. (Multi-Sport Researcher 3 – Male)

Whilst nutritional periodisation can be viewed as a relatively new concept, this has been a widely popularised approach particularly in endurance based events. However, research surveying approaches to fuelling in elite racewalkers, has highlighted that individual strategies at the micro (within & across days), meso (weeks to months) and macro (across training cycles) levels can be heterogeneous, particularly in females who exhibit reluctance to increase both energy and carbohydrate intakes (Heikura et al., 2018). To that end and therefore contradicting the fuelling performance narrative, individuals within athlete group also often reported that they were concerned about

increases in body mass. Here, all the participant groups acknowledged the wider social and cultural pressures that are placed upon women in general and described how female athletes are not immune to these. More specifically, a *thin ideal* permeates general culture and for many women, this difficult to attain but often referenced *body image*, can influence nutritional habits and practices leading to undereating (Barrett & Petrie, 2020). Consistent with this, it was reported that many female athletes felt an ongoing need to regulate their body mass and composition, in an attempt to attain an ideal body image:

I feel like I got so wrapped up in how I was looking in a certain kit, I didn't want to look at photos of myself because I didn't like how I looked or I'd weighed myself the morning of and I knew that I was maybe heavier than normal, so I was often stressing about that. (Team Sport Athlete 1 – Non User)

I think every weight making athlete has body dysmorphia from needing to make weight and the struggles that brings with it. I think you're never truly happy with how you look and your body composition until you stand on the scales and then you only look like that for about 10 minutes anyway. (Weight Restricted Sport Athlete 2 – Non User)

As women we're so conscious about our weight, we're so conscious about how we look, how our body comps are, it's incredible when you actually think about it, like the stress that people go through when they know that someone's coming in to take their weight. You can just see it in people, some don't eat the day before because they're so worked up about it. (Team Sport Athlete 2 – Non User)

I do believe still there are still a lot of work to do in terms of females in understanding how to fuel their body over weight, because there are sometimes when I'm on National Team training camps and I'm looking at what some of these girls are eating and I'm, like, 'you literally have at least on your plate and we have a game tomorrow'. (Team Sport Athlete 3 – Non User)

It's about reiterating the benefits of fuelling, whereas some others I know have had a different mind-set of being lean is the best way to perform and now there's more of the science behind you need to fuel yourself to perform. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

Consistent with these insights, practitioners and researchers also recognised that female athletes are concerned with meeting culturally reinforced body images, which may also impact on fuelling practices:

Whether it's weight or appearance, they're sensitive and rightly so, we've judged women based on looks forever and there's a perfectionism ideal that's out there and I think what I've learned is don't assume that because they're elite athletes and they're strong, ripped and fit, that they don't have body image issues. We know eating disorders are likely more prevalent in female sport than anywhere. (Multi-Sport Practitioner 1 – Female)

With the females it's looking at body image with some of them. I think at the minute there's a bigger issue with social media influences. I had one athlete who came down and sat next to me and she just said 'look, I'm so confused, I follow this person, this person and this person and I haven't got a clue what's true or what's false'. None of them are verified, they're just influencers you know, out there to confuse more than anything else because they don't care about the athletes' needs, it's not bespoke, it's just generic information. (Weight Restricted Sport Practitioner 1 – Female)

I know previously I've had to undo a lot of the negative connotations people have put on food around carbohydrate loading. So, I've had players that wouldn't want to eat any carbs before games because they're worried they're going to get fat because in order to improve their body comp they've cut carbs out. They've seen it's worked, not realised it's calories and then now don't want to eat carbs again and not realise they need it to perform. So that balance between body comp and fuelling is huge. (Team Sport Researcher 1 – Male)

Related to these athletes' experiences, Annis et al. (2004, p. 156) suggest that, "women are more likely to express dissatisfaction and distress with body image than men". This is not surprising given that in comparison to men, women may experience a barrage of ideal body messages from peers, family and media concerning diet, fashion, cosmetics and cosmetic procedures (de Valle et al., 2021; Mingoia et al., 2017). These elite sportswomen therefore straddled a tension between the wider social pressures to conform to a thin ideal and the prevailing performance narrative. Furthermore, it was identified that individuals within the sporting environment, including coaches and practitioners, reinforced the performance or thin ideal narratives through their everyday practices. In the case of the performance narrative, practitioners often encouraged and guided athletes to fuel for the sport demands they faced:

267 Last year one of the players that I was chatting to after the game and she was like ‘when it went into
268 extra time, I just knew we were the better team because you’re always banging on about carbs, you’re
269 always shoving gels under our nose. (Team Sport Practitioner 1 – Female)

270
271 So, some of them, they’ve got reminders or sort of fuelling strategies actually inputted into their training
272 app, so when they’re logging onto their sessions they’ve got, you know, ‘this is what you need to do
273 fuelling wise’ so it’s very sort of straight forward. (Endurance Sport Practitioner 1 – Female)

274
275 Getting them to fuel appropriately is key. I want them to understand ‘this is what I need, this is what my
276 plate needs to look like’ and have a visual of portion size and understanding of ‘how hard have I trained?
277 What do I need to replenish that energy store and what does that look like relative to me as a person?’
278 (Multi-Sport Practitioner 1 – Female)

279 Conversely, athletes, coaches and practitioners within the sporting context, occasionally reinforced the societal
280 expectation for females to attain a thin ideal:

281 A lot of these kids know nothing and their coaches say to them ‘you’ve got to be this weight’ and they
282 are only 14 years old and especially as a female when you’re going through coming onto periods for the
283 first time, your hormones, your cycles, suddenly you weigh 5 pounds heavier and your coach is like ‘why
284 are you so heavy?’. (Weight Restricted Sport Athlete 1 – Hormonal Contraceptive User)

285
286 Sometimes as little as a single comment from a coach directed at a female about weight or body shape
287 or body composition can affect them for years, can lead to disordered eating behaviours and those are
288 the kind of things you read and go ‘oh sure’, but I’ve witnessed it with my own eyes. (Multi-Sport
289 Practitioner 1 – Female)

290
291 So, it’s almost like what we had to do first was heal them all, emotionally, like they’d all been beaten up
292 about their weight and told they’re fat and told not to eat, so trying to intersect body composition from
293 performance, as far as coaches are all concerned, lighter is better. (Team Sport Practitioner 1 – Female)

294 These accounts reveal that not only do female athletes straddle a tension between performance and thin ideal
295 narratives, but that within the sporting environment, comments from other participants may have negative
296 implications for athletes by encouraging inappropriate leanness and under fuelling. These reinforcements may

have been made unwittingly, but nonetheless represent confused and contradictory approaches to nutritional practice. Additionally, the measurement of body composition featured in many of the participant accounts and whilst this may provide assessments to enable evidenced based recommendations to enhance sporting performance, a number of participants identified how this can also encourage athletes to obsessively monitor their body mass and therefore under fuel as means to achieving leanness:

Basically, one player in particular had a really emotional reaction to her skinfolds and then I relayed that back to the sports scientist and he told me that she'd been making herself sick to achieve targets previously. And I was like 'so you didn't think to tell me that before I took her body composition?'.
(Team Sport Practitioner 1 – Female)

I've done it myself in my early days, you get your ISAK Level 1 and you go and do a sum of 8 skin folds and you just feedback that sum of 8 and you give them an arbitrary number and more often than not you put it into red, amber, green, which is not based on anything because it just becomes an isolated measure of fatness, which I don't believe is helpful. (Team Sport Practitioner 2 – Male)

Across these examples, there is a need for stakeholder groups to recognise the bio-psycho-social context that athletes inhabit, including the thin ideal and body image pressures that permeate wider cultures. Without doing so, there is a danger that through these comments and measurement practices, athletes are conceived solely as docile bodies to be moulded or as physical tools for the job (Gearity & Mills, 2012). Such an impoverished technocratic view neglects the emotional and social aspects of being a performer (Cronin et al., 2019) and in particular, a female athlete who may be under pressure to conform to a thin ideal body image.

Theme 1 therefore highlights that a tension between fuelling for performance and striving for a socially desirable body image, could also manifest in athletes consciously or unconsciously choosing to under fuel for training and competition. However, it is important to note, that such actions can result in a subsequent status of low energy availability, leading to acute and chronic maladaptive effects on both health and performance, as has been well characterised in both the Female Athlete Triad and Relative Energy Deficiency in Sports models (Mountjoy et al., 2018; Nattiv et al., 2007). With this in mind, practitioners and researchers should be mindful of the bio-psycho-social implications of their practices, as it should be recognised that the performance and thin ideal are not abstract narratives solely generated by wider society, but also manifest in the micro-interactions of those participants within the everyday sporting contexts.

Theme 2: Sport nutrition practice is influenced by a range of female specific factors, therefore presenting a number of unique individual challenges

As athletes and sport nutrition practitioners seek to navigate the tension between fuelling for performance and thin ideal narratives, insights from the data revealed how individual menstrual status (i.e., menstrual cycles, menstrual irregularities and/or hormonal contraceptive use) posed unique challenges. Consistent with recent qualitative studies (Brown et al., 2021; Findlay et al., 2020), athletes reported a variety of symptoms, which appear regardless of being a hormonal contraceptive user or non-user:

I take contraceptives because I get really bad cramps and I just took the implant because it was easier to have, but I still get my cycle, so I still feel the week before much more sluggish and fatigued, usually especially the 2-3 days before I just feel pretty bad. I will still get cramps, but it's less often, so maybe I'll go a few cycles and then I'll have a bad cramp phase, but overall, it's less. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

It's really hard to be honest, I've had to take a lot of pain killers that's how painful it gets. I have something called pre-menstrual dysphoria, so it really, really knocks your mind and it really kicks the shit out of you physically in terms of a cascade of symptoms. (Weight Restricted Sport Athlete 2 – Non User)

During that week I have my period my internal body temperature rises so I'm hotter more of the time and so therefore I'm sweating more, which is probably why I also crave more salt (Weight Restricted Sport Athlete 1 – Hormonal Contraceptive User)

So, the biggest, biggest factor that affects my training, is the effect it has on my stomach. It's a huge, huge trigger, it is with quite a lot of women I've spoken too, they have bad stomachs at that time, but for me, I find as an athlete it's so hard because then I'm not getting in the right nutrition, I'm not absorbing it right and I feel I'm becoming ill. (Team Sport Athlete 1 – Non User)

This diverse symptomology means that providing nutritional support can be complex because individuated bio-psycho-social needs require bespoke care, with the prevailing narratives of the practitioner and researchers highlighted how supporting female athletes during this time can be challenging:

There's like, water retention as well which again, is a very blurry line that can impact weight and, you know, all it takes is a girl to get on the weighing scales at the wrong time of the month and they've put on an extra kilo and a half, two kilos in some instances and that massively throws them off and that can lead to then a change of behaviour with food. (Weight Restricted Sport Practitioner 1 – Female)

Another piece that you've got to be on top of with is iron and ferritins. I've joked before that any new female endurance athlete that presents is anaemic unless proven otherwise. I would say that as a whole and there's data to support this too, for every male we get four females with gastrointestinal issues. So, it's tends to be that female athletes are more challenging to manage nutritionally because they seem to be less predictable in terms of their responses to traditional nutrition interventions. (Multi-Sport Researcher 3 – Male)

Some of the common things that are reported are changes because of cravings or a loss of appetite. Obviously, the impact of menstrual cramping as well can have an impact from an appetite perspective. If someone gets extreme menstrual cramping that's obviously really painful and again that is likely to have a direct effect. A lot also report changes in their gut function too. (Endurance Sport Practitioner 1 – Female)

As highlighted in the latter quote, another commonly reported challenge across the participant groups, was the conflict in battling cravings:

Before my bleed I'll want more sweets, but I think that goes along with carbs because sugar is a carb, so maybe that's why women crave chocolate, I don't know. But I definitely get strong cravings at certain points, but it's hard to explain why. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

I think the challenge is around premenstrual syndrome and periods and that point of time when your appetite's going to be higher, you're going to be craving a lot of crap food and then there's this argument in yourself between 'oh do I really want to lose weight or not?' and just craving a lot of crap food. (Team Sport Athlete 3 – Non User)

Women do tend to eat more in the late luteal phase of their cycle and report this all the time, their cravings go up and they report more cravings for sweet fatty foods like chocolate. But women often do feel bad

386 about cravings, so I think a lot of women will eat differently at different stages of their cycle and again
387 it's that latter half of the cycle that really seems to get them. (Multi-Sport Practitioner 1 – Female)

388

389 I definitely hear the athletes talk about specific cravings certain around times within the cycle and
390 generally they would be for chocolate or really, like, savoury carbohydrates. I would say definitely
391 around phases of the cycle they would talk about sweet things a bit more. (Team Sport Practitioner 1 –
392 Female)

393

394 It's very difficult as a male to go 'no you don't need it' because I've never had that feeling, so I haven't
395 ever experienced that physiological or psychological response to what is happening, so it's very difficult
396 for me. What I have to do is empathise and say, 'if you are going to have chocolate try this' or 'limit it
397 to this' or reduce this on this day, so I'll try and find a solution for them to have the chocolate because I
398 don't feel like I can say to them 'no you can't have chocolate' or 'no you can't have this because it's not
399 in your plan'. (Team Sport Researcher 1 – Male)

400 These experiences support evidence that craving and food sensitivities appear to be synonymous across female
401 athletic groups independent of contraceptive status (Ihalainen et al., 2021; Tucci et al., 2010). Interestingly,
402 athletes', practitioners' and researchers' responses to cravings were almost always considered in relation to the
403 performance narrative i.e., *will this help me perform* and/or in relation to the thin ideal i.e., *will this help me control*
404 *body mass*. Additionally, both the sex and the underlying knowledge appeared to influence any support provided
405 as has been previously demonstrated (Brown & Knight, 2022; Clarke et al., 2021) and which is further expanded
406 upon in theme 3. This is an important challenge for practitioners to consider, given changes to nutritional intake
407 mediated by cravings and external pressures can have implications on females' mental health and feelings of self,
408 which may be tied to overall body dissatisfaction (Ryan et al., 2021).

409 In addition to the challenges noted above, further contradictory nutritional approaches also manifested within the
410 elite sport environment, with some participants demonstrating espoused views by advocating for a *food first*
411 approach, before later listing extensive use of female specific dietary supplements:

412 I'm very, very much an advocate of a food first balanced diet –

413 I'll take collagen and stuff, as it's meant to be good for females if you're picking up a niggle. I also take
414 are vitamin D... I have omega 3 in the morning and if I need it iron. I also take a probiotic for my stomach.

415 I'll also use protein powder... I usually have the electrolyte tabs... I often have the vitamin C... so the

nitrate bars are a favourite...I used to use creatine...I'll also use tart cherry juice for recovery and to help my sleep. (Endurance Sport Athlete 2 – Hormonal Contraceptive User)

My focus is to shift away from supplements to food first –

I guess you could say I follow the IOC paper on this, so you've got your correcting female deficiency supplements, so your irons, your vitamin Ds, your B12s, you've got your treating a condition like a stress fracture, so your calcium and then you've got your sort of training aid supplements or your protein powders and your creatine and then you've got your competition supplements like your caffeine, your beetroot, things like that. (Multi-Sport Practitioner 1 – Female)

I think more supplements you kind of layer on, then the bigger a distraction it is from actual real food - protein and creatine would definitely be our two biggest ones from a training perspective. And then from a basic perspective it's probably more bicarb and caffeine would be the two big ones...we obviously use sports foods like carb gels, powders...collagen is something that we use... vitamin D and probiotics I suppose would be another big one we use in females. (Multi-Sport Researcher 1 – Female)

These dietary supplements reflect strategies to mitigate injury (i.e., collagen), protect bone health (i.e., calcium and vitamin D) and those proposed to offset menstrual symptomology (omega 3, iron, probiotics, B vitamins), which are factors of concern in female athlete populations (Khatri et al., 2021; Nattiv et al., 2007). Nevertheless, the participants' discourse reflects a tension between an ideal context (i.e., food first) and a performance focus on maintenance and/or growth of muscle mass alongside health related goals , thereby once more confirming that an athletes' body is one to be amended in line with the prevailing performance narrative.

Overall, theme 2 demonstrates that nutrition support for female athletes is influenced by individual experiences of varied menstrual status, diverse symptomology and specific performance requirements. On this basis, providing such support is a complex process, given these factors are both personalised and dynamic i.e., changeable over time. To that end, a current popularised concept of a *generalised* and *one size fits all* approach to implementing sport nutrition practice based around phases of the menstrual cycle, does not appear to be a practical strategy when engaging with female athletes, given the individualised contexts highlighted within this theme .

Theme 3: A continuing need for ongoing education and further research requirements centred around female nutrition

In the face of the complex challenge to provide sport nutritional support, all participants emphasised a need for ongoing education and further research. In terms of education, athletes explicitly advocated for more knowledge and practical understanding:

I think educating people is the best way for them to understand, because I went to university and it wasn't until I started competing when I was in my early 20s that I learned anything about nutrition. So just basic nutrition, let alone female nutrition and how the female cycle affects you performing, all of these things are really important. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

I think if we were educated younger, you'd probably get into the importance of nutrition earlier. I just think some teams aren't able to provide the money they need to put into nutrition to then support women in the right way. (Team Sport Athlete 2 – Non User)

I think one thing is not knowing how much you should be eating, because players don't really track it, so I think if maybe they did, they would eat more. (Team Sport Athlete 3 – Non User)

Practitioners similarly reinforced the need for athlete education:

There are numerous areas to consider with the female athlete. You've obviously got the menstrual side of things and then you've got the energy availability side of things and body image side of things and that whole education around it is crucial. (Weight Restricted Sport Practitioner 1 – Female)

The biggest thing that I think we can do to help female athletes is really those younger, vulnerable athletes who don't have this support and making sure that they're getting the right messages of what the important things to focus on are. They need education. (Endurance Sport Practitioner 1 – Female)

Quite simply better knowledge around their day to day fuelling, I think if players are educated well around how to fuel for their daily training sessions and during competition and shown to do it properly and energy and time is spent in teaching and application around weighing food, food systems, then I believe that's the most important way to go for female athletes. (Team Sport Practitioner 2 – Male)

475 While a call for further education of athletes was recurrent across the data, it was also notable that many athletes
476 had learnt from their prior nutritional experiences. Specifically, reflecting on different nutritional approaches was
477 a source of knowledge and experiencing the embodied consequences of these strategies led to changes in
478 behaviour:

479 I think I've just learnt the hard way, I've under fuelled, I've done it all the wrong way around in the past
480 and really suffered as a consequence. (Endurance Sport Athlete 2 – Hormonal Contraceptive User)

481
482 It's taken a lot of trial and error for me to work out what I need best going into a game, but I think now
483 I've kind of got the balance between 'okay, I need to make sure that I fuel with enough carbs. (Team
484 Sport Athlete 1 – Non User)

485
486 Have I learnt the hard way about doing it wrong? Yes, I have. Have I absolutely messed up the weight
487 cut and then just gone for a McDonalds? Yes. And was it the worst prep ever? Yeah, it was, I felt awful
488 and it was a terrible way to fuel. (Weight Restricted Sport Athlete 2 – Non User)

489 Additionally, practitioners described providing formal workshops and individual advice to athletes. Related to
490 this, how practitioners care for athletes in sport contexts has received some recent attention, with authors calling
491 for an ethic of care in high performance sport (Cronin et al., 2020; Fisher et al., 2019). In keeping with this theme,
492 some sport nutrition practitioners articulated practices such as paying attention to and collaborating with female
493 athletes to support their complex nutritional needs:

494 So, we work on grams per kilo and we've got ranges for the group in terms of where we think people
495 should be at on different days and at different phases and then that's sort of individualised based on some
496 of the power meter data to get an indication of expenditure they might do in those rides. (Endurance
497 Sport Practitioner 1 – Female)

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499 I mean the idea is they've got individual plans and I guess it's working back from what we're trying to
500 achieve in that training block, so overarching principles, what we're trying to achieve and then what the
501 sessions look like and what we would need to get out of each individual session and then looking at total
502 fuelling. (Multi-Sport Researcher 1 – Female)

Importantly, data from the thematic analysis also revealed that in contrast to the other participants, three practitioners (two of whom were female) did not consider menstrual or contraceptive status to be linked to athlete nutrition or performance:

I couldn't tell you off the top of my head, who was or wasn't on contraception unless I went specifically asking, the medics. From my perspective, irrespective of whether they're on contraception or not, I've never identified that as information that I necessarily needed to know and I'm not sure it would alter what I was trying to strategically achieve... I had 6 years with a team and I never had that conversation once with any player about female issues. (Team Sport Practitioner 2 – Male)

I couldn't reel off whether or not they're on oral contraceptives or not, plus I might not necessarily ask them the level of detail of how many milligrams of progesterone or oestrogen and I'll be honest, I don't know the numbers that track their cycle. Some of them probably do, but I just haven't had a conversation about it, because I don't think it's relevant to my practice. (Multi-Sport Practitioner 2 – Female)

As a nutritionist no I don't track, I do wonder how much in terms of that info is medical, it's almost like who owns that job? I know that there are some athletes that do track themselves, but I couldn't put a number on it. To be honest I've not gone out there across how many athletes on our programme and asked the question, as realistically is it important for me to know that? (Weight Restricted Sport Practitioner 1 – Female)

This highlights how practitioners in high performance sport settings might also benefit from education as has been previously highlighted (Brown & Knight, 2022; Clarke et al., 2021), particularly given the well-established differences in nutritional regulation between the sexes and how this may also be influenced by menstrual and hormonal contraceptive cycles (Areta & Elliott-Sale, 2022).

Beyond these perceptions, there was also a recognition that female ovarian health remains somewhat of a taboo subject in high performance sport settings. It was suggested that male coaches under appreciate the importance of these factors and felt uncomfortable discussing them. For some participants, menstrual and contraceptive status were considered as solely medical issues and therefore outsourced:

I engaged with one coach previously and said 'I'm seeing some trends here that are concerning, like, one of your girls isn't having a period and you know, another one isn't eating breakfast ever and I think is eating about, like, 1,500 - 1,800 calories a day, something's really off here' and he asked me 'so are you

533 telling me that I should be talking to my athletes about their periods?', to which I said 'honestly, probably
534 you should!'. (Multi-Sport Practitioner 1 – Female)

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536 Generally, I think with a lot of practitioners who are either male or female, that barrier has been crossed
537 very well. Where we are with the coaches, I think there's probably a long way to go in terms of female
538 performance conversations. There's a couple of athletes that I have started to work with that have been
539 so appreciative because they're like, 'I'm 28 years old and not a single coach has sat down and asked me
540 these questions before'. (Multi-Sport Researcher 3 – Male)

541

542 Now in sport those conversations happen openly, but within the closed confidentiality of the doctors.
543 Performance nutrition is the aspect that I've got expertise in, so I acknowledged it was medically led and
544 shouldn't involve me. (Team Sport Practitioner 2 – Male)

545 Coupling this stigma, is a recognition from all of the participants that research on female ovarian health and sport
546 nutrition requirements remains inadequate. Based on this constraint, there was a recognition that much research
547 has been conducted on male populations and a desire for more bespoke information:

548 Understanding the differences and the needs of the male and female body is definitely important. I think
549 more research could be done. (Endurance Sport Athlete 1 – Hormonal Contraceptive User)

550

551 I think first and foremost we need the research into female athletes, that is absolutely key as we just don't
552 know enough. (Team Sport Athlete 1 – Non User)

553

554 I think, from my perspective, I don't feel there's enough science out there to be able to definitively say
555 to a female athlete 'okay, we know that if, you know, this type of nutritional strategy is going to help you
556 at this time of the month' or whatever, I just don't think there's enough information out there about it.
557 (Multi-Sport Practitioner 2 – Female)

558 Theme 3 therefore demonstrates that athletes, practitioners and researchers within this study appreciated
559 experiential learning, individualised care and the openness of some practitioners and coaches to explore female
560 sport nutrition from the perspective of menstrual status. Nonetheless there remains a need for rigorous and
561 population specific research and widespread education campaigns designed to challenge stigmas and ensure
562 positive and effective nutritional strategies for female athletes.

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Conclusions

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Recommendations

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This study provides the first ever exploration of athletes', practitioners' and researchers' perceptions of female nutrition practices in elite sporting environments. A common theme highlighted amongst all participant groups was the task of adequately fuelling for both training and competition demands. Paradoxically, all groups further reported that many females are concerned about how fuelling may also negatively affect body mass and body composition goals. Overall, these concerns are deeply rooted in the perception of a thin ideal body image, driven by societal ideals. This concern was further precipitated by sport specific stakeholders i.e., coaches and support staff, through everyday practices e.g., body composition measurement and a desire for lean athletes. The findings also demonstrated the complex nature of providing sport nutrition support to elite female athlete populations by describing how variations in the female menstrual cycle and hormonal contraceptive associated symptomology, leads to individuated influences on cravings and approaches to dietary intakes and supplementation. These individual contexts necessitate personalised care based on female specific research, yet all participant groups recognised a need for more education and highlighted that the paucity of female specific examinations within the current research literature, make this difficult to employ in practice. Worryingly within the practitioner group, some individuals did not recognise how athletes' menstrual cycles, contraceptive use and associated symptomology may affect nutrition support and subsequent sporting performance.

Through the above insights, this study contributes towards addressing the sex data gap by detailing the nutritional experiences of female athletes from a bio-psycho-social perspective. It also directs both researchers and practitioners working with female athletes to consider:

- (i) Nutritional interventions that provide personalised and appropriate fuelling, whilst understanding individual female athletes' perceptions of body image
- (ii) The role of coaching and practitioner staff in caring for female athletes who may experience body dysmorphia, with a view to implementing strategies to reduce its prevalence
- (iii) Tracking menstrual and/or contraceptive status and understanding how to use this data for the benefit of individuated approaches to sport nutritional and training practices
- (iv) Education interventions with female athletes based on experiential and collaborative pedagogies
- (v) Educational interventions that support practitioners to understand the bio-psycho-social influences on female athletes and challenge menstruation stigma in sport

In doing so, this study provides a significant platform for those exploring future nutrition research and practices, that are specific to female populations in elite sports.

Reflections and Future Considerations

As first author when conducting these interviews, I often felt had a unique perspective, given I was biologically born and identify as a male. With this in mind, at the beginning of the process I often perceived this afforded me a strong position to conduct this research, as I had no previous experiences and biases of being or identifying as a female. However, I became innately aware throughout the process of conducting the interviews, that a female perspective may have provided me with a richer view in examining the aims of the study. This became very apparent to me when exploring the data with other female members of the authorship team and them raising points I couldn't have possibly considered from a male context. For example, not considering or even appreciating that we could have requested all participants provide their demographic information i.e., body mass, stature and even contraceptive status of those female practitioners and researchers, in order to create parity across our enquiries. To that end, the dynamic between interviewers and interviewees of different sexes when conducting interviews that explore factors specific to females is certainly a consideration for future research. However, despite this and as a former athlete, coach and current practitioner/research scientist, I did feel this put me in a positive position to build considerable rapport and open dialogue with each participant, allowing me to build trust and engage in deeply rich accounts of individual experiences and perceptions within the realm of female sport nutrition. I often reflected post interview on how the discussion unfolded and tried to identify if any of my own biases had shaped the discussions. This is a process I would encourage all those who conduct this type of research to engage with. Additionally, this study also made me aware of several ethical factors, that at the time of conducting data collection I had not considered. After wider consultation with the authorship team, we had long discussions regarding the utilisation of our pilot interviews and also whether or not we should share the collated themes with each participant prior to publication. Whilst we finally chose not to do this, this is certainly a consideration for future research designs, in garnering what the participants think about final perceptions of their interviews and for greater transparency in ethical caring of those we engage with. Finally, we did not include an analysis of specific factors related to participant race/ethnicity or sporting identity i.e., sport type within the study and this is certainly an area for consideration in future research. With this in mind and despite these limitations, we hope this investigation stimulates further discussion and acts as an initial catalyst for further qualitative enquiry within this area of research.

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Table 1.

Key Domains, Topic Areas and Example Questions Employed Across the Differing Participant Group Interviews

Domain 1: BACKGROUND DEMOGRAPHICS		
Topic	Example Questions Athletes	Example Questions Practitioners/Researchers
Sporting history	<i>How long have you participated in this sport? How long have you been competing/practicing?</i>	
Experience of working with or providing nutritional support	<i>Have you ever worked with a nutritionist and for how long? If so, what was the frequency of input? If not, what is your source of nutritional guidance?</i>	<i>What is the frequency and type of nutritional input you provide to the athletes you work with?</i>
Performance conversations around the female athlete	<i>Are you aware of and comfortable discussing your ovarian health with coaches/practitioners and if not why? Does the sex of the individual dictate this type of conversation?</i>	<i>Are you aware of and comfortable discussing the ovarian health of the athletes you work with and if not, why? Does the sex of an individual when working with female athletes' dictate these conversations?</i>
Understanding of contraceptive status	<i>What is your contraceptive status and what motivated your choice? Do you track your cycle and if so, how?</i>	<i>Do you know each of the athlete's you work with contraceptive status and is it important to know? If so, do you know what motivated the athlete's choice? Do you know which type of contraception your athletes may be taking? Do you know if the athletes (or do you encourage them) track their cycle & if so, how?</i>
Domain 2: THE ROLE OF NUTRITION IN DETERMINING SPORTING PERFORMANCE		
Topic	Example Questions Athletes	Example Questions Practitioners/Researchers
Influence and priorities of nutrition in sport	<i>Does nutrition influence performance in your sport? If so, what are your key performance nutrition priorities that have the biggest performance impact? What are your responses based on and how has this been established?</i>	
Approaches to training day and competition nutrition	<i>What are your typical nutritional habits in terms of how many meals/snacks and the amount of fluid you intake per day and why is it structured in this way? Do you ever plan and/or periodise your nutrition in relation to training/competition days and if so, why (or why not)? Do you ever deliberately skip meals and if so, why? Do you ever use nutritional supplements and if so, why (or why not)?</i>	<i>What are your suggested typical nutritional strategies in terms of how many meals/snacks and the amount of fluid your athletes should intake per day and why is it structured in this way? Do you ever plan and/or periodise your nutrition strategies in relation to training/competition days and if so, why (or why not)? Do you know if your athletes ever deliberately skip meals and if so, why? Do you ever recommend the use of nutritional supplements and if so, why (or why not)?</i>
Domain 3: SPORT NUTRITIONAL CHALLENGES SPECIFIC TO THE FEMALE ATHLETE		
Topic	Example Questions Athletes	Example Questions Practitioners/Researchers
Nutritional requirements and habits throughout the menstrual cycle/stages of contraceptive use	<i>Do you feel that your nutritional needs and/or habits change throughout the menstrual cycle/stages of contraceptive use? If so, why is this and what do you think are the reasons?</i>	<i>Do you feel that the athletes you work with nutritional needs and/or habits change throughout the menstrual cycle/stages of contraceptive use? If so, why is this and what do you think are the reasons?</i>
Identification of initiatives for further development and support in female sport nutrition	<i>How do you believe sport scientists and nutritionists can really help female athletes in the area of sport nutrition?</i>	