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Recreational Endurance Athletes' Knowledge and Attitudes towards Carbohydrates and the Factors Influencing Carbohydrate-Fuelling Practices.

DECLARATION FORM



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1. This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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https://copilot.microsoft.com/	16/09/2026	Help with running tests using SPSS	Can you guide me with preparing my data set to run tests using SPSS?
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Abstract

Introduction

Carbohydrate availability is a key determinant of endurance performance. Insufficient carbohydrate intake can negatively impact training adaptations and lead to earlier fatigue onset (Burke *et al.*, 2011; Podlogar *et al.*, 2022). Despite well-established evidence-based recommendations for carbohydrate intake in endurance sport, research shows that athletes often do not achieve these recommended intakes. This study aimed to examine recreational endurance athletes' knowledge of evidence-based carbohydrate requirements, their reported carbohydrate fuelling practices, and the factors influencing these behaviours.

Methods

A cross-sectional mixed-methods design was utilised. 22 recreational endurance athletes completed an online survey assessing their self-reported knowledge of carbohydrate requirements, attitudes towards carbohydrate intake and endurance performance, and their carbohydrate-fuelling practices. Six participants then participated in semi-structured interviews (SSI). Quantitative data were analysed descriptively using Microsoft Excel, with additional statistical analyses conducted in IBM SPSS Statistics. Qualitative data were analysed using Braun & Clarke's (2006) six-phase thematic analysis framework.

Results

Participants generally demonstrated positive attitudes towards carbohydrate intake and endurance performance. Most participants reported adjusting their carbohydrate intake according to training demands and deliberately implementing carbohydrate-fuelling practices. Despite this, knowledge of evidence-based recommendations was less consistent, with over half of participants unable to identify recommendations for daily carbohydrate intake. Online resources were the most frequently reported source of nutrition information. Thematic analysis was used for the SSI and identified four main themes: understanding of carbohydrate fuelling for endurance performance; application of carbohydrate fuelling strategies; knowledge of evidence-based

recommendations; factors influencing carbohydrate intake. Practical, financial, gastrointestinal and body-composition-related factors were identified as prominent influences on fuelling practices, suggesting that knowledge deficits alone did not determine behaviour.

Conclusions

The findings of this study indicate that endurance athletes deliberately engage in carbohydrate-fuelling practices, despite incomplete knowledge of formal recommendations, suggesting that factors beyond knowledge influenced behaviours. Application of the Capability, Opportunity, Motivation-Behaviour (COM-B) model provided a useful framework for understanding participants' decision-making, demonstrating that knowledge alone may not determine behaviour (Michie *et al.*, 2011). Future sports nutrition interventions should focus not only on improving recreational endurance athletes' knowledge of carbohydrate recommendations, but also on supporting the translation into realistic, sustainable fuelling practices whilst overcoming practical and motivational barriers to implementation.

Key words: recreational endurance athletes, carbohydrate requirements, fuelling practices, COM-B

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List of Abbreviations

ACSM – American College of Sports Medicine

CEAC-Q – Carbohydrate for Endurance Athletes Questionnaire

COM-B – Capability, Opportunity, Motivation – Behaviour

HCPC – Health and Care Professions Council

KAP – Knowledge-Attitude-Practice

SSI – Semi-structured interviews

UWTSD – University of Wales Trinity St David

VO₂max – Maximal Oxygen Uptake

SPSS – Statistical Package for the Social Sciences

HCP – Health Care Professional

g·kg⁻¹·day⁻¹ - grams per kilogram of body weight per day

g·kg⁻¹·h⁻¹ - grams per kilogram of body weight per hour

g·h⁻¹ - grams per hour

Chapter 1 - Introduction

1.1 Introduction to chapter

This chapter introduces the research topic of carbohydrate knowledge and fuelling practices among endurance athletes. It provides the background and rationale for the study, the aims and objectives, and the research questions. It also outlines the researcher's motivation for undertaking the project and the overall structure of the dissertation.

1.2 Background and context

Endurance sports, also known as aerobic training, are typically characterised by repetitive, isotonic contractions of large muscle groups over a prolonged duration. For example, such activities include running, swimming, rowing and cycling (Morici *et al.*, 2016). These activities involve muscular contractions at a lower force and reduced power outputs for an extended duration of time (Best, 2020). Carbohydrate availability is a key determinant of endurance capacity (Noakes *et al.*, 2026). Ensuring high carbohydrate availability before, during and after endurance exercise is essential for optimising performance and supporting recovery. Adequate carbohydrate intake helps the maintenance of blood glucose concentrations and maximises both skeletal and hepatic glycogen stores prior to exercise (Podlogar *et al.*, 2022).

Participation in endurance sports such as marathon running, triathlon and cycling has increased considerably in recent decades (Lepers *et al.*, 2013; Scheerder *et al.*, 2015). Alongside this growth, there is an increased interest in nutrition and dietary strategies to optimise health (Kabata *et al.*, 2022). Sports nutrition is a rapidly growing sector with increasing demand for evidence-based recommendations (Carey *et al.*, 2023). Nutrition is a key determinant of endurance training, performance and recovery. Appropriate nutritional strategies can support glycogen storage, delay fatigue and enhance recovery (Burke *et al.*, 2004). Despite the increased interest of ketogenic diets in endurance sports (Sun *et al.*, 2024), carbohydrates remain the key energy substrate for moderate

to high-intensity endurance exercise and remain central to current sports nutrition recommendations (Podlogar *et al.*, 2022).

Given the importance of carbohydrates for endurance performance, both recreational and elite athletes require knowledge of evidence-based recommendations and the skills to translate them into practical, day-to-day fuelling practices (Naderi *et al.*, 2023). However, current research suggests that athletes often do not meet the recommendations for carbohydrate intake, suggesting potential knowledge deficits or alternative factors influencing their behaviours. Understanding these factors is important to optimise performance, recovery and to promote an individual's long-term health. Recreational endurance athletes represent a relevant demographic for this topic, given their high carbohydrate requirements and the importance of carbohydrate availability for endurance performance.

Nutrition knowledge has been recognised as a key determinant of dietary behaviour, and a lack of knowledge can lead to poorer dietary choices. This can increase the risk of various non-communicable diseases, including cardiovascular disease and diabetes (Halki *et al.*, 2016). Within athletic populations, improving knowledge of evidence-based recommendations for training, competition and recovery can support them to make informed choices on their fuelling practices which align with their training demands and performance goals. However, many practical, social and motivational factors can influence behaviour and fuelling practices, representing an area worth investigating within sports nutrition research. These may include sporting environment, cultural backgrounds, and individuals' variations in appetite and taste preferences (Vásquez-Espino *et al.*, 2022).

1.3 Rationale for the study

It is well established in the field of sports and exercise nutrition that carbohydrates are critical for exercise and athletic performance (Podlogar *et al.*, 2022). This is reflected in the dietary carbohydrate guidelines for endurance activities, see table 2.1 (Thomas *et al.*, 2016). Despite this, current literature suggests that endurance athletes consume

less than the recommended amount of carbohydrates, though whether this is unintentional or intentional is unclear (Baranauskas *et al.*, 2015).

In an environment where access to nutrition information is readily available, it can be increasingly difficult for individuals to determine its accuracy and reliability. Social media can play a role in promoting health education whilst also acting as a vehicle for the rapid spread of misinformation (Alsaratee and Yunusa, 2025). The increasing popularity of endurance sports, alongside this growing access to nutrition information, may expose athletes to inconsistent or conflicting information regarding carbohydrate intake. Understanding athletes' knowledge of evidence-based carbohydrate recommendations and how these are applied in practice is highly relevant to ensure fuelling strategies are implemented safely and effectively.

Although evidence-based carbohydrate recommendations are well established, there remains uncertainty regarding athletes' understanding of these recommendations and the extent to which knowledge influences their fuelling practices (Pozaić *et al.*, 2023; Boucherville *et al.*, 2023). Whilst previous studies have assessed nutrition knowledge among athletes and others have assessed carbohydrate intake practices, relatively few studies have integrated both perspectives to explore how knowledge translates into behaviour (Sampson *et al.*, 2024; Baranauskas *et al.*, 2015; Scrivin *et al.*, 2023). Furthermore, there are relatively few studies which have included qualitative research exploring athletes' experiences and the factors influencing their decision-making processes regarding carbohydrate fuelling behaviours (Bentley *et al.*, 2019; Ryan *et al.*, 2026; Fortis *et al.*, 2026). Therefore, this study seeks to examine recreational endurance athletes' knowledge of carbohydrate requirements, reported fuelling practices and the factors influencing these behaviours. As such, there is justification for research examining not only athletes' knowledge, but also how this is applied in practice and what factors influence their implementation. As fuelling practices are likely influenced by other factors beyond knowledge alone, this study interprets findings using the Capability, Opportunity, Motivation-Behaviour (COM-B) model (Michie *et al.*, 2011).

The findings of this study have the potential to inform sports nutrition practices by improving understanding of the barriers and facilitators influencing carbohydrate-fuelling behaviours among recreational endurance athletes. Improved understanding may support sports nutritionists, dietitians and coaches in educating athletes on translating acquired knowledge into practical, sustainable day-to-day practice. For example, supporting with meal planning and carbohydrate periodisation which aligns with their training load, which will support athletes to implement the evidence-based recommendations.

1.4 Study context

The study was conducted among recreational endurance athletes from South Wales using an online mixed-method design. Inclusion criteria included adults who participate in at least 30 minutes of endurance activities, twice per week. Participants were recruited through a local triathlon club known to the lead researcher. All participants completed a survey and then a select number completed semi-structured interviews (SSI). The study explored participants' knowledge of evidence-based carbohydrate requirements, attitudes towards carbohydrates and endurance performance, and their carbohydrate fuelling practices.

A mixed-methods approach was utilised and considered appropriate as it allowed assessment of participants' knowledge and fuelling practices through quantitative data collection, and further exploration of their attitudes, beliefs and decision-making on fuelling practices, through qualitative data collection. Combining both methods provided a comprehensive understanding of the relationship between carbohydrate knowledge and dietary practices amongst participants.

1.5 Research aim and objectives

This study aimed to examine endurance athletes' knowledge of evidence-based carbohydrate requirements, their reported carbohydrate fuelling practices, and the factors influencing these behaviours.

Objectives

- 1) To assess participants' knowledge and understanding of recommended carbohydrate intakes for endurance training, competition and recovery.
- 2) To explore participants' attitudes towards carbohydrate intake and endurance performance.
- 3) To explore participants' reported carbohydrate-fuelling practices.
- 4) To identify factors influencing carbohydrate-fuelling behaviours.
- 5) To interpret the findings using the COM-B model of behaviour.

1.6 Research questions

The study sought to address the following questions:

- 1) What knowledge do participants possess regarding evidence-based carbohydrate requirements for endurance performance and recovery?
- 2) What are participants' typical carbohydrate-fuelling practices and which factors are influencing these behaviours?
- 3) To what extent does knowledge appear to influence participants' fuelling practices?

1.7 Researcher motivation

The researcher's interest in this topic stems from personal involvement in endurance sport and professional experiences as a registered dietitian. The researcher has personal experience in running, having completed three marathons and numerous other running events. As a member of a local triathlon club, they have experienced first-hand the uncertainty around fuelling endurance training. Having also worked in a professional capacity with endurance athletes, this has further highlighted inconsistencies between evidence-based recommendations and athletes' fuelling practices; often observing under-fuelling and poor timing of carbohydrate consumption. These experiences highlighted a recurring discrepancy between evidence-based recommendations and real-world fuelling practices. This prompted an interest in better understanding whether carbohydrate-fuelling practices are primarily influenced by knowledge or by other practical, social and motivational factors.

1.8 Dissertation structure

The dissertation is structured into six chapters, and the sequence is as follows:

- Chapter One introduces the research topic, outlines the study rationale and presents the aim and objectives.
- Chapter Two presents a critical review of the literature relating to evidence-based carbohydrate recommendations, athletes' nutrition knowledge and attitudes, and factors influencing implementation of carbohydrate fuelling practices.
- Chapter Three describes the research methodology, including study design, participant recruitment, data collection methods and methods of analysis for quantitative and qualitative data.
- Chapter Four presents the findings from the online survey and SSI.
- Chapter Five discusses the findings in relation to existing literature and interprets them using the COM-B framework. It also presents the practical implications, identifies the study's strengths and limitations, and provides suggestions for future research.
- Chapter Six presents a summary of the study and presents the overall conclusions.

1.9 Chapter summary

This chapter has introduced the research topic, outlined the rationale for the study, and presented the research aims, objectives and research questions. It has also situated the study within the wider field of sports nutrition and explained the structure of the dissertation. The next chapter critically reviews relevant literature relating to carbohydrate requirements for endurance performance, athlete nutrition knowledge and behavioural influences on their fuelling practices.

Chapter Two – A review of the literature

2.1 Introduction to the chapter

This chapter will summarise and critically analyse the existing literature on carbohydrate requirements in endurance sport. Firstly, it will discuss the evidence-based recommendations for carbohydrate intake, before exploring athletes' knowledge and understanding of these recommendations. The chapter will then explore if athletes' knowledge is implemented in day-to-day dietary practices. Lastly, the chapter will identify gaps in existing literature before establishing the rationale for the present study.

2.2 Review of the literature

2.2.1 Search strategy

Google scholar was used to identify peer-reviewed articles and journals relating to carbohydrate requirements, nutrition knowledge and dietary practices in endurance athletes. Searches were conducted using key terms including carbohydrate requirements; endurance athletes; athlete knowledge; athlete attitudes; fuelling practices. Focus was prioritised on peer-reviewed sources published from 2015 onwards to ensure the literature review reflects up-to-date evidence and sports nutrition guidelines. References used by relevant articles were also screened to identify any additional relevant information.

2.2.2 Study selection

Studies were selected based on their relevance to the aims and objectives of the study. These included articles which researched carbohydrate requirements, athletes' nutrition knowledge and dietary intake, and behavioural influences on fuelling practices amongst endurance athletes. Studies were excluded if they focused primarily on non-endurance sports and participant populations with specific medical conditions or injuries.

2.3 Carbohydrates

Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen and are classed as a macronutrient. Dietary carbohydrates are primarily metabolised into glucose which can be oxidised to generate ATP which can be used directly by cells and tissues as a direct energy source (Campbell, 2017). Glucose can also be converted to glycogen which is predominantly stored in the liver and skeletal muscle as an energy reserve. For active individuals, carbohydrate availability is important to sustain the demands of physical activity, particularly high intensity exercise or competitions (Podlogar *et al.*, 2022). Glycogen availability, along with exogenous carbohydrate intakes during exercise, are a key determinant of endurance capacity. They help to mitigate exercise-induced hypoglycaemia and delay the onset of fatigue (Noakes *et al.*, 2026).

2.4 The role of carbohydrates in endurance performance

Endurance activities such as running, swimming, rowing and cycling have high energy demands due to the prolonged involvement of large muscle groups (Morici *et al.*, 2016). Carbohydrates are a key energy substrate for endurance exercise, particularly as exercise intensity increases, as carbohydrate oxidation supports a rapid rate of adenosine triphosphate (ATP) production (Podlogar *et al.*, 2022). Glycogen stored in skeletal muscle and the liver act as a readily available source of glucose during exercise to help maintain blood glucose concentrations and support sustained muscular contractions (Cao *et al.*, 2025).

Research consistently demonstrates that, during prolonged and/or high intensity exercise, reduction in muscle glycogen availability is associated with compromised endurance performance and an earlier onset of fatigue (Ortenblad *et al.*, 2013; Podlogar *et al.*, 2022). The phenomenon of “hitting the wall” or “bonking” is believed to be associated with glycogen depletion (Cao *et al.*, 2025). As such, carbohydrate availability before and during endurance exercise is key, especially for prolonged or higher intensity endurance activities (Noakes *et al.*, 2026). The importance of

carbohydrate availability provides the physiological basis for the development of evidence-based recommendations in endurance sport, see table 2.1.

2.5 Carbohydrate recommendations for endurance exercise

Table 2.1: Summary of macronutrient recommendations for endurance athletes (Thomas *et al.*, 2016).

Nutrient	Endurance athletes
Carbohydrate	6-10 g·kg ⁻¹ ·day ⁻¹ (moderate-high intensity exercise)
Protein	1.2-2.0 g·kg ⁻¹ ·day ⁻¹
Fat	20-35% total energy intake
Pre-exercise carbohydrate	1-4 g·kg ⁻¹ · consumed 1-4 hours before
During exercise carbohydrate (60-150 minutes)	30-60g per hour
During exercise carbohydrate (>150-180 minutes)	Up to 90g per hour
Carbohydrate loading (for events >90 minutes)	10-12g·kg ⁻¹ ·day ⁻¹ (for 36-48 hours)

Table 2.1 summarises current macronutrient recommendations for endurance athletes, with a breakdown of carbohydrate requirements based on duration of training.

Sport nutrition guidelines advocate for strategic carbohydrate consumption before, during and after exercise to enhance performance (Burke *et al.*, 2011; Jeukendrup *et al.*, 2014). Stellingwerff *et al.* (2014) found that 82% of 61 published studies showed statistically significant endurance performance benefits from carbohydrate supplementation. Recommendations are generally expressed relative to body mass and vary according to exercise duration and intensity. For day-to-day endurance training (i.e. approximately 1-3 hours of moderate-high intensity exercise per day), the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine recommend 6-10 g·kg⁻¹·day⁻¹ carbohydrates per day (Thomas *et al.*,

2016). Intakes can fluctuate within this range, depending on the volume and intensity of exercise, whilst higher intakes may be advisable when glycogen restoration is a priority e.g. during short recovery periods. Pre-exercise carbohydrate intake can further support carbohydrate availability, with recommendations suggesting an intake of $1\text{--}4\text{ g}\cdot\text{kg}^{-1}$ of carbohydrates one to four hours before exercise (Hargreaves *et al.*, 2004). For endurance events lasting over 90 minutes, a carbohydrate loading strategy of $10\text{--}12\text{ g}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ is recommended, in the 24-48 hours preceding an event (Burke *et al.*, 2011). These requirements are higher than those for strength and power-based sports, which are recommended at 3-7g per kg of body weight per day (Jäger *et al.*, 2017).

During prolonged endurance exercise lasting over 90 minutes, exogenous carbohydrate intake helps maintain carbohydrate availability, support exercise performance and delay fatigue onset (Burke *et al.*, 2004). Current recommendations advise carbohydrate intakes of $30\text{--}60\text{ g}\cdot\text{hr}^{-1}$, increasing to $60\text{--}90\text{ g}\cdot\text{hr}^{-1}$, as tolerated, for exercise exceeding 150 minutes (Mata *et al.*, 2019). Post-exercise carbohydrate intake is also important, particularly when recovery periods are short, as rapid glycogen restoration can support subsequent training or competition. The recommendations for rapid refuelling are $1.2\text{--}1.4\text{ g}\cdot\text{kg}^{-1}\cdot\text{hour}^{-1}$ for the first 4 hours then resume daily fuel needs (Thomas *et al.*, 2016). These reflect the importance of considering carbohydrate requirements in relation to an individual's training and recovery demands, rather than a single fixed daily target.

Despite the availability of evidence-based recommendations, their day-to-day implementation require an individual to understand how they can be translated into practical and sustainable dietary strategies which can be applied to their dynamic training schedule. The literature therefore suggests, that although athletes generally recognise the importance of carbohydrate for endurance performance, their understanding of specific recommendations for training, competition and recovery appears to be less consistent (Sampson *et al.*, 2024; Scrivin *et al.*, 2023; Pozaić *et al.*, 2023; Boucherville *et al.*, 2023).

2.6 Athletes' knowledge of carbohydrate recommendations

Sampson *et al.* (2024) assessed the knowledge of carbohydrate for competition in 1,016 endurance athletes using the Carbohydrates for Endurance Athletes in Competition Questionnaire (CEAC-Q). The findings demonstrated knowledge deficits across multiple domains including carbohydrate metabolism, carbohydrate loading, intra-exercise fuelling, and carbohydrates for recovery. Less than a third of participants correctly identified recommendations relating to carbohydrate-loading and post-exercise recovery, whilst fewer than half correctly identified recommendations for endurance events lasting longer than 150 minutes. These findings support that, although some athletes recognise the importance of carbohydrates for exercise performance, detailed understanding of evidence-based recommendations remains limited. Similarly, Scrivin *et al.*, (2023) found that endurance athletes generally recognise the importance of carbohydrates for exercise performance, with most participants agreeing that consuming carbohydrates improved their exercise performance. Participants were also able to identify common carbohydrate-containing foods and beverages and reported increasing their carbohydrate intake before exercise as their most frequently used strategy. However, the study did not objectively quantify participants' carbohydrate intake; therefore, it is unclear whether their reported knowledge translated into strategies that aligned with evidence-based recommendations. Together, these findings indicate that athletes may recognise the importance of carbohydrates for endurance performance without necessarily understanding how evidence-based recommendations should be applied. Furthermore, the existing literature has limited insight into the factors impacting athletes' decision-making on carbohydrate fuelling practices. This present study therefore seeks to further explore this relationship by examining recreational endurance athletes' knowledge of evidence-based carbohydrate recommendations, their attitudes towards carbohydrates and endurance performance, their fuelling practices and the decision-making process behind these behaviours.

2.7 Factors influencing athletes' nutrition knowledge

Some studies have investigated how sporting experience and competitive status can influence athletes' nutrition knowledge. Boucherville *et al* (2023) evaluated nutrition

knowledge amongst recreational athletes and found that 63.8% demonstrated awareness that carbohydrate consumption during exercise helps maintain blood glucose concentration. Despite this, less than 40% of participants correctly identified that 30-60g of carbohydrates per hour is recommended for events lasting between 60-90 minutes. The study demonstrated that participants with more than five years of exercise experience had higher scores across all nutrition domains, compared to those with less experience. Interestingly, greater sporting status does not appear to correspond with improved nutritional knowledge. Pozaić *et al.*, (2023) found that 54.3% of professional athletes and 69.1% of recreational athletes demonstrated poor levels of nutrition knowledge, suggesting that sport participation at a higher level does not automatically equate to greater nutritional knowledge. Collectively, these findings suggest that athletes possess a general awareness of the importance of carbohydrates for endurance performance, yet there remain inconsistencies in their understanding of specific evidence-based recommendations. Greater experience in sport may be associated with improved nutrition knowledge (Boucherville *et al.*, 2023) however, sporting status alone does not appear to guarantee a higher level of understanding (Pozaić *et al.*, 2023). This suggests that repeated participation in endurance sport does not necessarily result in accurate knowledge of carbohydrate requirements and highlights the importance of targeted nutrition education.

Whilst these studies provide valuable insights, they have several methodological limitations. Most rely on cross-sectional questionnaire designs and self-reported responses. Such approaches can identify knowledge deficits but provide limited insight into whether greater nutritional knowledge translates into carbohydrate intake and fuelling practices which align with evidence-based recommendations.

2.8 Translation of athletes' knowledge into dietary practices

Studies which investigate carbohydrate intake in endurance athletes suggest that many do not consistently achieve the recommended amounts. Baranauskas *et al.* (2015) found that 80.8% of 146 Lithuanian endurance athletes consumed less than the recommended amount of carbohydrates. Participants reported an average

carbohydrate intake of $5.6 \text{ g}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$, which is below the recommended range ($6\text{-}10\text{ g}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$). Differences were observed between the type of sport, with cyclists more likely to meet the lower end of recommended amounts ($6.4 \text{ g}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$), compared with long-distance runners. However, interpretation of these results should be cautious as the study used a 24-hour dietary recall, which may not accurately reflect habitual intake or variation in carbohydrate requirements across different training cycles. On the other hand, Fortis *et al.* (2026) used weighed food diaries and remote food photography methods in female endurance athletes competing in the Ironman world championships. They found that most athletes failed to meet the recommended carbohydrate intake of $8\text{-}12\text{ g}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ in the 24-48 hours before their competition.

2.8.1 The knowledge-practice gap

Although knowledge of carbohydrate recommendations is often assumed to influence dietary behaviour, research consistently demonstrates that nutrition knowledge alone does not reliably predict dietary behaviours. Sampson *et al.* (2024) examined the relationship between carbohydrate knowledge and self-reported carbohydrate intake in 50 endurance athletes. They found no significant association between knowledge of carbohydrate recommendations and self-reported intake. These findings suggest that possessing greater knowledge doesn't automatically translate into dietary practices which align with evidence-based recommendations. When considered alongside Baranauskas *et al.* (2015)'s study that endurance athletes failed to meet recommended carbohydrate intakes, this suggests that there may be other factors which are contributing to the knowledge-practice gap.

2.8.2 Barriers to achieving recommended carbohydrate intakes

A scoping review of 21 studies relating to athletes' nutritional knowledge and dietary intake found that limited access to practical, evidence-based nutritional guidance is a key barrier to improving nutritional knowledge (Hopper *et al.*, 2025). This suggests that nutrition knowledge may be influenced not only by individual factors, but also by structural and educational limitations, including access to qualified nutrition

professionals. However, access to nutrition education represents only one potential influence on suboptimal carbohydrate intake in athletes. Athletes may be aware of evidence-based carbohydrate recommendations yet still fail to meet them in practice due to a range of other physiological, psychological and contextual barriers. For example, barriers such as gastrointestinal symptoms, difficulties consuming enough carbohydrates, and sociocultural influences such as body composition concerns may also contribute to sub-optimal fuelling practices.

There is robust evidence which demonstrates that inadequate energy intake and chronic under-fuelling can lead to low energy availability (LEA), which is associated with a range of physiological consequences. Historically, these consequences were described through the female athlete triad and included low bone mineral density and menstrual cycle disturbances. More recently, the concept of Relative Energy Deficiency Syndrome (RED-S) has been introduced which encompasses a cluster of symptoms, including reduced athletic performance, increased risk of injury, endocrine and gastrointestinal disorders, and recurring infections (Mountjoy *et al.*, 2023). This term recognises that the physiological and psychological effects of LEA can occur in both males and females (Grabia *et al.*, 2014).

Despite evidence of sub-optimal carbohydrate intake in endurance sport, the reasons remain unclear. Under-fuelling may be intentional, for example, the desire to reduce body fat or manipulate body composition, or unintentional, potentially reflecting insufficient knowledge and understanding of energy and carbohydrate requirements. It is also plausible that inadequate energy intake reflects a combination of these factors. A review of the dietary survey literature shows that female endurance athletes are less likely to achieve carbohydrate recommendations, with body composition concerns proposed as a potential contributing factor (Burke *et al.*, 2001). This is particularly relevant given the significant energy and carbohydrate demands of endurance activity.

Collectively, the literature suggests that the relationship between nutrition knowledge and dietary practices is complex and multifactorial. Although knowledge represents one potential influence on carbohydrate fuelling, intake may also be influenced by

practical, physiological, psychological and contextual factors. Understanding this relationship therefore requires consideration of how knowledge, opportunities and motivation influence dietary behaviour.

2.9 Theoretical framework

2.9.1. The Knowledge-Attitude-Practice model

The present study initially interpreted findings using the Knowledge–Attitude–Practice (KAP) model, which provides a framework for understanding health behaviours by considering the relationship between individuals’ knowledge, attitudes and subsequent practices (Zarei *et al.*, 2024). In the context of endurance sport, the KAP model provides a framework for examining the relationship between athletes’ self-reported knowledge of evidence-based carbohydrate recommendations and their reported carbohydrate fuelling practices. Within this study, the KAP model suggests that greater knowledge of carbohydrate recommendations may be associated with more positive attitudes towards carbohydrate consumption and, in turn, more appropriate fuelling strategies around training and competition. The KAP model has been widely applied within nutrition and public health research due to its simple explanation of how educational interventions may influence health-related behaviours (Dyett *et al.*, 2025).

However, the literature reviewed in this chapter suggests that knowledge alone does not consistently predict dietary behaviours, and consideration of other influential factors is required. Several studies have demonstrated that endurance athletes may recognise the importance of carbohydrate intake while still failing to achieve recommended target intakes (Sampson *et al.*, 2024; Baranauskas *et al.*, 2015). This highlights a limitation of applying the KAP framework, which may not adequately capture the complexity of fuelling behaviours. Increased knowledge does not always necessarily lead to behaviour change, as dietary practices may also be influenced by factors beyond knowledge and attitudes alone.

2.9.2. The Capability, Opportunity, Motivation-Behaviour model

To further understand this discrepancy, the Capability, Opportunity, Motivation – Behaviour (COM-B) model is also applied within this present study (Michie *et al.*, 2011). The COM-B model proposes that behaviour results from the interaction between capability, opportunity and motivation. This provides a broader framework for understanding why recreational endurance athletes may or may not translate their knowledge of carbohydrate recommendations into day-to-day practice. Within this study, capability may include knowledge of evidence-based carbohydrate recommendations and the ability to apply them in practice. Opportunity may include access to sport nutrition professionals, the sporting environment and access to appropriate foods. Motivation may include attitudes towards carbohydrates, beliefs about body composition, performance goals and any other factors that may influence fuelling decisions. A qualitative analysis by Bentley *et al.* (2019) used the COM-B model to understand the barriers and enablers of adhering to nutritional guidance in high-performance sport. The study found that nutritional adherence is multi-factorial and influenced by all three components within COM-B. This is particularly relevant to the present study, as it provides a framework through which athletes' reported carbohydrate fuelling practices can be considered alongside knowledge, environmental factors, and motivational influences which may shape those practices.

2.10 Research gap

This chapter has demonstrated that carbohydrate availability and appropriate carbohydrate intake are fundamental for optimising endurance performance, and insufficient intake can negatively impact training adaptations and lead to early onset of fatigue (Burke *et al.*, 2011). Recommendations for carbohydrate intakes in endurance sport are well established and are presented in table 2.1 (Thomas *et al.*, 2016). Despite the availability of these evidence-based recommendations, research shows that endurance athletes often do not meet these targets despite varying levels of nutrition knowledge. The research suggests that predicting dietary behaviours is multifactorial and cannot be adequately explained by nutrition knowledge alone, however existing literature remains limited in several aspects. There is evidence examining the relationship between carbohydrate knowledge and reported carbohydrate intake;

however, research is more limited regarding the exploration of contextual and behavioural factors that may explain why knowledge does or does not translate into appropriate fuelling practices. Furthermore, there is limited qualitative insight into athletes' experiences of applying carbohydrate recommendations within their own training and competitions, including the practical, physiological, psychological and contextual factors that may influence their carbohydrate fuelling practices.

2.11 Chapter summary

This chapter has presented and critically analysed scientific literature relating to athletes' knowledge of evidence-based carbohydrate recommendations, implementation of carbohydrate fuelling practices and possible barriers to implementation. This present study therefore aims to examine recreational endurance athletes' knowledge of evidence-based carbohydrate recommendations, their attitudes towards carbohydrates and endurance performance, and their reported carbohydrate fuelling practices. This will allow evaluation of the extent to which their reported practices align with current evidence-based recommendations. The inclusion of qualitative interviews provides an opportunity to explore athletes' experiences of applying carbohydrate recommendations in practice and the factors that may influence their fuelling practices. In doing so, this study seeks to provide further insight into the relationship between nutritional knowledge and practical fuelling behaviours within endurance sport.

Chapter 3: Methodology

3.1 Introduction to chapter

This chapter outlines the research philosophy, study design, participant recruitment, data collection and analysis procedures, ethical considerations, and overall timetable used in this project to allow any replication and justify the validity of the approach.

3.2 Study design

This study adopts a pragmatic research paradigm. A pragmatic approach allows the integration of both qualitative and quantitative data, enabling a more in-depth understanding of the relationship between carbohydrate knowledge and fuelling practices (Elgeddawy and Abouria 2024). As this present study sought to assess recreational endurance athletes' attitudes, beliefs and knowledge of evidence-based carbohydrate recommendations in endurance sports and factors influencing their fuelling practices, a pragmatic approach was considered appropriate.

This study adopts a relativist ontological position, recognising that individuals may have different levels of understanding and multiple interpretations of carbohydrate recommendations for endurance sport, based on their personal beliefs and sporting experience (Pretorius, 2024). The study acknowledges that multiple interpretations exist due to human perception, rather than assuming a single objective understanding of carbohydrate-related knowledge and fuelling practices. Furthermore, a pragmatic epistemology was adopted. Pragmatism recognises that knowledge can be obtained through multiple forms of evidence e.g. personal experiences and the outcomes they produce, therefore supporting the use of a mixed-method approach (Elgeddawy and Abouria 2024). Within this study, quantitative data provided insight into participants' knowledge and attitudes towards carbohydrates and endurance performance, whilst qualitative data allowed exploration of participants' experiences and perceptions relating to their carbohydrate intake, fuelling practices and endurance training.

Neither a purely positivist nor interpretivist approach was considered sufficient to address the research aims. Whilst positivism would have captured measurable aspects of carbohydrate knowledge and behaviour, it would have offered limited insight into participants' experiences and perceptions. Conversely, interpretivism which explores subjective experiences and meanings, would have lacked the structured data necessary to identify broader patterns (Park *et al.*, 2020). Consequently, a pragmatic mixed-methods approach was considered most appropriate.

Therefore, a convergent, cross-sectional mixed methods design was utilised. Quantitative and qualitative data were collected during the same phase of the research and analysed independently before being integrated during interpretation of the findings. The discussion of the findings provided a comprehensive understanding of the relationship between carbohydrate knowledge and fuelling practices among recreational endurance athletes.

3.3 Research setting

The study was conducted remotely using online data collection methods. Quantitative survey data was collected via Microsoft Forms whilst qualitative data was collected through SSI. The use of an online platform provided a practical and time-efficient method of data collection, by reducing geographical barriers to participation (Wu *et al.*, 2022). The survey was sent into a local triathlon club's WhatsApp group, which meant participants could complete the survey at a time and place convenient to them, compared to face-to-face collection. Furthermore, the use of an online survey is appropriate for post graduate research given no additional costs.

SSI were conducted both remotely via online communication platforms and face-to-face at locations convenient to participants. This reduced participant burden by limiting any travelling time or associated costs. The use of online platforms for qualitative data collection has been identified as a practical and cost-effective approach, which can produce data comparable to traditional face-to-face interviews (Archibald *et al.*, 2019).

The combination of online surveys and SSI was considered a pragmatic approach for this research project.

3.4. Participants

Inclusion criteria were adults aged 18 years and over, who participated in at least 30 minutes of endurance activity on two or more occasions per week. A review by Jones *et al* (2000) considers endurance exercise to be any continuous activity lasting from 5 to 240 minutes completed at around 65-100% of $\text{VO}_{2\text{ max}}$. However, a narrative review by Spiering *et al* (2021) identified that, in general populations, endurance performance can be maintained for up to 15 weeks when training frequency is as low as two sessions per week (13-26 minutes) if intensity is maintained. As such, it was decided that eligible participants needed to be participating in an endurance activity lasting at least 30 minutes, twice a week.

3.4.1 Participant recruitment

Participant recruitment used opportunistic and convenience sampling via the principal researcher's friends and associates. Convenience sampling is a practical approach for post graduate research as it can recruit participants based on factors such as accessibility, geographical proximity and the willingness to participate (Etikan *et al.*, 2016). A sampling frame included a complete list of potential participants from existing social and professional contacts. This method was chosen as it allowed recruitment of participants who were known to participate in endurance sport. Admittedly, this convenience sampling increases the likelihood of selection bias and may reduce the generalisability of the findings; however, it provided a pragmatic approach given the logistical and practical constraints of a postgraduate project. The sample was therefore considered appropriate in meeting the research aims and objectives as all participants met the predefined inclusion criteria. It must be acknowledged that the findings may not be representative of all individuals participating in endurance activities and can't produce generalisable conclusions, limiting the external validity of findings.

3.4.2 Sample size

A total of 22 participants completed the online survey. Given the exploratory nature of the study, the relatively homogenous sample, and constraints associated with postgraduate research, this sample was considered sufficient to address the research aims (Creswell and Clark, 2018). A total of six SSI were conducted. The interview sample size was justified based on the principle of data saturation, which is the point at which no new themes become apparent, and any new data collected fails to contribute to new insights (Roberts *et al.*, 2026). A systematic review by Hennink *et al.* (2022) reported thematic saturation in relatively homogenous samples is commonly achieved within 9-17 interviews, with core themes frequently identified in the first 6-12. Given the homogeneous sample in this study and the focused nature of the research questions, a total of six interviews was considered sufficient to generate rich and meaningful data to explore the research questions.

3.5 Research methods

3.5.1 Online survey

The first part of data collection involved an online survey. The survey collected data including participants' self-reported knowledge, attitudes and beliefs towards carbohydrates and endurance performance. This included questions on evidence-based carbohydrate recommendations for endurance sport, as well as participants' own fuelling practices for their endurance training. The survey was developed using Microsoft Forms and distributed to participants via text. The survey included a range of question types, including multiple choice, Likert scales and open and closed questions, (see Appendix B). Including multiple question types is beneficial to increase the likelihood of obtaining more meaningful findings. Likert scales, multiple choice and closed questions are useful to represent the research agenda, whilst open-ended questions help validate and expand on these responses, potentially identifying new issues (O'Cathain *et al.*, 2004).

Using an online survey, which can be distributed via a hyperlink to participants' email or phone number can lead to a larger number of responses. Due to time and resource constraints for this research project, only a small sample of participants would be achievable using alternative data collection methods e.g., one-to-one interview or focus groups.

3.5.2 Semi-structured interviews (SSI)

The initial study design included a self-reported three-day food diary to estimate objective carbohydrate intake and compare this with participants' survey responses. However, participant compliance was low, with many food diaries incomplete or not returned at all. It is acknowledged that completing food diaries has significant participant burden, especially if recording of multiple days is required (Whybrow *et al.*, 2020). Given these challenges and time constraints, it was decided that SSI were better suited for this study. They also allowed participants to discuss their experiences, beliefs and fuelling practices in greater depth than could be achieved with survey responses alone. Transcripts of the SSI can be found in Appendix C.

SSI were conducted with a subset of survey participants to gain deeper insight into their knowledge, attitudes and behaviours relating to carbohydrates and endurance training. Participants who completed the survey were invited to take part in a follow-up interview. SSI were conducted individually, consisting primarily of open-ended questions, with some probing questions to generate greater depth in participant responses. These were often followed up with 'why' or 'how' questions to gain further depth and insight. The interview guide was developed based on the research aims and relevant literature on sports nutrition knowledge. Specifically, elements from the Nutrition for Sport Knowledge Questionnaire developed by Trakman *et al* (2017) were used to guide the interview structure. This questionnaire has sub-sections which can be used individually, and the questions allow identification of differences in knowledge across athletes of different ages, genders and abilities. SSI can obtain useful data on participants' thoughts, feelings and attitudes by using guided questions which allows for some flexibility (Adams, 2015). The interview questions were also designed to

expand on themes identified within the survey, particularly in relation to knowledge, beliefs and self-reported carbohydrate fuelling practices.

In this current study, SSI were conducted with the researcher and participant only, and averaged approximately 10 minutes, allowing plenty of time for participant-led discussion. Due to time constraints, the SSI were not formally piloted; however, the interview structure was guided by the survey and relevant literature. No SSI were repeated or removed.

3.6 Data analysis

Quantitative data was analysed using Microsoft Excel and IBM SPSS Statistics software. Prior to analysis, data was screened for any inaccuracies, missing values and coding errors. Descriptive statistics, including frequencies and percentages, were used to summarise participants' characteristics and survey responses.

Due to the small sample size ($n=22$) and the ordinal nature of several variables, non-parametric statistical tests were selected (Politi *et al.*, 2021). Variables included participants' gender, years of experience in endurance sport, knowledge of carbohydrate requirements, self-reported confidence in carbohydrate knowledge and whether participants adjusted their carbohydrate intake according to their training load. Mann-Whitney U tests were used to compare confidence scores between independent groups, including gender, carbohydrate knowledge and carbohydrate-adjustment behaviour. Relationships between years of experience in endurance sport and confidence were examined using Spearman's rank-order correlation. The relationship between years of experience in endurance sport and participants' knowledge of carbohydrate requirements was assessed using a Fisherman-Freeman-Halton Exact Test, where expected cell counts were insufficient to meet the assumptions of Pearson's Chi-square testing. A significance value of $p < 0.05$ was used throughout (Slim *et al.*, 2026).

Thematic analysis for the SSI was conducted using the Braun and Clarke's (2006) six-phase reflexive framework. Table 3.1 illustrates the six-phase approach (Braun and Clarke, 2006). The coding framework and thematic map generated during the thematic analysis process are presented in Appendix E.

Table 3.1: Application of Braun & Clarke's six-phased reflexive framework in this study.

Phase	Application in current study
1) Familiarisation with the data	Reading of interview transcripts to gain familiarity with the data
2) Generating initial codes	Segments of interview transcripts were coded systematically
3) Searching for themes	Related codes were grouped into potential themes
4) Reviewing themes	Themes were reviewed and refined
5) Defining and naming themes	Final themes and sub-themes were identified
6) Writing the report	Results were written using supporting quotes from transcripts.

3.7 Ethical considerations

This study was approved by the ethics committee at the University of Wales Trinity St David prior to data collection. All participants were provided with an electronic participant information sheet which outlined the aims of the study, the method of data collection and their rights as a participant. This included that their participation was entirely voluntary and they could withdraw from the study at any time. Participants were informed that the study was being conducted as part of a post-graduate dissertation with the UWTSD. Participants were required to electronically confirm their consent to participation prior to completing the survey and SSI. Given the researcher is a registered dietitian, the study was conducted in accordance with the HCPC Standards of Conduct, Performance and Ethics (Health and Care Professions Council, 2024).

Survey and SSI data were anonymised, with no personally identifiable information retained and all data collected was stored securely on the UWTSD One Drive platform. Interview recordings and transcripts were anonymised prior to analysis and participants were assigned unique identification codes. The data will be securely deleted upon completion of the project. Appendix E contains the ethical approval documentation.

3.8 Timescale for research

Table 3.2: Research timescale

Activity	Date completed
Research proposal	September 2025
Ethics application and approval	September 2025
Literature review	October – November 2025
Survey development	October – November 2025
Survey data collection	January – February 2026
Methodology chapter	March-April 2026
Semi-structured interviews	May-July 2026
Data analysis	August 2026
Results chapter	August 2026
Discussion chapter	August 2026
Final editing and formatting	September 2026

Table 3.2 illustrates the timeline for the completion of this research project. The project was conducted between September 2025 to September 2026.

Chapter 4: Results

4.1 Introduction

This chapter presents the findings of this study. Quantitative results from the online survey are presented first, followed by the qualitative findings from the SSI.

4.2 Quantitative findings

This section presents the quantitative findings from the online survey. Results are organised according to participant characteristics, knowledge of carbohydrate recommendations, reported fuelling practices, attitudes and beliefs towards carbohydrate intake, sources of nutrition information and inferential statistical analyses.

4.2.1 Participant characteristics

Table 4.1: Age group of participants (total = 22)

Age group (years)	Number (%)
25-34	13 (59.1)
35-44	4 (18.2)
45-54	4 (18.2)
>65	1 (4.5)

Table 4.2: Gender distribution of participants

Gender	Number (%)
Female	11 (50)
Male	11 (50)

Table 4.3: Participants' years of experience in endurance sport

Experience in endurance training (years)	Number (%)
<2 years	4 (18.2)
2-5 years	4 (18.2)

>5 years	14 (63.6)
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4.2.2 Knowledge of carbohydrate recommendations

4.2.2.1 Self-reported confidence in knowledge of carbohydrate recommendations

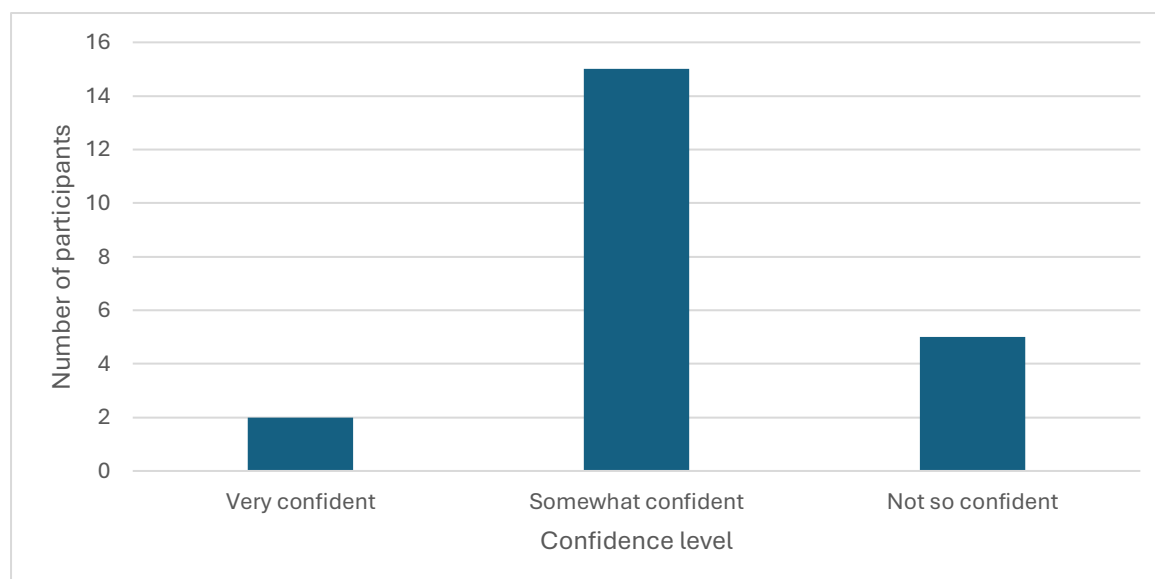


Figure 4.1: Participants' self-reported confidence in their knowledge of carbohydrate recommendations for endurance exercise.

Figure 4.1 demonstrates participants' self-reported confidence in their knowledge of carbohydrate recommendations for endurance training. Most participants reported moderate confidence in their knowledge of carbohydrate recommendations for endurance exercise. Approximately two-thirds of participants (68.2%, n=15) described themselves as 'somewhat confident' whilst fewer reported feeling 'very confident' (9.1%, n=2) and 'not so confident' (22.7%, n=5).

4.2.2.2 Knowledge of daily carbohydrate recommendations

Table 4.4: Participants' knowledge of daily carbohydrate recommendations for endurance training.

Response	Number (% of sample)
3-5g/kg of body weight	3 (13.6)
5-7g/kg of body weight	4 (18.2)
6-10g/kg of body weight	3 (13.6)
Not sure	12 (54.5)

Table 4.4 suggests variable knowledge levels amongst participants regarding recommended daily carbohydrate intake for endurance training. Current recommendations for moderate-to-high intensity endurance training are 6-10g·kg⁻¹·day⁻¹. Only three participants selected this range (13.6%), whilst over half of participants (54.5%) reported being unsure.

4.2.3 Carbohydrate fuelling practices

4.2.3.1 Adjusting carbohydrate intake based on training load

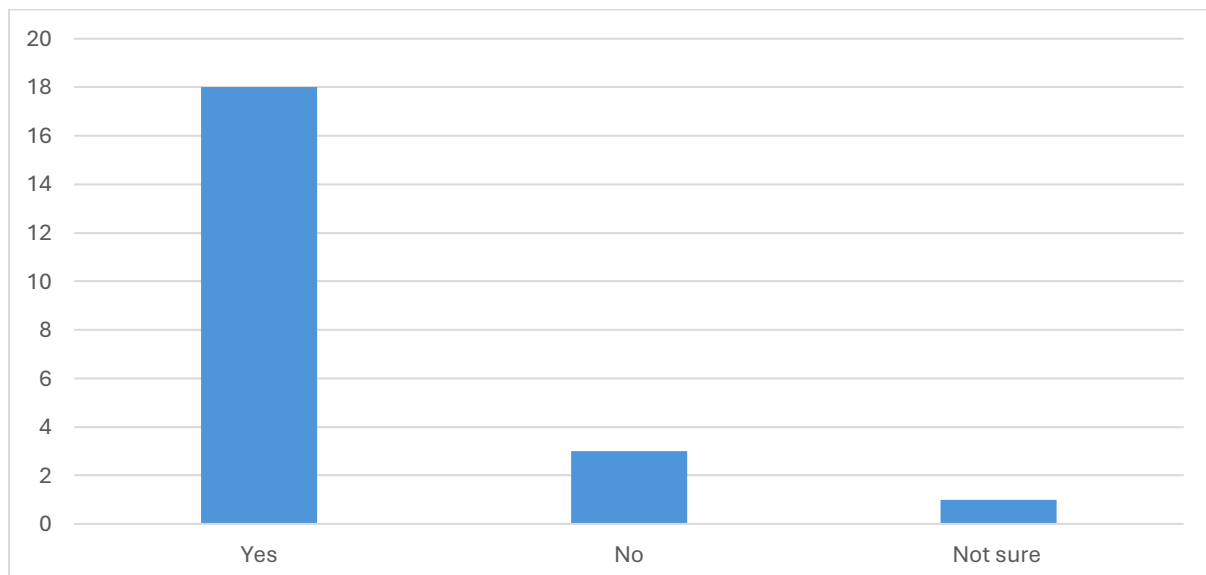


Figure 4.2: Participant response to whether they adjust their carbohydrate intake based on their training load.

Figure 4.2 shows that most participants (81.8%) adjust their carbohydrate intake based on their training load. Fewer participants reported they do not make any adjustments (13.6%) and one participant was not sure (4.5%).

4.2.3.2 Pre-exercise nutrition practices

When asked to specify their pre-training/event meal or snack of choice, all participants reported consuming foods which were predominantly carbohydrate-based. Commonly reported choices included porridge, bagels, honey, bananas and pasta.

4.2.3.3 Carbohydrate intake during exercise

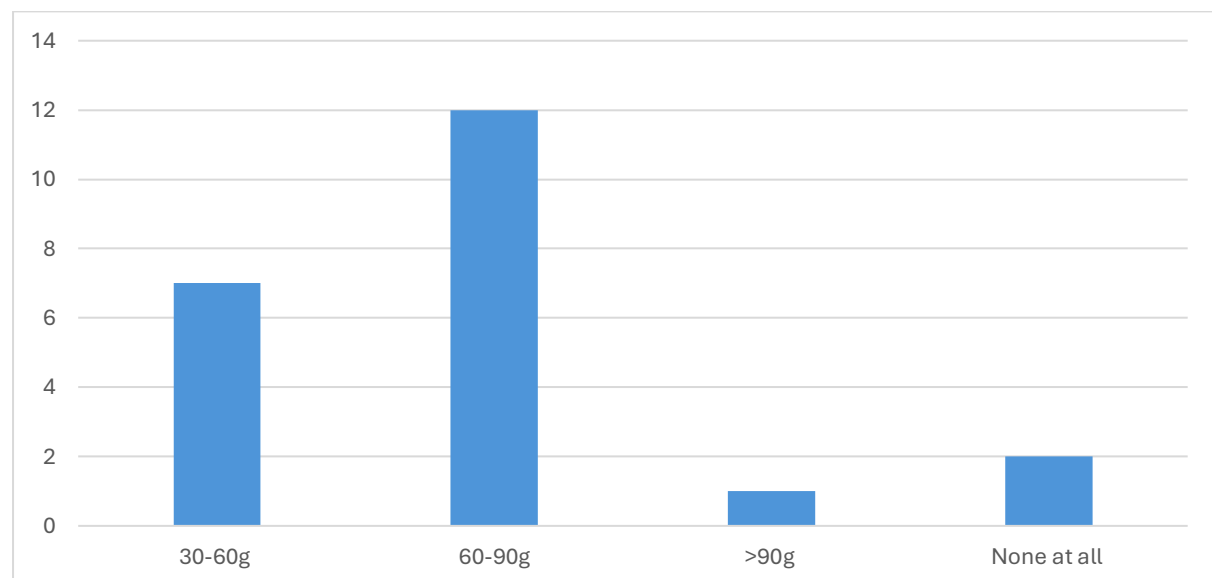


Figure 4.3: Participants' self-reported hourly carbohydrate intake during prolonged endurance training.

Figure 4.3 illustrates that over half of participants (54.5%) consume 60-90g of carbohydrates during prolonged endurance training, followed by 40.9% reporting an intake of 30-60g per hour. One participant reported consuming >90g per hour, whilst two participants reported not consuming carbohydrates during prolonged endurance training.

4.2.3.4 Duration of exercise before carbohydrate consumption

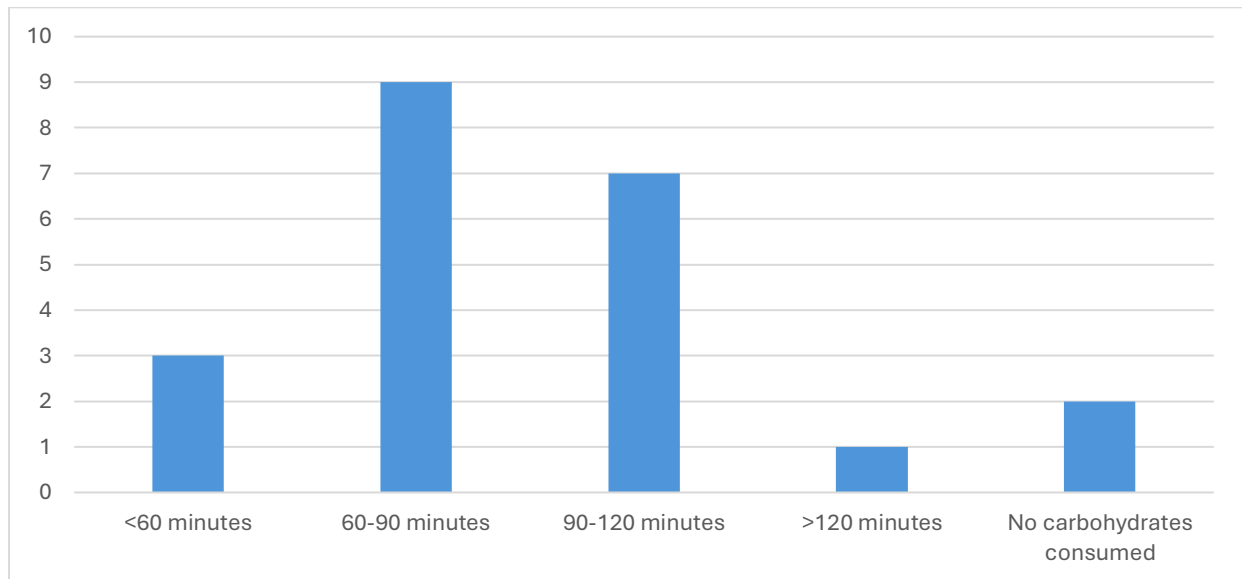


Figure 4.4: Exercise duration at which participants reported consuming carbohydrates during endurance training or competition.

Figure 4.4 illustrates the exercise duration at which participants report consuming carbohydrates. Most participants (72.7%) reported initiating carbohydrate intake during exercise lasting between 60-120 minutes, with fewer consuming carbohydrates in events <60 minutes or >120 minutes.

4.2.4 Attitudes and beliefs towards carbohydrate consumption

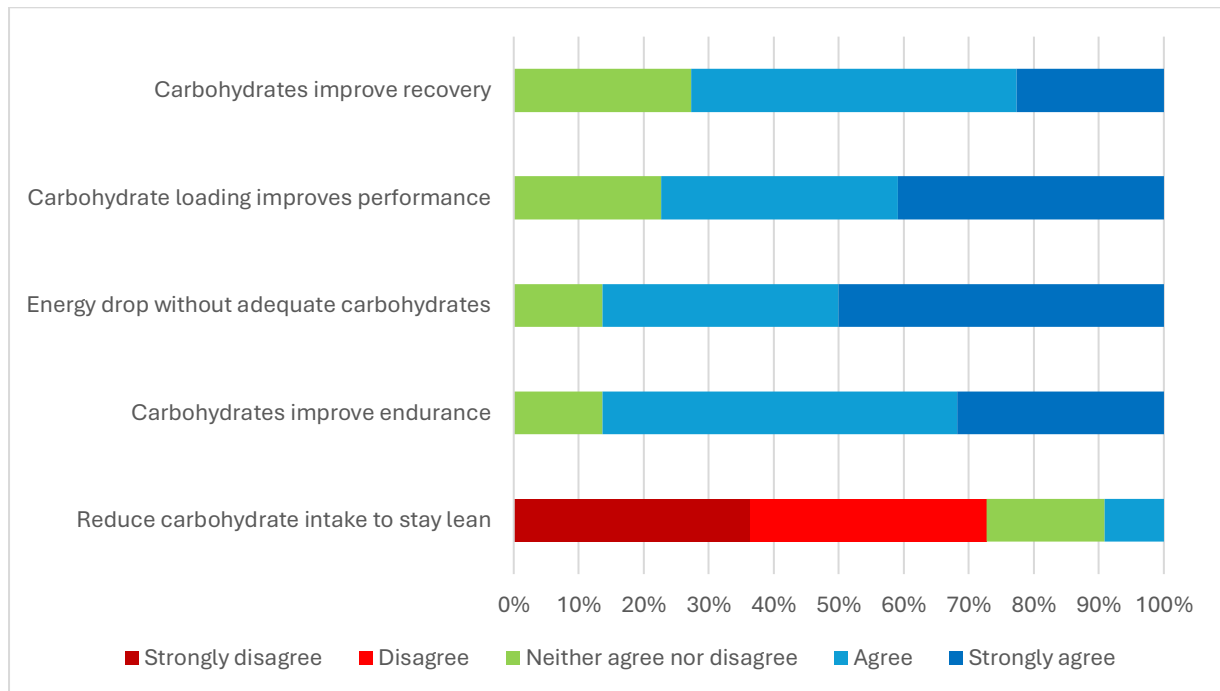


Figure 4.5: Participants' attitudes and beliefs towards carbohydrate intake and endurance performance.

Figure 4.5 illustrates participants' attitudes towards carbohydrate intake and endurance performance. Generally, most participants agreed or strongly agreed that consuming carbohydrates improves their endurance performance and recovery. The strongest agreement (86.4% of participants) was observed for the statement relating to a drop in energy levels with inadequate intake of carbohydrates. In contrast, most participants (72.8%) disagreed or strongly disagreed that they intentionally reduce their carbohydrate intake to stay lean.

4.2.5 Sources of information regarding carbohydrate requirements

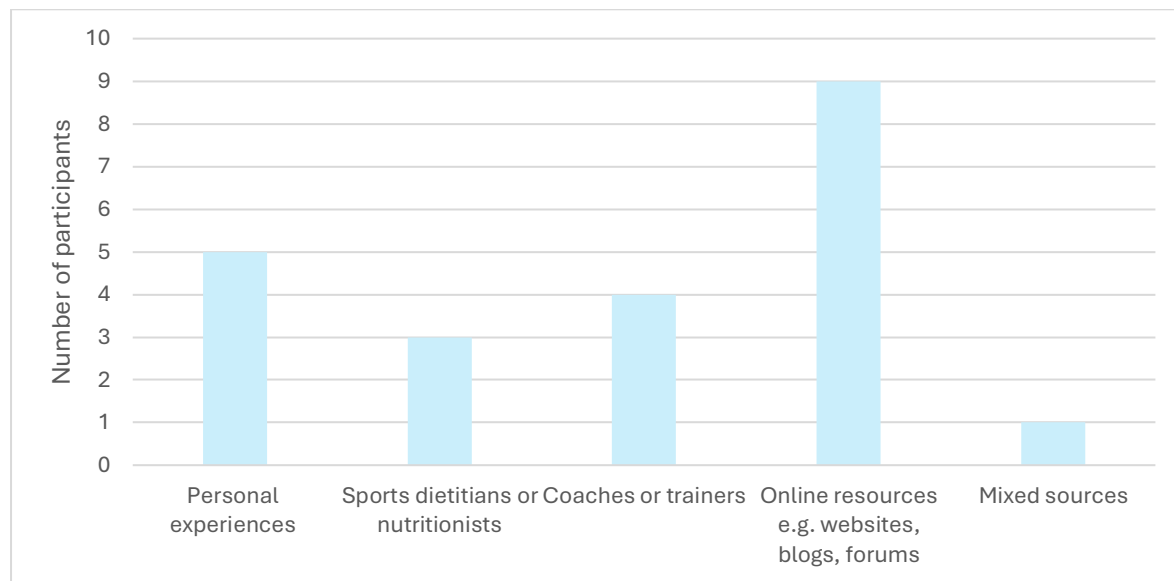


Figure 4.6: Sources of information used by participants to inform carbohydrate-fuelling practices.

Figure 4.6 illustrates the primary sources of information used by participants to inform carbohydrate requirements for endurance training. Online resources were the most common answer (40.9%), followed by personal experience (22.7%), and coaches or trainers (18.2%). A smaller number of participants reported using either sports dietitians or nutritionists for information (13.6%) and one participant reported using a combination of coaching advice and their own independent research, which was categorised as a mixed source.

4.2.6 Inferential statistical analysis

4.2.6.1 Years of experience in sport and carbohydrate knowledge

A Fisherman-Freeman-Halton Exact Test was used to examine any relationship between participants' years of experience in endurance sport and their knowledge of carbohydrate requirements for endurance exercise. No statistically significant

association was identified between years of experience and participants' knowledge ($p=1.000$).

4.2.6.2 Reported confidence and knowledge of carbohydrate recommendations

A Mann-Whitney U test was conducted to examine whether self-reported confidence differed according to participants' knowledge of carbohydrate recommendations. Participants who correctly identified carbohydrate requirements ($n=3$) demonstrated higher confidence ranks (mean rank = 15.83) than those who were incorrect or unsure (mean rank = 10.82). However, this difference was not statistically significant ($U = 15.5$, $p = 0.226$).

4.2.6.3 Gender differences in confidence

A Mann-Whitney U test was conducted to assess whether self-reported confidence levels differed according to gender. Female participants demonstrated a slightly higher confidence rank (mean rank = 12.09) than male participants (mean rank = 10.91), however this difference was not statistically significant ($U = 54.00$, $p = 0.699$).

4.2.6.4 Years of experience and confidence in carbohydrate recommendations

A Spearman's rank-order correlation was conducted to examine the relationship between years of experience in endurance sport and self-reported confidence in carbohydrate recommendations. No significant relationship was found ($r_s = -0.036$, $p = 0.873$).

4.2.6.5 Confidence in carbohydrate recommendations and adjusting carbohydrate intake

A Mann-Whitney U test was conducted to examine whether confidence in carbohydrate requirements differed according to whether participants adjusted their carbohydrate intake based on training load. Participants who did not adjust their intake reported

slightly higher confidence ranks (mean rank = 12.50) than those who did make adjustments (mean rank = 10.75). However, this difference was not statistically significant, $U = 22.50$, $p = 0.669$.

4.2.6.6 Summary of statistical tests

Table 4.5: Summary of inferential statistics used in SPSS

Variables	Test	Statistic	P- value
Experience vs knowledge	Fisherman-Freeman-Halton Exact Test	Exact test	1.000
Knowledge vs confidence	Mann-Whitney U	$U=15.50$	0.226
Gender vs confidence	Mann-Whitney U	$U=54.00$	0.699
Experience vs confidence	Spearman's rho	$r_s = -0.036$	0.873
Confidence vs Carbohydrate adjustment	Mann-Whitney U	$U=22.5$	0.669

Collectively, these statistical analyses did not identify any significant relationships between years of experience in endurance sport, gender, knowledge of carbohydrate recommendations or carbohydrate adjustments based on training load (all $p > 0.05$). See Appendix D for the SPSS output.

4.2.7 Summary of quantitative findings

In summary, most participants demonstrated positive attitudes towards carbohydrate intake and endurance exercise and reported deliberate fuelling practices in their own training. Whilst most participants reported feeling somewhat confident in their knowledge of carbohydrate recommendations for endurance exercise, knowledge of specific evidence-based recommendations was less consistent, with over half reporting they were unsure of recommended daily intakes. Online resources were the most frequently reported source of nutrition information.

4.3 Qualitative findings

Thematic analysis for the SSI was conducted using the Braun and Victoria Clarke's (2006) six-phase reflexive framework (Braun and Clarke, 2006). Four themes were identified from the data (1) Understanding of carbohydrate fuelling for endurance performance; (2) Application of carbohydrate fuelling strategies; (3) Knowledge of evidence-based recommendations; (4) Factors influencing carbohydrate intake.

4.3.1 Overview of themes

Table 4.6: Themes and Sub-themes identified through thematic analysis

Theme	Sub-themes
Understanding of carbohydrate fuelling for endurance performance	- Recognition of carbohydrates as an energy source - Variable physiological understanding and uncertainty
Application of carbohydrate fuelling strategies	- Deliberate fuelling strategy - Experience-based learning - Inconsistent implementation
Knowledge of evidence-based recommendations	- Carbohydrate loading recommendations - Greater awareness of practical fuelling strategies than formal recommendations - Limited knowledge of recovery recommendations
Factors influencing carbohydrate fuelling practices	- Body composition concerns - Gastrointestinal barriers - Practical barriers - Cost considerations

4.3.2: Understanding of carbohydrate fuelling for endurance performance

Generally, participants demonstrated an awareness that carbohydrates play a role in supporting endurance performance. All participants described carbohydrates as providing energy and enabling sustained exercise performance.

4.3.2.1 Recognition of carbohydrates as an energy source

Five out of six participants recognised carbohydrates as an energy or fuel source for endurance exercise. Participants described carbohydrates as

“one of the main fuel sources for endurance performance” (ID1)

and

“carbs are one of the main energy sources for the body, especially in endurance sports”
(ID3)

Several participants also associated carbohydrate consumption with the ability to sustain exercise performance for longer durations. For example:

“you can go for longer” (ID 6)

Overall, the findings suggest that participants were able to broadly recognise the importance of carbohydrates for endurance performance.

4.3.2.2 Variable physiological understanding

Despite general awareness of carbohydrates as an energy source, the level of physiological knowledge and understanding varied. Three participants demonstrated awareness of glycogen as a storage molecule. For example, when asked how carbohydrates stored in the body, answers included:

“stored in glycogen in muscles and body” (ID3)

And

“I think it becomes glycogen when it's stored, which will be stored in and around the muscles and then used when needed” (ID1)

Other participants were uncertain and acknowledged they didn't know the answer, for example:

“I don't know. I have no idea” (ID5).

These findings suggest that despite recognition of carbohydrates as an energy source, detailed physiological knowledge was inconsistent amongst participants.

4.3.3 Application of carbohydrate fuelling strategies

4.3.3.1 Deliberate fuelling strategy

Participants described implementing a range of deliberate fuelling practices, both before and during endurance exercise, suggesting that carbohydrate intake was considered an important factor for their training. For example, answers included:

“Over two-hour events, I usually carb load and I also use carbs within my racing” (ID1)

And

“Yes, particularly for pretraining or racing, and then anything over like 90 minutes, during as well” (ID3)

And

“Yes, 100%. I recently started taking gels for my runs. Fast carbs, easy to absorb whilst on the run” (ID4)

4.3.3.2 Experience-based learning

Many participants described using personal experiences to influence their practices, rather than referencing specific nutrition recommendations. Some participants described how fuelling makes them feel physically. For example:

“I think more is feeling the difference when I haven’t carb loaded. And then I try and do a big session in my training plan, and then it doesn’t go to plan, because I know I haven’t fuelled even though I’m trying to fuel the session with carbs.” (ID1)

And

“If I don’t eat enough the day before, I feel rubbish” (ID6).

Others referred to obtaining information from alternative sources, such as podcasts, rather than referencing specific evidence-based recommendations. For example:

“When you hear podcasts and they say ‘I take this much’, then I’m like oh interesting, but I’m not sure how it would work” (ID2)

4.3.3.3 Inconsistent implementation

Despite recognising the importance of carbohydrate for endurance training, several participants reported inconsistent implementation of fuelling strategies, whether that was related to evidence-based recommendations or their own interpretations from personal experiences. For example, when asked if they consider carbohydrates for endurance training and competitions, one participant stated:

“Yes, but mostly competitions. With training, I should take it more often” (ID2)

Another participant reported consuming carbohydrates regularly but not following a particular structure for fuelling. For example:

“If I’m being honest, it doesn’t change with anything” and “I don’t adjust carbs in my training” (ID4).

4.3.4 Knowledge of evidence-based recommendations

4.3.4.1 Carbohydrate loading recommendations

Participants’ knowledge of carbohydrate loading recommendations was variable. Whilst some participants were able to identify recommended intake ranges for carbohydrate loading with some accuracy, others demonstrated uncertainty. For example, one participant stated:

“10 to 12 grams per kilogram of body weight” (ID3)

Whilst another provided a wider range,

“It’s probably between 8 and 12 grams per kilogram of body weight” (ID1).

The remainder of participants demonstrated uncertainty. For example,

“300 grams?”

And

“Yeah. No idea. 100g? 150g? 200g?”

4.3.4.2 Greater awareness of practical fuelling strategies than formal recommendations

Interestingly, some participants described their carbohydrate fuelling practices before exercise or competitions but were unable to accurately identify evidence-based recommendations. This pattern was evident across several participants who described opting for carbohydrate-based fuelling practices, despite demonstrating limited knowledge of evidence-based recommendations. For example, one participant described consuming porridge, spaghetti bolognese, garlic bread, and chocolate cake with ice cream before an event lasting over 90 minutes. When asked to identify carbohydrate loading recommendations the participant answered

“I don’t know, but if I’m racing it’s 70g, because I’m 70kg”

4.3.4.3 Limited knowledge of recovery recommendations

Despite acknowledging the importance of carbohydrates before and during endurance training, knowledge deficits were evident in relation to post-exercise and recovery recommendations. When asked how much carbohydrate should be consumed following glycogen-depleting exercise, none of the participants correctly identified evidence-based recommendations. Responses included:

“I don’t think about it” (ID6)

And

“I’ve no idea on that one” (ID5).

One participant attempted to provide a specific answer but still expressed uncertainty.

“I haven’t actually thought too much about the amount that I need afterwards, but I would have thought if it was, say, an Iron Man, where it is eight hour an event, then it would be towards that 8 to 12 grams per kilogram body weight the day after to really get rid of that depletion”

When asked about their food choices post-exercise, many relied on personal experience, whilst others referenced the need for carbohydrates, protein and hydration. Several participants reported a preference for milkshakes, for example:

“Hydration, protein and carbs. Preference would be, if it's been quite an intense workout, a milkshake, just because easy to get down.” (ID3)

And

“I do like a milkshake, straight after a race, which is usually quite high in in most things, so, carbs, fats, protein” (ID1).

4.3.5 Factors influencing carbohydrate fuelling practices

Participants reported several factors which influenced their attitudes towards carbohydrate consumption.

4.3.5.1 Body composition concerns

Although only one participant discussed body composition concerns, this issue emerged as a potential influence on their attitude towards carbohydrate intake. When asked if they have any reservations towards increasing their carbohydrate intakes, the participant stated:

“I guess, subconsciously yes” and “A lot of social media when I was growing up was around like, ‘carbs are bad’, and ‘carbs make you put on weight” (ID3).

4.3.5.2 Gastrointestinal barriers

Although only one participant reported gastrointestinal issues as a barrier to increasing their carbohydrate intake, the issue emerged as a notable influence on their carbohydrate intake. They stated:

“I can't handle a lot in my stomach.” And “I gag when I eat a lot of carbs” (ID6).

4.3.5.3 Practical barriers

Several participants reported practical considerations influencing their fuelling practices. For example:

“I'm not very good at taking gels because I just find them really sticky.” (ID5)

And

“If I upped it (carbohydrates) from 70 to 100g, that means much more pockets” (ID2)

4.3.5.4 Cost considerations

Participants identified cost as an influential factor on their fuelling practices. Whilst participants reported preferences for different brands of carbohydrate-based products, affordability appeared to influence final purchasing decisions. For example, one participant stated:

“I guess it comes down to cost of each brand. When you're taking on a lot of gels in the week and in training, you know that makes a big takes a big part in that.” (ID1)

4.4 Summary of qualitative findings

Thematic analysis identified four main themes from the SSI. Generally, participants demonstrated awareness of the importance of carbohydrates for endurance exercise and reported implementing carbohydrate fuelling practices around their training.

Despite this, participants' knowledge of evidence-based carbohydrate recommendations varied considerably, particularly with respect to post-exercise carbohydrate intakes. Participants also described several factors influencing carbohydrate intake, including gastrointestinal and practical considerations.

Chapter 5: Discussion

5.1 Introduction

The aim of this study was to examine recreational endurance athletes' knowledge of carbohydrate recommendations, their attitudes towards carbohydrates and endurance performance, and their reported carbohydrate fuelling practices. This chapter presents the interpretation of the study's findings in relation to existing literature and theoretical frameworks.

5.2 Discussion of findings

5.2.1 Knowledge of carbohydrate requirements

The SSI results demonstrate that participants recognised the importance of carbohydrates for endurance performance, describing them as “one of the main energy sources for the body”. These findings are consistent with those reported by Scrivin *et al.* (2023), who found that endurance athletes recognised the importance of carbohydrates, with most participants agreeing that consuming carbohydrates improved their exercise performance. This was also mirrored in the results of this study; 86.3% of participants agreed or strongly agreed that carbohydrates improved their endurance performance. Scrivin *et al.* (2023) also found that participants were able to identify carbohydrate-containing foods. Whilst this was not directly assessed in this study, 100% of participants reported choosing a carbohydrate-based meal or snack before their endurance training or competitions. The findings suggest that recreational endurance athletes generally express positive attitudes towards carbohydrates for endurance performance, consistent with the findings reported by Scrivin *et al.* (2023). This is encouraging for coaches and sports dietitians/nutritionists, as this may reduce resistance to nutrition education and behaviour change. Nutrition interventions can therefore be focused on implementation of evidence-based fuelling strategies, rather than spending time challenging any negative attitudes or perceptions of carbohydrate consumption.

When asked about daily carbohydrate recommendations for endurance training, 54.5% of participants who completed the online survey reported being ‘not sure’. Table 2.1 illustrates carbohydrate requirements for endurance activities. Further exploration of participants’ knowledge of carbohydrate recommendations was investigated during the SSI. Considerable uncertainty was demonstrated by participants during the SSI when asked about evidence-based recommendations for carbohydrate loading and post-exercise recovery. Knowledge deficits were evident in relation to carbohydrate requirements for recovery. When asked how much carbohydrate should be consumed following glycogen-depleting exercise, no participant correctly identified evidence-based recommendations. For example, one participant stated “*I don’t think about it*”. This finding is consistent with that demonstrated by Sampson *et al.* (2023), who identified knowledge deficits across multiple domains, including carbohydrates for recovery. Ryan *et al.* (2026) also found that, compared to pre- and during event nutrition, post-event recovery received less attention in ultra-endurance runners. These findings suggest that post-exercise recovery nutrition may represent a poorly understood aspect of sports nutrition knowledge amongst endurance athletes. One explanation may be that athletes place more importance on pre- and intra-exercise fuelling due to their immediate impact on performance, whereas the benefits of recovery nutrition may be less noticeable as benefits may occur over a longer timeframe. As a result, athletes may be less likely to seek information on recovery nutrition, potentially explaining the knowledge deficits observed among participants. Ryan *et al.* (2026) also suggests that athletes may justify opting for more indulgent and suboptimal dietary choice post-exercise due to their high energy expenditure following endurance activity. Csanaky *et al.* (2025) also found that recreational endurance athletes’ knowledge of recovery nutrition was sub-optimal and highlights a critical area for improvement. The researchers suggest that this may reflect knowledge deficits, but also competing priorities such as weight management, an emphasis on protein intake, and reliance on non-professional sources of nutrition information.

5.2.2 Carbohydrate-fuelling practices and the knowledge-behaviour relationship

The results of the online surveys suggest that athletes report implementing deliberate carbohydrate fuelling practices, despite limited knowledge and uncertainty of evidence-based recommendations. Specifically, 81.8% reported adjusting their carbohydrate intake according to their training load, whilst only 9% reported not consuming carbohydrates during exercise. This suggests that participants recognised the importance for carbohydrate fuelling but may have limited understanding and awareness of the quantities recommended for their training load. This finding is consistent with Rothschild *et al.* (2026), who found that although endurance athletes generally increased carbohydrate intake with greater training volume and duration, many did not adequately periodise their carbohydrate intake according to day-to-day training demands. Whilst the Knowledge-Attitudes-Practice (KAP) model proposes that knowledge influences attitudes and subsequently behaviour (Zarei *et al.*, 2024), this study's findings challenge the assumption that increasing knowledge alone will improve dietary behaviour, and that this relationship may be more complex. Overall, participants demonstrated positive attitudes towards carbohydrate use for endurance performance, and reported engaging in carbohydrate-fuelling practices, despite limited knowledge of evidence-based recommendations. This could indicate that participants may not rely on formal nutrition knowledge and that carbohydrate fuelling practices may be influenced by additional factors. For example, participants identified factors including gastrointestinal discomfort, cost, practicality, body composition concerns and personal experience. Similar findings were found in a recent study by Fortis *et al.* (2026) who investigated pre-race nutrition behaviours in female endurance athletes competing at the Ironman world championships. The authors concluded that, despite awareness of carbohydrate loading recommendations, their implementation was impacted by as much psychosocial and contextual factors as by knowledge.

Participants may have developed their fuelling practices through experimenting with different strategies and reflecting on their past experiences. For example, one participant stated *"I think more is feeling the difference when I haven't carb loaded. And then I try and do a big session in my training plan, and then it doesn't go to plan, because I know I haven't fuelled even though I'm trying to fuel the session with carbs."* Accumulated experience of fuelling their training sessions and competitions may

further refine these practices. Furthermore, achieving their desired performance outcomes may reinforce athletes' behaviours, rather than referring to any formal knowledge of evidence-based recommendations. Fortis *et al.* (2026) found that female triathletes used past successes and failures to fine-tune their fuelling practices, whilst using these experiences to adjust their nutrition plans to address previous issues such as gastrointestinal distress. This process aligns with the experiential learning theory whereby behaviours are refined through repeated cycles of experience, feedback and adaptation (Kolb, 1984).

The findings of this study also suggest a difference between theoretical and practical nutrition knowledge. Despite participants demonstrating uncertainty regarding evidence-based recommendations (see table 2.1) most reported deliberately adjusting their carbohydrate intake based on their training load. This suggests that participants may possess practical knowledge that enables them to implement fuelling practices, even in the absence of detailed knowledge of evidence-based recommendations. The findings challenge the assumption that knowledge alone determines fuelling practices and suggests that additional factors may be influencing behaviour. Consequently, nutrition interventions may need to focus on supporting athletes to translate evidence-based recommendations into practical strategies, rather than solely increasing athletes' factual knowledge. These findings may be better aligned with the COM-B model which proposes that behaviour results from the interaction of capability, opportunity and motivation (Michie *et al.*, 2011)

5.2.3 Interpretation using the COM-B model

Applying the COM-B model to this study suggests that participants' fuelling practices are influenced by an interaction between capability, motivation and opportunity (Michie *et al.*, 2011).

Capability

Capability refers to an individual's ability to engage in a particular behaviour; this includes their physical ability and as well as knowledge (Michie *et al.*, 2011). In this

present study, 68.2% of participants reported feeling ‘somewhat confident’ in their knowledge of carbohydrate recommendations; however, 54.5% reported being ‘unsure’ of evidence-based recommendations, suggesting considerable uncertainty and variability in knowledge. Despite this, most participants demonstrated deliberate engagement with carbohydrate-fuelling practices. This finding is consistent with Ryan *et al.* (2026) who found that ultra-endurance runners self-reported moderate levels of nutrition knowledge but did not consistently implement fuelling strategies. The study found that ultra-endurance runners relied on experiential decision making and bodily cues, including hunger and thirst. Together, these findings suggest that participants possess nutrition-related capability to support their fuelling practice, even in the absence of detailed knowledge and understanding of evidence-based recommendations. As such, capability may extend beyond factual knowledge to also include experiential learning to inform and implement fuelling practices. As discussed previously, several participants described using past experiences to inform their fuelling practices, which aligns with findings from Fortis *et al.* (2026), suggesting that endurance athletes refine their nutrition strategies through repeated experiences during training and competitions

Opportunity

The second component of the COM-B model is opportunity, which encompasses physical and social factors that influence individuals’ ability to perform a behaviour. For example, this includes an individual’s access to resources, time, supportive social environments and interpersonal influences (Michie *et al.*, 2011). In this present study, opportunity-related influences included cost and practical barriers, whilst engagement with sports nutritionists and dietitians was limited compared with the use of online resources, personal experience and coaches/trainers. This may reflect the modern environment, whereby access to nutrition information is instant and available in different formats including social media platforms, online forums and podcasts. Whilst this availability may improve awareness of the important role of carbohydrates for endurance sport, it doesn’t necessarily ensure that the information is accurate and evidence based. A systematic review found that online nutrition information is often inaccurate and of poor quality, potentially subjecting consumers to inaccurate

information (Denniss *et al.*, 2023). This is consistent with findings reported by Mahoney *et al.* (2019) who found that health professionals (HCP) which included dietitians, doctors, and nurses were considered the least accessible and interesting, and used the least often. Reasons for this included lack of belief in the HCP's experience with prescribing nutrition to ultra-endurance professionals. Ryan *et al.* (2026) found that ultra-endurance runners relied on the internet and other athletes as a key source of information. In this study, the low use of sports nutritionists/dietitians may provide a partial explanation as to why awareness of carbohydrate importance was strongly cited but accurate knowledge of evidence-based recommendations was limited. However, it is also possible that participants deliberately favour alternative sources because they perceive them as more relevant or practical to their circumstances, for example, a coach or trainer that also participates in the same sporting field. This interpretation is supported by Ryan *et al.* (2026) who similarly found that ultra-endurance runners recognised the importance of nutrition for performance, but their behavioural strategies were heavily influenced by alternative sources of information, including their peers and social media, over professional support.

Motivation

The third component of the COM-B model is motivation, which refers to an individual's internal processes which direct behaviour, including reflective processes such as decision making and planning, and automatic processes involving emotions, impulses and habits (Michie *et al.*, 2011). Overall, participants consistently reported positive attitudes towards carbohydrate use and its positive impact on improving endurance performance, which may encourage fuelling behaviours despite knowledge deficits. The results of the online survey also shows that participants describe feeling a decline in energy levels when carbohydrate intake is insufficient. These findings suggest that achieving performance-related goals are a key motivational driver for carbohydrate fuelling practices, especially as most participants report that carbohydrates improve their endurance performance. The desire to optimise performance may encourage participants to engage in carbohydrate fuelling practices, despite knowledge deficits and uncertainty regarding evidence-based recommendations. It must be acknowledged that barriers to carbohydrate intake emerged during thematic analysis of SSI. Within the

COM-B model, body composition concerns and gastrointestinal discomfort may represent motivational barriers which influence athletes' engagement with carbohydrate fuelling practices. One participant described how social media impacted their previous perception of carbohydrates, describing them like 'carbs are bad', and 'carbs make you put on weight'. When asked about any reservations towards increasing carbohydrate intake, the same participant said, "*I guess, subconsciously yes*", highlighting that previous experiences may still be influencing their fuelling practices. This finding is consistent with the literature that body composition concerns can be a potential barrier for athletes meeting their carbohydrate requirements (Burke *et al.*, 2001). Similarly, gastrointestinal symptoms or discomfort may reduce athletes' motivation to consume carbohydrates. In this present study, only one participant described gastrointestinal discomfort with carbohydrate intake, stating "*I can't handle a lot in my stomach*" and "*I gag when I eat a lot of carbs*". Interestingly, the literature shows that exercise-induced gastrointestinal symptoms are prevalent in endurance sports with incidence rates >60%, compared to <10% in strength and power sports. Symptoms can include bloating, heartburn, mild regurgitation and the urge to defecate (Costa *et al.*, 2017; Gaskell *et al.*, 2023). This suggests that motivation may play a role in achieving desired performance outcomes, but also to avoid negative physiological experiences and concerns relating to body composition. Consequently, athletes may experience competing motivational influences when making fuelling decisions, balancing performance enhancement against potential body composition concerns or gastrointestinal symptoms.

Overall, the COM-B model provided a useful framework for interpreting the findings of this current study (Michie *et al.*, 2011), demonstrating that carbohydrate fuelling practices are not influenced by knowledge alone, but a combination of experiential learning, environmental opportunities and competing motivational factors. Like the present study, Ryan *et al.* (2026) identified themes relating to capability, opportunity and motivation that influenced nutrition practices, suggesting that nutritional behaviours are shaped by a complex interaction of factors, rather than knowledge alone.

5.3 Practical implications

Despite athletes recognising the importance of carbohydrates for endurance performance, deficits in knowledge of evidence-based recommendations were evident, particularly relating to carbohydrate loading and post-exercise recovery. Education interventions targeted at recreational endurance athletes should move beyond promoting the importance of carbohydrates and focus on improving their understanding of the practical use of carbohydrate recommendations across different training cycles and during competitions. Knowledge deficits were consistent for post-exercise recovery nutrition. The aim of post-exercise carbohydrate intake is to restore liver and muscle glycogen stores. Current recommendations suggest 1-1.2 g·kg⁻¹ per hour for the first four hours post-exercise, to optimise glycogen replenishment (Podlogar *et al.*, 2022). These findings suggest that future interventions should focus on improving recreational endurance athletes' knowledge and the translation into practical fuelling strategies. Focus should also be given to recovery nutrition, particularly for those competing in multi-day events, to ensure they are managing fatigue and training load (Naderi *et al.*, 2025).

Even with improving athletes' knowledge of evidence-based recommendations, the results suggest that this alone is not the only driver behind carbohydrate-fuelling practices. This study suggests that despite knowledge deficits, participants still demonstrated deliberate implementation of carbohydrate-fuelling strategies. Future education interventions should also consider how to support athletes in translating the acquired knowledge into practical, sustainable day-to-day practice. For example, meal planning guidance and carbohydrate periodisation around training, which will support athletes to implement the evidence-based recommendations.

Beyond athlete education, the findings also have implications for coaches and other members of an athletes' support network who may act as a first point of contact for advice, including support with nutrition. In this present study, participants reported limited use of sports nutritionists and dietitians compared to alternative sources including online resources, personal experience and their coaches or trainers. As

discussed previously, this may be because athletes perceive them as more relevant or practical to their sport-specific circumstances, particularly if their coach or trainer also participates in the same sporting field (Ryan *et al.*, 2026). This highlights a need for collaboration between coaches and sports nutrition professionals to ensure athletes receive consistent, evidence-based information to inform their fuelling practices. Furthermore, sport organisations should consider providing coaches with appropriate nutrition education to help them identify any potential concerns relating to athletes' nutritional practices and refer to registered sports dietitians or nutritionists when required (Hamnlund *et al.*, 2024). The results of this study suggest that greater accessibility and promotion of sports dietitians and nutritionists is warranted. A recommendation by The International Consensus Conference "Optimising Performance of the Elite Athlete" is that athletes should engage with qualified HCP, including sports dietitians, either individually or in a multi-disciplinary team. They recommend an assessment of dietary intake and nutritional status, in addition to assessment of athletes' nutrition knowledge, capability, motivation, beliefs and preferences. This will help inform a holistic fuelling plan tailored to an individual's circumstances, including their unique physiology and training demands (Bangsbo *et al.*, 2025).

Any interventions should also address motivational and practical barriers, in addition to education alone. In this study, participants cited several barriers which may limit their implementation of evidence-based carbohydrate recommendations, including gastrointestinal issues, cost and practical considerations. Sports nutritionists and dietitians should provide not only nutrition knowledge, but also practical, tailored strategies to overcome these challenges. Gastrointestinal distress is common in endurance sports, and nutrition can have a strong impact on symptoms (Fortis *et al.*, 2026). For example, a systematic analysis by Martinez *et al.* (2023) shows that practical support and repeated exposure to nutrients before and/or during exercise can reduce gut discomfort. Sports nutritionist and dietitians can support with these gut-training strategies, as well as addressing any financial burdens by providing affordable carbohydrate-rich foods.

5.4 Strengths and limitations

A mixed-methods design can provide a more in-depth understanding of complex research questions, including those in social and health research (Taherdoost, 2022). The online survey provided quantitative insights into recreational endurance athletes' knowledge, attitudes and fuelling practices and results suggest an overall positive attitude towards carbohydrate fuelling and endurance performance. The SSI enabled further exploration of participants' personal experiences, attitudes and beliefs. This method allowed increased flexibility alongside the structured survey, to gain a better understanding into participants' uncertainties regarding carbohydrate recommendations and the practical barriers to their implementation. The SSI also allowed the researcher to explore any interesting themes which emerged during the interviews (DeJonckheere & Vaughn, 2019). The use of a mixed-methods design is a key strength of this study as it allowed quantitative and qualitative findings to be compared and integrated. For example, the results of the online survey indicate that 81.8% of participants adjusted their carbohydrate intake according to their training load, whilst the SSI data provided further insight into how participants developed these practices and explored any barriers to their implementation.

Another strength of this study was the examination of both carbohydrate knowledge and fuelling practices, which allowed exploration of the relationship between them. The use of behavioural frameworks, including the KAP and COM-B models, provided a theoretical basis for interpreting the findings and provided insights into alternative factors influencing carbohydrate-fuelling practices, beyond participants' knowledge alone (Michie *et al.*, 2011; Zarei *et al.*, 2024). The COM-B model provided a framework for interpreting the findings and understanding why participants engaged in carbohydrate fuelling despite deficits in formal nutrition knowledge, by considering the interaction of capability, opportunity and motivation (Michie *et al.*, 2011). Given the focus on recreational endurance athletes, the results provide practical relevance for sport practitioners, including sports nutritionists and dietitians, and athletes themselves who want to optimise their carbohydrate-fuelling practices.

Another consideration is the researcher's position as a registered dietitian and an active participant in endurance sport, particularly long-distance running. This position means that the researcher has prior knowledge and personal experience of carbohydrate fuelling practices and this may have helped build and support rapport with participants completing the SSI. It must be acknowledged that this position may have influenced the researcher's interpretation of qualitative findings. As such, researcher reflexivity was considered throughout the analysis process to identify and minimise the influence of any biases or personal assumptions (Braun and Clarke, 2021; Mao *et al.*, 2016).

This present study is not without its limitations. Firstly, the sample size was small; $n=6$ for SSI, and $n=22$ for the online survey, which may have reduced statistical power whilst conducting inferential statistics. Whilst no statistical findings were significant, it is still possible that meaningful relationships existed between variables, but could not be detected due to the limited sample size. The interview sample was justified based on the principle of data saturation; core themes are frequently identified in the first 6-12 interviews in relatively homogenous samples (Hennink *et al.*, 2022). However, the small overall sample limits the transferability of the findings to the wider endurance athlete population. A larger sample size would allow for exploration of subgroup differences, such as gender, age and competitive status. Individuals with a particular interest in sports nutrition may have been more likely to participate, potentially influencing the results (Ryan *et al.*, 2026). Despite the useful qualitative data obtained from the SSI, they were relatively short in duration (~10 minutes), which may have limited the depth of information provided by participants. Longer interviews, with more probing questions, may have generated additional insights into participants' attitudes, experiences and decision-making process regarding carbohydrate fuelling practices.

Self-reported surveys are commonly used to assess attitudes and behaviours but can be subject to recall bias and social desirability bias. This may be more pronounced when surveys include questions which are sensitive, as individuals may alter or misreport their answers due to concerns about social disapproval or their behaviours being perceived as less desirable (Teh *et al.*, 2023). In the context of this study, reported

carbohydrate-fuelling practices may not accurately reflect actual dietary intake. Future research could incorporate quantitative dietary assessment methods, such as food diaries or dietary recalls, to provide more objective estimates of carbohydrate intake to compare with evidence-based recommendations.

Given the researcher's personal interest in endurance sport, participants were recruited through social networks known to the researcher. The survey was distributed via text to a targeted demographic i.e. a South Wales based triathlon club local to the researcher. The Whatssapp group in which the survey was distributed contained 99 members, meaning the response rate was 22.2%. Wu *et al.* (2022) found that the average online survey response rate is 44.1% and that sending the survey to a clearly defined and refined population yielded a higher response rate compared to sending it to more participants generally. Distributing the survey to a larger number of endurance sport clubs may have yielded a higher response rate. A further limitation of this study is the use of convenience sampling. As the survey was targeted at individuals participating in endurance sport, participants may be more likely to have an interest in nutrition and carbohydrate fuelling practices. Furthermore, the study did not assess or control for any formal nutrition education which participants may possess. Consequently, this may have introduced variability in participants' baseline knowledge of nutrition in endurance sport and made it more difficult to ascertain if response reflected knowledge obtained through sporting experience, formal education, professional training or a combination of these factors.

It is acknowledged that participants' carbohydrate knowledge was assessed only using a small number of objective knowledge questions. Whilst this provided an insight into participants' understanding of key carbohydrate recommendations, it is unlikely to have captured the full breadth and depth sports nutrition knowledge. Consequently, one can argue that participants' knowledge may be over- or underestimated.

5.5 Recommendations for future research

Future research should consider the use of larger sample sizes with increased diversity. This would allow comparisons across demographic and sporting sub-groups and may

improve the transferability of findings. The use of longitudinal studies may inform researchers on how athletes' fuelling practice change over a season. Rothschild *et al.* (2026) found that, over a 12-week period, athletes generally increased their carbohydrate intake with longer exercise duration; however, many did not consistently align carbohydrate intake with their training load. This highlights the value of longitudinal research to further investigate how athletes adjust their carbohydrate intake before, during and after endurance exercise in line with changing training demands across a season. Future research should also consider the use of validated sports nutrition knowledge questionnaires to provide a more comprehensive assessment of carbohydrate knowledge and understanding of evidence-based recommendations. They should also consider objective methods of dietary assessment, such as weighed food diaries or dietary recalls, to compare reported vs actual carbohydrate intake. Intervention studies using sport-specific nutrition education could be used to explore the impact of improved carbohydrate knowledge on fuelling practices and performance outcomes. A systematic review by Bordin *et al.* (2021) found that nutrition education does not consistently translate into improved dietary behaviours amongst athletes. However, the included studies varied in heterogeneity and quality, and the authors acknowledge there is limited research to inform the efficacy of nutrition education interventions in athletes. Given the common reports of sub-optimal carbohydrate intake within the literature, these findings highlight the need for high quality nutrition interventions for this demographic, in line with sport-specific evidenced-based recommendations. Future intervention studies may also be informed by the COM-B model to design strategies which consider and target capability, opportunity and motivation influences, rather than focusing exclusively on knowledge alone (Michie *et al.*, 2011).

Chapter Six - Conclusion

The aim of this study was to examine recreational endurance athletes' knowledge of evidence-based carbohydrate recommendations, their attitudes towards carbohydrates and endurance performance, their reported carbohydrate fuelling practices and the factors influencing these behaviours.

The study found that participants recognised the importance of carbohydrates and reported adjusting their carbohydrate intake based on their training load. Consistent with previous research, the results of the study suggest knowledge deficits relating to evidence-based carbohydrate recommendations, particularly for carbohydrate loading and carbohydrates for recovery (Sampson *et al.*, 2024; Csanaky *et al.*, 2025). Despite these knowledge deficits, participants reported deliberate carbohydrate-fuelling practices influenced by practical, social and financial factors. The COM-B model provided an explanatory framework to interpret findings, suggesting that participants' fuelling behaviour was influenced by an interaction between capability, motivation and opportunity, and not simply by knowledge alone (Michie *et al.*, 2011). For example, participants identified influencing factors including gastrointestinal discomfort, cost, practicality, body composition concerns and personal experience. This supports existing literature which suggests that nutrition knowledge does not consistently translate into fuelling practices (Sampson *et al.*, 2024; Ryan *et al.*, 2026).

Overall, participants demonstrated positive attitudes towards carbohydrate use for endurance performance, consistent with findings reported by Scrivin *et al.* (2023) and reported engaging in carbohydrate-fuelling practices, despite limited knowledge of evidence-based recommendations. Collectively, the findings suggest that formal nutrition knowledge alone isn't the sole determinant of participants' carbohydrate fuelling practices and that they may be influenced by additional factors. Participants reported deliberate fuelling practices despite uncertainty regarding evidence-based recommendations, with behaviours developed through experience and a range of practical, social and motivational factors. Sports nutrition interventions should focus not only on improving knowledge of recreational endurance athletes, but also on supporting the translation into realistic, sustainable fuelling practices whilst

overcoming practical and motivational barriers to implementation. Future research should consider large sample sizes, the use of validated sports nutrition questionnaires and objective measures of participants' carbohydrate intake. The use of frameworks such as the COM-B model may help future research understand the influence of capability, opportunity and motivation on athletes' carbohydrate fuelling practices.

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List of appendices

Appendix A: Participant Information Sheet

We would like you to invite you to take part in the above-named research study. Before you decide whether to take part, please take time to read the following information.

The aim of this project is to gain an understanding on the knowledge and attitudes of recreational athletes on carbohydrate requirements for endurance training. We are asking individuals who meet the following eligibility criteria, to take part: -Aged between 19-65 -Participate in an endurance activity (examples include running, cycling, swimming, hybrid training e.g. HYROX, rowing) which lasts from 30-240 minutes, at least twice a week.

Taking part in the questionnaire is entirely voluntary. If you decide to participate, you can always change your mind and stop mid-way through completing the questionnaire and you will not be asked why you've stopped.

We will ask you to complete a questionnaire which we anticipate will take you between 5-10 minutes to complete. All information obtained will be anonymous. There is an option at the end of the survey to leave your email address should you want to participate in part 2 of the study.

This project has received ethical approval from Ethics Committee of University of Wales Trinity St David.

Thank you for taking the time to read this information sheet. Please click 'Yes' if you wish to continue.

Appendix B: Survey Questionnaire

Analysis of endurance athletes' knowledge of their carbohydrate requirements. When you submit this form, it will not automatically collect your details like name and email address unless you provide it yourself.

1. Participants information sheet (appendix A)

2. What is your age?

18-24

25-34

35-44

45-54

55-65

>65

3. Please specify your gender.

Female

Male
Non-binary
Prefer not to say

4. Which sport(s) or exercise do you participate in?

5. On average, how many hours do you train per week?

Less than 2 hours

2-6 hours

7-12 hours

>12 hours

6. How many years have you been involved in your sport?

<2 years

2-5 years

>5 years

7. How confident do you feel about your knowledge of carbohydrate requirements for endurance training?

Very confident

Somewhat confident

Not so confident

Not confident at all

8. Where do you primarily obtain information about your carbohydrate needs for endurance training?

Coaches or trainers

Sports dietitians or nutritionists

Online resources e.g. websites, blogs, forums

Books or journal articles

Personal experiences

9. Have you ever adjusted your carbohydrate intake based on your training load?

Yes

No

Not sure

10. If you answered 'Yes', which adjustments to your carbohydrate intake do you undertake?

11. In your experience, how does consuming carbohydrates before training affect your performance?

I feel a noticeable improvement

I feel slightly better

I don't notice any difference

I feel worse

I don't usually consume carbohydrates before training

12. How does your performance change during long training session when you DON'T consume carbohydrates?

I feel fatigued more quickly

I feel no difference

I feel better

I haven't tried training without carbohydrates

13. Have you ever experienced hitting the wall, or 'bonking'? If so, what do you think contributed to it?

14. What is your pre-training or pre-event meal or snack of choice?

15. How long before the training/event would you consume the meal/snack?

Less than 1 hour

1-2 hours

>2 hours

16. Which duration of training or event would you typically consume carbohydrates during it?

<60 minutes

60-90 minutes

90-120 minutes

>120 minutes

I don't consume carbohydrates during training

17. How many grams per hour of carbohydrates would you typically consume during prolonged training or an event?

No carbohydrates at all

30-60g

60-90

>90g

18. To your understanding, how much carbohydrate is generally recommended per day for endurance athletes participating in daily, moderate-high intensity exercise?

3-5g per kg of body weight

5-7g per kg of body weight

6-10g per kg of body weight

Not sure

19. Please answer the following statements.

20. Thank you for completing this survey. We're recruiting athletes to complete a food diary which we will analyse. This will allow us to compare athletes' knowledge and beliefs vs their actual intake of carbohydrates. If you would be happy to complete a food diary for analysis, please leave your e-mail below. Thank you.

Appendix C: Transcripts of semi-structured interviews

Interview 1 (ID1)

Okay, to your understanding, how does consuming carbohydrates improve endurance performance?

So, from my understanding, carbohydrates is one of the main fuel sources for endurance performance, allowing us to work at an intensity above fat metabolism. So, yeah, really important.

To your understanding. How are carbohydrates stored in the body?

Uhhh Store, not entirely sure. I think they turn it the it becomes glycogen when it's stored, which will be stored in and around the muscles and then used when needed.

Are carbohydrates, something you consider during your endurance training and all competition?

Yeah, because I compete over two-hour events, I usually carb load and I also use carbs within my racing.

Okay, great.

Have you had any reservations about increasing your carbohydrate intake for your endurance training?

No, never. If anything, I probably need to add more carbs.

Add more carbs?

Add more carbs.

Okay, moving on to pre-exercise before an endurance training session or competition lasting over 90 minutes, talk me through your nutrition choices in the 24 to 48 hours beforehand?

Depending on the intensity and the duration of the either training session or race?

yeah or race, yes.

If it's a, for example, a four hour long, hard training session, I would be conscious of the carb loading in 24 hours before I would probably look towards 10, maybe 12 grams per kilogram of body weight in the 24 hours before, just to load up the glycogen stores. And then I would look to fuel, if I was just trying to fuel the session, I'd probably look about

90 grams per hour if I was training, trying to train my gut to withstand the amount of carbs that I'm wanting to take on and use. I might try and up that sometimes, as I get close to events, to more 120 grams to train my gut to be able to withstand that amount of carbohydrates during the four-hour session. So, it is a different approach, I guess, for different sessions, but I definitely am aware of the carb intake needed to perform if I am trying to perform over an intense session,

And when you are carb loading the day before you said, for 24 hours, how would you structure that in your day? Are you focusing on increasing the portions at mealtimes or introducing extra snacks? How do you go about that?

That process combination of both snacks, combination of increasing meal size, and I guess the content of that meal so there is more carb dependent. And then yeah, extra snacks is needed because I am a heavy athlete, and that will require me to, yeah, to continuously be eating carbs throughout the day, basically before, before either big session or a big race.

And when you do have those big races, or the longer sessions, where you're focusing on the carb load, and you'll do that for the 24 hours beforehand, or any longer?

Usually 24 hours, if I'm doing an Ironman, it might be for the two days prior, just to make sure that I am fully, you know, fuelled up ready to perform, but yeah, in the past, it was more focuses on that last 24 hours before the event. Great.

So, from your understanding, why does carbohydrate loading before those longer sessions or competitions endurance focused help increase your performance?

To my understanding, it is to do with the storage of then glycogen around the muscles prior to starting that activity, so that starting that race, if you're loaded up and you've got an increased store of glycogen, then you've got energy there to use when you are in that event, when you are working at intensity that is requiring you to burn carbs and sustain the effort you need that carb storage as well as the intake that you're taking on during the event. Okay, great.

And do you feel a difference in how you feel in your performance on a session where you have focused on carb loading compared to one where you haven't, maybe focused so much on it the day before?

Yeah, 100% I think more so is feeling the difference when I haven't and knowing that I haven't so when, like, I have a bad day, every day, no, you know, I haven't, maybe thought about it too much, and then I try and do a big session in my training plan, and then it doesn't go to plan, because I know and I can feel in my body that I Haven't fuelled even though I'm trying to fuel the session with carbs. Sometimes it's almost too late either that I've probably not carbed loaded enough and even taken on 100 odd grams per hour within that session. Say it's in a four-hour session, I'm gonna get to like three hours and I have been fuelling with a 100 grams, it can still have a negative effect that I haven't pre fuelled for that session. So, yeah, it definitely makes a difference.

I feel that, yeah, if you can pre load as well as during as well.

Okay, fab. And I think you might have answered this already, but to your understanding, again, when carbohydrate loading before a competition or long training session, what is the recommended range of carbohydrate intake per day?

It's probably between eight and 12 grams per kilogram of body weight.

Moving on to during exercise, so you've talked about a little bit about consuming carbs during your exercise and training. So, we know that you do that, but talk me through the duration of training sessions that you decide, right I'm taking carbs during it, and sort of how much and when you consume them?

I think anything over 90 minutes, for me is a session that I would like to take carbs on if it's just a two hour easy bike ride, and I've just and I've had carb loading prior to it, then maybe I would have a low carb intake for that two hours, so maybe a 40 grams an hour, just to kind of top my carbs up so I don't get too depleted. If it's an intense two hour session, it's not an easy two hours, I would then up at maybe more towards 80 grams an hour, because it is an intense session, not to necessarily fuel the session itself, but more for the recovery effect after that session, because I'm usually training two to three times a day, and I know that I need to just keep on top of my carbohydrate levels during the day. Yeah, there's change.

And do you have a preference of the type of carbohydrates you consume? For example, to your gels, choose actual food drinks. What's your preference?

I don't necessarily have a preference. I think I find it easy to consume any carbs. I think gels are easy to know the amount that you're taking on each time that you take it on, whereas, obviously, fluid, if you're mixing it up, certain, yeah, you're not, maybe not quite sure at certain points how much you've taken on. So I do like gels, because they do give you that out and out. When you've taken on 40 grams, you've taken on 40 grams. But in terms of ease of taking on carbs, then a liquid form is easy as well. So I mix it up

Great. And do you have a preference of brands for those gels? Any ones you prefer over another?

I tend to use SIS. I've used a lot of other brands as well. I'm not that fussy on which brands I use. I guess it comes down to cost of each brand. When you're taking on a lot of gels in the week and in training, you know that makes a big takes a big part in that. But I'm pretty flexible in using High Five, Maurten and any other Yeah, okay.

Now moving on to post exercise. So following glycogen depleting exercise, so those longer sessions or competitions. What do you prioritise from a nutrition perspective, when it comes to recovery?

I do tend to try and carb up after the session, so I know that that's really important, particularly after, say, an Iron Man I would be the next day eating a lot of or trying to eat

a lot of carbohydrates, because I know that my body's been depleted of that carbohydrates, not just in the session, but afterwards, in its recovery. So, I do tend to go for carbs. I will also supplement that with protein. But for my sport, I do think it's important to load back up with the carbs, because you don't if you've been depleted, because you don't want that to be affecting your next session or the next day of training.

Okay, great. And following that exercise or competition, how soon after that are you prioritizing that recovery, need or drink of choice?

It depends on how my body's feeling. If I'm feeling, yeah, if I'm feeling not that hungry, I try my best today, within the first half hour, to get some liquid, form of carbohydrates, or just any type of food, really, that is going to give me some benefit in that depletion that I've had. And then within the couple of hours, I'm looking at trying to get a proper meal in things that are going to be high, high in carbs, high in protein, and start to take away that depletion in my body.

Amazing. Okay, and to your understanding following glycogen depleting exercise, how much carbohydrates should you eat after?

I haven't actually thought too much about the amount that I need afterwards, but I would have thought if it was, say, an Iron Man, where it is eight hour an event, then it would be towards that eight to 12 grams per kilogram body weight the day after to really get rid of that depletion. If there's a lower, say, something a four hour event, or a smaller session training session, then it wouldn't be maybe as much, maybe be like five to eight grams per kilogram of body weight for that kind of recoup of the depletion.

Okay, great. And the last question, what do you think are factors that can improve or enhance your glycogen replenishment after exercise?

What?

What do you think are factors that can improve or enhance so trying to replenish the glycogen stores, like you said, so eating plenty of carbs. What other factors do you think that can improve or enhance that recovery or replenishment process?

Hydration? Some, yeah, obviously protein as well as the carbs and yeah, rest, electrolytes, potentially, if you've lost electrolytes, yeah?

And last question, actually, I'll add one more. Do you have a go to meal, snack or drink of choice, post exercise?

Yeah, I do like a milkshake, straight after a race, with a chocolate milkshake, which is usually quite high in in most things, so, carbs, fats, protein, yeah, I do like milkshake or milk or whatever.

Interview 2 (ID2)

Okay, all right, to your understanding, how does consuming carbohydrates improve endurance performance?

Oh, good question. As in, if I'm it's different when I train to when I race. So when I race, I actually concentrate on my carbohydrates and how much I take based on my body weight. But then when I train, I hardly do, only on long, long bike rides,

okay? And what do you mean by long time wise?

Three, four hours? Anything two and under, I don't bother. It's water or just normal,

And when you do consume those carbs, how do you think it improves your endurance?

I don't bonk that's one main thing. And I do actually, I'm not sure if it's mentally, physically or just thinking it, but if I took a gel or something, or 20 minutes before race, I do feel like, Oh, I feel good. It might just be my my infant in it, but it might actually be physiologically.

And to your understanding, how do you store carbohydrates in the body? How are carbohydrates stored?

I don't know. I just eat and drink

And when, when carbohydrates break down in the body. How do you store them? It doesn't matter if you don't know.

No clue.

You've kind of answered this a little bit but just feel free to expand. Are carbohydrates something you consider during your endurance training and all competitions?

Yes, but mostly competitions. With training, I should take it more often. If it's a hard session, I would, but if it's just an easy session, I'm just like, yeah, go as normal.

Okay, and so you said if the session was under three hours or under, you wouldn't bother taking carbs in it. But if it was a hard session that was two hours or less, would you then take carbohydrates?

Yeah, but it would mostly be about before training.

Have you had any reservations about increasing your carbohydrate intake for your endurance training?

No, but then when I look at, or when you hear podcasts or whatever, and they say, Oh, I take this much, and they're like, Oh, interesting, but I'm not sure how it would work. Or basically you'd take on much more. So, like, carbs I use, What do I use? High five, which

are 20 grams. And then I've got precision hydrations, which are 30, and I've got the chews that are 60. But then, if I upped it from 70 to 100 that means much more pockets.

And okay, so you'd say being able to store the actual food on your body is like a limitation or a barrier?

Yeah, but then that's just excuses, really, but you know what I mean.

Okay, all right, second category is pre-exercise, so before an endurance training session or competition that's over 90 minutes, talk me through your nutrition choices in the 24 to 48 hours beforehand?

So say the race is on a Sunday. So, on a Saturday morning, I'd have porridge in the morning, then for lunch, then it would probably just be some sort of carbs. And then it's the supper where I actually think about it most. So, it's usually spaghetti bolognese, garlic bread, chocolate cake and ice cream. So, and that's for even if it's a sub 90 minute or a 90 minute, if it's a race, it's always spag boll.

Okay, so that's the 24 hours before. Are you are you aware of any changes you make for two days before, 48 hours before?

Just load up on the carbs and the potatoes, the rice and try and lack the fibre.

So you mentioned about increasing carbs at meals. What about like in between with snacks?

I'd have more snacks, which is flapjacks, bagles, and try and get them then every two hours, really two hours.

And why do you think carbohydrate loading before a competitive endurance event helps to increase your performance?

I think everybody just says, 'Eat your carbs or get your carbs in'. And since then, I've just been like, okay, fine, okay.

So you think you're more influenced by more people say, rather than how it makes you how it makes you feel?

Yeah.

And to your understanding when you're carbohydrate loading before a competition, what's the recommended range of carbohydrate intake per day?

Ooh, per day? That's a good one. I don't know, per hour, but if I'm racing, it's 70 because I'm 70 kilograms.

Okay, so you are you based that off your own weight? That you take 70 grams per hour?

Yeah, an hour.

Okay, during exercise. So, do you consume you've kind of answered this already, but do you consume carbohydrates during your exercise or training? So talk me through if you are choosing to take carbohydrates during it, how and when do you take it during that session?

So, I tend then to, if I'm eating every 20 minutes and then drinking every 30 minutes, like but then obviously, so if I was on a bike ride, I'd drink a bottle of precision hydration, which is 60 grams of carbs, and then I'd probably have a gel. So, I'd have finished the bottle within the hour, and then, say, on the hour or 20 minutes before I take my gel.

Okay, so you take about 60, grams an hour, at least, and then maybe that 20-30 gram extra with the gel. Okay, and talk me through when, and what you'd consume over 90 minutes. You've already mentioned about the drink and the gel. Do you do that then every hour?

Every hour, but I'd mix it up then, even if it's a gel, if it's a chew, if it's a Flapjack, so try and get something different in.

Do you have a preference out of those?

I was chew person, but now I'm a precision hydration gel and a Flapjack.

And then post exercise. So following glycogen depleting exercise, when you deplete your energy stores, what do you prioritise? From a nutrition perspective, when it comes to your recovery?

It depends. If I'm at home, it's easier. Say today. Now I'm an hour away from home. I haven't got anything with me, so it's basically just drive home, have a shower, and then supper is ready.

And what would be your meal, snack, drink of choice? Not necessarily today, but ideally?

Strawberry milkshake. Yeah, strawberry milkshake. I do like a strawberry milkshake.

And why would you choose a strawberry milkshake? What are the properties that you'd think that's good for recovery? Or is it something again, that you've just come across?

I think because the calories as well in a milkshake, say, 400 milliliters, well, that's 200 calories. Ish, I think is it? Yeah, I should be doing more. I should have a protein shake or an apple, something straight away afterwards. But I don't.

And how soon after the exercise, in an ideal world, would you consume something like that milkshake?

Should be straight away, but I wait about half an hour, an hour, depends on how I feel. Yeah, I should be more prepared.

And to your understanding or to your knowledge, what following the glycogen depleting exercise. How much carbohydrates should you eat after a session or a competition?

I don't know. Is it still the same? Is it still 70, or is it less? I don't know.

What do you think are factors that can improve or enhance glycogen replenishment post exercise? So after exercise, you consume carbohydrates and you store that in the form of glycogen in your liver and your muscles. But can you think of anything that might improve that process after exercise?

No, trying to eat or drink something straight away, before or within that 20 minutes. I think so.

Interview 3 (ID3)

To your understanding, how does consuming carbohydrates improve endurance performance?

So, carbs are one of the main energy sources for the body, especially in endurance sports. I think carbs are stored as glycogen in muscles and body?

Okay, fab, so you understand where it's stored as well. But second question is to your understanding, how is carbohydrate stored in the body? So glycogen, yeah, but anything else from your understanding about that?

I don't know.

Are carbohydrates something you consider during your endurance training and or competitions?

Yes, particularly, it like pretraining or racing, and then anything over like 90 minutes, during as well.

Okay, have you had any reservations about increasing your carbohydrate intake for your endurance training?

I guess subconsciously yes, because of, probably, like, media growing up. I'd say, yeah, probably subconsciously, without realising that it probably has affected, like, how willing I was, maybe to increase carbs, but, in terms of what I would actively try and do and actively try and consume carbs.

And in terms of the reservation from the media side of things, what in particular was the factor that would put you off increasing them?

So a lot of media when I was growing up was around like, 'carbs are bad', and 'carbs make you put on weight', or for like athletes going to the gym, or whatever, the protein is all you need to eat and the carbs aren't essential, I think, is the main thing about it, yeah, maybe not being essential, or maybe carbs being like a bad in, quote, unquote, like food source.

Then next set of questions off a pre-exercise, so before an endurance training session or competition that's over 90 minutes, talk me through your nutrition choices in the 24 to 48 hours beforehand?

Um, if it's a training session, my diet wouldn't change that much compared to day to day, because a lot of my training is a is over 90 minutes anyway. Um, but pre session or pre workout, it would be something simple, like simple carbs, like white bread or, yeah, usually white bread is my go-to. But if it was over a 90-minute race, I would change it the day before to just eating more in general, and keeping my meals for the day a bit simpler as well, like lower fibre, higher carb, compared to what I'd normally eat in a normal day. But that's, yeah, that's before competition, rather than day to day training.

Okay, and how do you go about that process? You've mentioned about increasing the amount you're eating the day, e.g. before eating more carbs than you usually would. Do you focus on more meals, or would you include additional snacks or drinks in between then as well?

Yes, meals probably being a bit more carb focused, but also snacks, snacking on, like, things that I probably wouldn't usually snack on, that are like bigger and more like a meal, really like mini meals.

Okay, and to your understanding, why does carbohydrate loading before a competitive endurance event help to increase performance?

Maybe because your glycogen stores are maximized, and then you're not playing like catch up during the race or during the training session. So, you're like, you're not playing catch up, as in, you already can, like, dip into your glycogen stores that have been loaded pre the day, few days before.

Okay, great, and to your understanding, when you're carbohydrate loading before a competition, what is the recommended range of carbohydrates intake per day?

Oh, um, I'm either like on a number that is right or like way off. I'm gonna say like, is it 10 to 12 grams per kilogram body weight?

Then, okay, and then during exercise. So, do you consume carbohydrates during your exercise or training?

If it tends to be over 90 minutes, then yes.

Okay, and talk me through when and what you'd consume?

Okay, so if it was a session over 90 minutes, if it's something high intensity, like running over 90 minutes, I would start taking gels half an hour in. And I would, I usually aim for 60 grams of carbs an hour. Well, between 60 to 70, taking something in every half hour or every 25 to 30 minutes. If it's lower intensity, like a cycle over 90 minutes, isn't that long a cycle anything over, like, two hours, I'd probably eat them. So, if that was the case, I'd go for something like, again, like, maybe a bit less 40 to 60 grams an hour. But I prefer to eat something on the bike, so I'll have, like, yeah, something solid as and when on the bike. But running, I'm a bit stricter with running, okay?

And that's because, yeah, that's because of the higher intensity levels from the running compared to the bike?

Yeah, higher demand I feel for carbs.

What's your preference of carbs, you mentioned briefly there, but gels and food. But what preference would you have for either? just talk me through that again.

Okay. For gels, I like the SIS Beta Fuel gels, because of the consistency and flavour, they're easy to get down. And I also quite like the pH gels. They're quite unoffensive and, like, there's not loads in there thing, so you can get it down in like, two mouthfuls. On the bike, I like the beta field chews because it tastes nice. And if I want something more solid, I'll have a banana, or I'll have, like, a bacon roll. Or, like, if there's a coffee, stop, yeah, maybe cake?

Okay, last set of questions, post exercise, so following glycogen, depleting exercise, what would you prioritize from a nutrition perspective when it comes to your recovery?

Hydration, protein and carbs.

What would your meal, snack, drink of choice be, and how soon after the exercise do you typically consume it? What times do you think you should consume it if you don't think you're already doing that?

Preference would be, if it's been quite an intense workout, a milkshake, just because easy to get down. If it's not been that intense, maybe like eggs on toast. That's my goal, to, or a bowl of cereal. How long after? I probably go again, if it's intense, I do struggle to eat straight after, so it's probably like within an hour, less intense, maybe like 90 mins. In terms of what I think it should be, maybe an hour, okay?

And to your understanding, following glycogen, depleting exercise, how much carbohydrates should you eat?

Oh, following? Okay, oh, God, I don't know! If a carb load is 10 to 12, maybe, like, five to six grams per kilogram body weight?

And what do you think are factors that can improve or enhance glycogen replenishment post exercise?

Can you ask me that again?

Yeah, so what do you think are factors that can improve or enhance the rebuilding of glycogen after exercise?

Whether you've been like depleted before, maybe? So like, if you've not eaten enough glycogen or consumed enough glycogen pre and during exercise. So then maybe your body, like, doesn't know what to do with the new glycogen or can absorb it's fast. Don't think type. I think any, any...and time after, like, How long after the exercise you consume it? So if you've left it too long, maybe it wouldn't be as beneficial as having it sooner.

Interview 4 (ID4)

To your understanding, how does consuming carbohydrates improve endurance performance?

From my understanding, consuming carbohydrates before endurance race gives you energy. It fuels the muscles, for example, for a long-distance run, the more carbs you you eat before, the better your run will be in some uncertain terms.

To your understanding, how are carbohydrates stored in the body?

As glucose. I don't actually know, in the muscles? I don't know. I don't know the answer.

Are carbohydrates something you consider during your endurance training and/or competitions?

Yes, 100%. I recently started using gels for my runs. Fast carbs, easy to absorb whilst on the run.

Have you had any reservations about increasing your carb intake for your endurance training?

Not at all.

Before an endurance training session or competition that's over 90 minutes or an hour and a half, talk me through your nutrition choices in the 24 to 48 hours beforehand.

If I'm being honest, it doesn't change with anything. I always try to have a source the carbs with any meal I have, whether that's lunch, dinner, or breakfast. Yeah, it doesn't, it won't change for any event. Like I say, I always try and have source carbs, so I don't really think any more about it.

So if you've got a longer session or something, you'll just eat normally. You're not going to think too much about it?

Yeah, I eat carbs. I eat loads of carbs anyway. Like I don't watch how much carbs I eat there.

So, you don't necessarily adjust your carb in place in your training?

No, unless you know, like for example, now I'm training for specifically for a marathon perhaps I'd be advised to, but prior to that, no I haven't really.

Why does carbohydrate loading before a competitive endurance event help increase performance to your understanding?

I don't know the science behind it, but from what I can gather it's stored in your body. So, it's like anything, the tank is full. Yeah, it's like a reserve of energy, I suppose. Already stored in your body.

To your understanding, when you're carb loading before a competition, what is the recommended range of carbohydrate intake per day?

I don't know.

Any guess?

Per day before an event?

Yeah, for carb loading. What's the guidelines?

300 grams?

Do you consume carbs during your exercise or training?

I have in the past and long bike ride I'd take a gel or banana or breakfast cereal bars

Would that need to be a specific duration for the bike ride for you to take carbs?

Yeah, but a bike ride tends to be you know at least two-three hours. So I'll always have some sort of gel, cereal bar, banana in that time. Running, not so much, but last half marathon I did take a gel, I think it was about halfway point. I think I need to start looking at doing it more often.

Okay, so if you've got a two or three hour bike ride, talk me through when and what you'd consume during that ride?

Again, I think no real specific structure behind it. Just when I'm feeling a bit, I suppose hungry. Or say, for example, if I'm going for three hours, I'll try and perhaps space it every hour, depending on how I got if I got a couple of gels and maybe even every half hour. But you know, if I just got one banana, then I'm going to take it the halfway point.

And what preference do you have of a carb? So, do you prefer like real food? If so, which type? Or do you prefer gels, chews, drinks?

On the bike?

Yeah, bike or running.

On the bike, it'd be like a banana, like a cereal bar, biscuits. Running, it would have to be a gel. I'm not going to take a banana on a run.

Any particular brands of gels?

SIS.

Any particular reason?

I think they've got more carbs in, 40 grams per sachet.

Okay, and then post exercise. So following glycogen depleting exercise, so when you've got rid of your stores, what do you prioritize from a nutrition perspective when it comes to recovery?

Protein and carbs.

And what is your meal or snack or drink of choice?

Any sort of carbs, so rice, pasta, potatoes with any sort of chicken or beef primarily, and veg.

And how soon after exercise would you have that meal? Do you time it or do you just eat whenever is convenient?

As soon as conveniently possible.

And to your understanding, following glycogen depleting exercise, how much carbs should you eat?

I don't know.

And are there any factors that you think could improve or enhance glycogen replenishment after exercise,

Hydration, sleep,

Okay. Anything else you want to add?

How much carbs do I need before the day before an event?

Interview 5 (ID5)

To your understanding, how does consuming carbohydrates improve your endurance performance?

Well, because if you have the stores, then you have more energy.

To your understanding, how are carbohydrates stored in the body?

I don't know. I have no idea. How are they stored? In like glucose. It turns into that other thing. Glucose? No. Glycogen!

Are carbohydrates something you consider during your endurance training and/or any competitions.

Yes, but I'm not very good at taking gels because I just find them really sticky. Is the truth. I usually have like loads before I go, and then like a jaffa cake, like when I'm like ready to go out the door. Maybe some sweets during a run, but I'm trying to get better at the gels.

Okay, so you have a focus on carbs like around when you're training? Like your mind is going towards carbs beforehand?

Yeah, yeah, yeah. So, like if I'm going for a run in the morning, I need to have a bagel now before I go.

Okay, and have you had any reservations about increasing your carbohydrate intake for your training?

Yeah, because I feel like I need to be better at having them during the run because I don't usually, so I need to improve that, and like before, like be more like structured rather than be like, 'Oh I'll have a bagel and a jaffa cake and this and that' and just like pick.

Okay, great. So, this pre-exercise. So, you might have mentioned a few things before, but you can say the same things again. So, before an endurance training session or a

competition that lasts over 90 minutes, over an hour and a half, talk me through your nutrition choices in the 24 to 48 hours beforehand.

Okay, I don't really think 48 hours before. But the day before, I'd probably like have like a normal day, which usually is a lot of carbs anyway, and then in the night I'd have like definitely have like pasta, garlic bread or bread. Okay, doesn't have to be garlic. And then maybe like some toast before bed or something, or like not before bed, like later. And then in the morning, then either like a bagel with banana or like a banana sandwich or like something like that.

Why does carbohydrate loading before a competitive endurance event, so like a half marathon/marathon, help increase performance?

Because I feel like if I did it, and I would just like hit the wall and like not have any energy to like get past like 10k if it was like a half marathon. And what was the other question? Oh no, it was the same question. Like you just need the energy stores.

And to your understanding, when you're carbohydrate loading before a competition or like a long training session. What is the recommended range of carbohydrate intake per day?

What, like how many grams? Yeah, no idea. 100? 150? 200? No, it's loads, isn't it? Because you had loads for Swansea half marathon. In my head, it's like as much as possible. But like, is that maybe that's detrimental? And then you're stuffed.

You might have said this already, but do you consume carbohydrates during your exercise or training?

No, but it's something I'm like conscious of that I need to, like, try more. If it's a race, then I'll always take what they've got, like a gel or like a sweet or something or Lucozade. Does that count? Okay, I'm alright with the lucozade, but the gels I always find like they're really hard to open and then I get sticky hands.

What are the barriers apart from the sticky hands and opening them?

Well, sometimes I feel like a gel is massive, and I'll have some, and then there's loads left, and I just like can't physically like get it down. But I have in the past, so I just feel like I just need to like get back into it. But I really like the gels that are like watery, so if I had like more access to them, then I probably would. I'm gonna try more now in the in the marathon.

So is it maybe, a case of now that you've got something to focus on that you'll practice more?

Yeah, I feel like I have to for the long runs.

So, talk me through when and what you'd consume, if anything, if you're training or exercising for over 90 minutes?

I just have some water.

Just water?

Yeah.

And have you got any preference of carbs that, if you were to have it during training?

Well, like when we did the half marathon, like our own half marathon at Christmas time, and we stopped, and we had the apple juice, I really liked that. That went down well. Sweets, I feel like sometimes they do, sometimes they don't. Like sometimes, like I can't like chew it. But like sometimes I can, if I like stop. That's it really. Juice is the best, or the the aqua gel.

So, following exercise where you've depleted your glycogen stores, you've been on a long training session. What would you prioritize from a nutrition perspective when it comes to your recovery?

Milkshake. Yeah, love the milkshake after. First of all, it's like a treat, it goes down well. Like I feel like this is helping. So, like Wednesday, I did my long run on the treadmill, walked home, and like picked up a milkshake on the way. Drank it on the rest of the walk home. So, I got home, I was like having a milkshake. Then I think I had some eggs on toast.

And what is it about the milkshake that you think like helps or is beneficial?

Is it a protein? Yeah, yeah. Yeah, I feel like in my head it's carbs before, protein after. So, I'm always like, right, I'll have the milkshake, I'll have yogurt, eggs, tuna, like a tuna sandwich.

And how soon after the exercise would you eat after?

Straight away because I'm always starving

To your understanding, following glycogen depleting exercise, how much carbohydrate should you eat?

after? Oh, I don't know. So, if it's 500 before...I don't know. I don't think about it.

And what do you think are factors that could improve or enhance glycogen replenishment post exercise? So, when you're consuming carbs after your body's storing it as glycogen, then for future, what other factors you think that could improve that process?

Like, what can I do to help?

Yeah. Anything else? Any other factors?

Like a Lucozade. So, sometimes I'll have a Lucozade. Actually, or a milkshake. I wouldn't have both. Either or. Yeah. Lucozade, some sweets, jelly babies.

Interview 6 (ID6)

So, to your understanding, how does consuming carbohydrate improve endurance performance?

Just, energy? I guess you can go for longer.

To your understanding, how are carbs stored in the body?

I don't know. Something to do with glucogen stores? I do know. Something to do with glucogen stores. And that's what we use then when we're in in endurance.

Are carbohydrates something you consider during your endurance training and/or competitions or events?

Yes. Yeah. All time. 60 to 70 grams an hour. Nothing more, I can't handle more.

Have you had any reservations about increasing your carb intake for your endurance training?

No, because I've always eaten quite a high carb diet. I've never really reduced carb intake, so no doesn't affect me.

Before an endurance training session or event that's over 90 minutes, talk me through like any nutrition choices you do in the one or two days before that.

Um. So, I would have like maybe a day, maybe... because I can't handle a lot of volume, I have like a three-day carb load, sometimes a bit longer. Mostly liquid carbs because I can't handle a lot in my stomach. Can't take it on board. So, then I'll just slowly have, you know depends really on training what I'm doing, it's mostly like juices and smoothies and stuff like that because I can't handle the volume. Yeah, yeah, because I gag when I eat a lot of carbs.

Okay, so you've talked about how you go about that process. Why do you think that carb loading before an event like that helps with your endurance performance?

I do know, but my mind doesn't work since having a baby.

Well, how do you think it helps you? Do you do it because you know it helps you, or because you've been told that it must help you?

Ah, yeah, I think so. I know I need it because if I don't, if I don't eat enough the day before, I feel like shit. I don't feel great. Don't feel like I've got enough energy to like push as hard as I would, whereas if I eat well for like a day or two before...say now I'm going for like a five hour ride, the night before and I haven't really thought about what I'm eating, then I'll just eat like a little bit, and then I'm like struggling to keep up and stuff.

So you can feel the difference?

Yeah, I need it. I don't think I need as much, as what I was told I needed because I felt fine for my long distance (triathlon).

And did you take less than what you were advised to take, and do you remember how much you were told to take?

Yeah, so I think it was like 70 to 80 grams an hour for the bike, and then obviously I ate quite a large carb breakfast. Yeah, I don't know what the carb content was, but it was a lot. But when it came to the bike, I struggled with the handling of the bike, so I couldn't take it all out. I was eating what I needed to eat, but I couldn't get the carb powder (in a bottle) in me as much as what I should have. It was more of a practical thing than anything. But I didn't feel like I needed it anyway. I felt fine.

To your understanding, when you're carb loading before a competition, do you know what the recommended range of carb intake should be per day?

I do know. Oh, it's your... per kilogram? Yeah. Yeah, per kilogram weight, like times 100 or something? So if I'm 65 kilos, I need 650?

Do you consume carbs during exercise of training – you've said during your competition. Do you do it in your training as well?

Yeah. I've practiced it, because I didn't want to affect my bowels

So, talk me through when and what you'd consume if the event is like over 90 minutes. You've mentioned about considering grams per hour?

So, I'd eat two to three hours before, and then I'd have 30 grams of carbs (gel) before, about 45 minutes before I start yeah, and then I would have 60-70 sometimes a little bit more if I can.

And that's on the bike and on the run?

Yeah, on the run then I reduced it down slightly. I had four gels on the run, so that's 120 grams. I didn't have that much, but I was drinking coke.

So, you planned to take less?

Yeah.

And do you have a preference of type of carbs? So like, would you prefer the gels, chews, drinks?

So for me, it's to do with what I'm doing. So, if it's the bike, I prefer the chews. If it's a run, I can't chew a sweet, so I have to have a gel.

And you mentioned about the carbs drink as well?

Yeah, that was 60 grams of carbs and 1000 of electrolytes, in one bottle.

Do you only have that for competition?

I would use that for training as well. I would take that out with me if I was going on a long ride. Well, I would take one bottle of that and then a bottle of electrolytes because it's a bit gaggy.

Any brands for the gels or chews?

Precision Hydration.

So, following glycogen depleting exercise, so we've got all of rid of your stores. What do you prioritize from a nutrition perspective when it comes to your recovery?

Um. I'm gonna tell you something that's gonna sound awful. Okay. I'll have a can of coke. Yeah, a full fat coke. Not all the time.

Is that something you've like always liked or something you've picked up?

I love coke, but I would only drink it once a year at Christmas. It's really bad for your teeth, really bad for you. It's not you know, it's just full of sugar isn't it. I don't drink it all the time, but I do drink it a lot more since doing endurance.

Is that to replace your carbs?

Yeah, and then I will eat something like more or less straight away.

Any preference for meal or snack, like when you have your food?

Just have like, I'll just have like a meat and two veg, something like that. Do you know what I mean? I'll have like a chicken salad with some potatoes or something, you know. Just a normal meal. I make sure I eat pretty soon after. Something savoury then.

The next question was actually, how do you have a window where you're like 'I need to eat within that amount of time' or?

No, I just try. Food is like a big thing for me, so I think about it all the time. So, I would be like 'I need to eat'. It would be straight away. Yeah, more or less, just to get it in.

And is that because you know you need it for recovery?

No because I love food and I'm hungry. I've got a good appetite.

To your understanding, following glycogen-depleted exercise. How much carbs should you eat?

I've no idea that one.

What do you think are factors that can improve or enhance glycogen replenishment after exercise?

No idea.

Appendix D: Quantitative results (SPSS output)

Frequencies

Notes		
Output Created		19-SEP-2026 14:21:56
Comments		
Input	Active Dataset	DataSet2
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.
Syntax		FREQUENCIES VARIABLES=Gender Years_in_sport Confidence_carbs Knowledge_carb_reqs /ORDER=ANALYSIS.
Resources	Processor Time	00:00:00.01
	Elapsed Time	00:00:00.00

Statistics

		Gender	Years_in_sport	Confidence_carbs	Knowledge_carb_reqs
N	Valid	22	22	22	22
	Missing	0	0	0	0

Frequency Table

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	11	50.0	50.0	50.0
	Female	11	50.0	50.0	100.0
	Total	22	100.0	100.0	

Years_in_sport

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<2 years	4	18.2	18.2	18.2
	2-5 years	4	18.2	18.2	36.4
	>5 years	14	63.6	63.6	100.0
	Total	22	100.0	100.0	

Confidence_carbs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not so confident	5	22.7	22.7	22.7
	Somewhat confident	15	68.2	68.2	90.9
	Very confident	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

Knowledge_carb_reqs

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Correct	3	13.6	13.6	13.6
	Incorrect/Not sure	19	86.4	86.4	100.0
	Total	22	100.0	100.0	

Crosstabs

Notes

Output Created		19-SEP-2026 14:25:03
Comments		
Input	Active Dataset	DataSet2
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each table are based on all the cases with valid data in the specified range(s) for all variables in each table.
Syntax		CROSSTABS /TABLES=Years_in_sport BY Knowledge_carb_reqs /FORMAT=AVALUE TABLES /STATISTICS=CHISQ /CELLS=COUNT EXPECTED ROW /COUNT ROUND CELL.
Resources	Processor Time	00:00:00.01
	Elapsed Time	00:00:00.00
	Dimensions Requested	2
	Cells Available	524245

Case Processing Summary

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_in_sport * Knowledge_carb_reqs	22	100.0%	0	0.0%	22	100.0%

Years_in_sport * Knowledge_carb_reqs Crosstabulation

			Knowledge_carb_reqs		
			Correct	Incorrect/Not sure	Total
Years_in_sport	<2 years	Count	1	3	4
		Expected Count	.5	3.5	4.0
		% within Years_in_sport	25.0%	75.0%	100.0%
	2-5 years	Count	0	4	4
		Expected Count	.5	3.5	4.0
		% within Years_in_sport	0.0%	100.0%	100.0%
	>5 years	Count	2	12	14
		Expected Count	1.9	12.1	14.0
		% within Years_in_sport	14.3%	85.7%	100.0%
Total	Count	3	19	22	
	Expected Count	3.0	19.0	22.0	
	% within Years_in_sport	13.6%	86.4%	100.0%	

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.075 ^a	2	.584
Likelihood Ratio	1.544	2	.462
Linear-by-Linear Association	.080	1	.778
N of Valid Cases	22		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .55.

Crosstabs

Notes

Output Created		19-SEP-2026 14:27:21
Comments		
Input	Active Dataset	DataSet2
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each table are based on all the cases with valid data in the specified range(s) for all variables in each table.
Syntax		CROSSTABS /TABLES=Years_in_sport BY Knowledge_carb_reqs /FORMAT=AVALUE TABLES /STATISTICS=CHISQ /CELLS=COUNT EXPECTED ROW /COUNT ROUND CELL /METHOD=EXACT TIMER(5).
Resources	Processor Time	00:00:00.03
	Elapsed Time	00:00:00.00
	Dimensions Requested	2
	Cells Available	524245
	Time for Exact Statistics	0:00:00.02

Case Processing Summary

	Valid		Cases Missing		Total	
	N	Percent	N	Percent	N	Percent
Years_in_sport * Knowledge_carb_reqs	22	100.0%	0	0.0%	22	100.0%

Years_in_sport * Knowledge_carb_reqs Crosstabulation

			Knowledge_carb_reqs		Total
			Correct	Incorrect/Not sure	
Years_in_sport	<2 years	Count	1	3	4
		Expected Count	.5	3.5	4.0
		% within Years_in_sport	25.0%	75.0%	100.0%
	2-5 years	Count	0	4	4
		Expected Count	.5	3.5	4.0
		% within Years_in_sport	0.0%	100.0%	100.0%
	>5 years	Count	2	12	14
		Expected Count	1.9	12.1	14.0
		% within Years_in_sport	14.3%	85.7%	100.0%
Total	Count		3	19	22
	Expected Count		3.0	19.0	22.0
	% within Years_in_sport		13.6%	86.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.075 ^a	2	.584	1.000	
Likelihood Ratio	1.544	2	.462	.855	
Fisher-Freeman-Halton Exact Test	1.166			1.000	
Linear-by-Linear Association	.080 ^b	1	.778	1.000	.527
N of Valid Cases	22				

Chi-Square Tests

	Point Probability
Pearson Chi-Square	
Likelihood Ratio	
Fisher-Freeman-Halton Exact Test	
Linear-by-Linear Association	.291
N of Valid Cases	

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .55.

b. The standardized statistic is .282.

NPar Tests

Notes

Output Created		19-SEP-2026 14:34:56
Comments		
Input	Active Dataset	DataSet2
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TESTS /M-W= Confidence_carbs BY Knowledge_carb_reqs(1 2) /MISSING ANALYSIS.
Resources	Processor Time	00:00:00.01
	Elapsed Time	00:00:00.00
	Number of Cases Allowed ^a	449389

a. Based on availability of workspace memory.

Mann-Whitney Test

Ranks

	Knowledge_carb_reqs	N	Mean Rank	Sum of Ranks
Confidence_carbs	Correct	3	15.83	47.50
	Incorrect/Not sure	19	10.82	205.50
	Total	22		

Test Statistics^a

	Confidence_carbs
Mann-Whitney U	15.500
Wilcoxon W	205.500
Z	-1.517
Asymp. Sig. (2-tailed)	.129
Exact Sig. [2*(1-tailed Sig.)]	.226 ^b

a. Grouping Variable:
Knowledge_carb_reqs

b. Not corrected for ties.

NPar Tests

Notes

Output Created		19-SEP-2026 14:36:39
Comments		
Input	Active Dataset	DataSet2
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TESTS /M-W= Confidence_carbs BY Gender(1 2) /MISSING ANALYSIS.
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00
	Number of Cases Allowed ^a	449389

a. Based on availability of workspace memory.

Mann-Whitney Test

Ranks

	Gender	N	Mean Rank	Sum of Ranks
Confidence_carbs	Male	11	10.91	120.00
	Female	11	12.09	133.00
	Total	22		

Test Statistics^a

	Confidence_carbs
Mann-Whitney U	54.000
Wilcoxon W	120.000
Z	-.521
Asymp. Sig. (2-tailed)	.603
Exact Sig. [2*(1-tailed Sig.)]	.699 ^b

a. Grouping Variable: Gender

b. Not corrected for ties.

Nonparametric Correlations

Notes

Output Created		19-SEP-2026 14:43:47
Comments		
Input	Active Dataset	DataSet2
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	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each pair of variables are based on all the cases with valid data for that pair.
Syntax		NONPAR CORR /VARIABLES=Years_in_sport Confidence_carbs /PRINT=SPEARMAN TWOTAIL NOSIG FULL /MISSING=PAIRWISE.
Resources	Processor Time	00:00:00.01
	Elapsed Time	00:00:00.00
	Number of Cases Allowed	629145 cases ^a

a. Based on availability of workspace memory

Correlations

		Years_in_sport	Confidence_carbs
Spearman's rho	Years_in_sport	Correlation Coefficient	1.000
		Sig. (2-tailed)	.
		N	22
	Confidence_carbs	Correlation Coefficient	-.036
		Sig. (2-tailed)	.873
		N	22

Spearman's rho Correlations

Highly Positive: (None)

Positive: (None)

No Linear Correlation: (None)

Negative: (Years_in_sport<---> Confidence_carbs)

Highly Negative: (None)

Note: Curated Help is calculated based on actual cell values, not the formatted values.

NPar Tests

Notes		
Output Created		19-SEP-2026 15:14:16
Comments		
Input	Active Dataset	DataSet2
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	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	22
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each test are based on all cases with valid data for the variable(s) used in that test.
Syntax		NPAR TESTS /M-W= Confidence_carbs BY Carb_adjust(1 2) /MISSING ANALYSIS.
Resources	Processor Time	00:00:00.01
	Elapsed Time	00:00:00.00
	Number of Cases Allowed ^a	449389

a. Based on availability of workspace memory.

Mann-Whitney Test

Ranks				
	Carb_adjust	N	Mean Rank	Sum of Ranks
Confidence_carbs	1	18	10.75	193.50
	2	3	12.50	37.50
	Total	21		

Test Statistics^a

	Confidence_carbs
Mann-Whitney U	22.500
Wilcoxon W	193.500
Z	-.544
Asymp. Sig. (2-tailed)	.586
Exact Sig. [2*(1-tailed Sig.)]	.669 ^b

a. Grouping Variable: Carb_adjust

b. Not corrected for ties.

Appendix E: Qualitative Analysis

Table E.1: Coding framework used during thematic analysis.

Participant	Quote. (Question: To your understanding, how does consuming carbohydrates improve endurance performance?)	Code
ID1	Carbohydrates are one of the main fuel sources for endurance performance, allowing us to work at an intensity above fat metabolism.	Carbohydrates as energy Understanding of physiology
ID2	I don't bonk that's one main thing	Impact on performance
ID3	carbs are one of the main energy sources for the body, especially in endurance sports.	Carbohydrates as energy source
ID4	consuming carbohydrates before endurance race gives you energy. It fuels the muscles, for example, for a long-distance run, the more carbs you you eat before, the better your run will be	Carbohydrates as energy source Impact on performance
ID5	Because if you have the stores, then you have more energy	Carbohydrates as energy source
ID6	Just, energy? I guess you can go for longer.	Carbohydrates as energy source Impact on performance
Participant	Quote: (Question: How are carbohydrates stored in the body?)	Code
ID1	Not entirely sure. I think it becomes glycogen when it's stored, which will be stored in and around the muscles and then used when needed	Variable physiological understanding; uncertainty
ID2	I don't know. I just eat and drink	Knowledge deficit
ID3	I think carbs are stored as glycogen in muscles and body?	Variable physiological understanding; uncertainty
ID4	As glucose. I don't actually know, in the muscles? I don't know. I don't know the answer.	Knowledge deficit
ID5	I don't know. I have no idea. How are they stored? In like glucose. It turns into that other thing. Glucose? No. Glycogen!	Variable physiological understanding; uncertainty
ID6	I don't know. Something to do with glucogen stores? I do know. Something to do with glucogen stores. And that's what we use then when we're in in endurance.	Variable physiological understanding; uncertainty

Participant	Quote (Question: Are carbohydrates, something you consider during your endurance training and all competition?)	Code
ID1	Over two-hour events, I usually carb load and I also use carbs within my racing.	Deliberate fuelling strategy
ID2	Yes, but mostly competitions. With training, I should take it more often. If it's a hard session, I would, but if it's just an easy session, I'm just like, yeah, go as normal. So when I race, I actually concentrate on my carbohydrates and how much I take based on my body weight. But then when I train, I hardly do, only on long, long bike rides.	Inconsistent implementation of recommendations. Limited knowledge of evidence-based recommendations.
ID3	Yes, particularly for pretraining or racing, and then anything over like 90 minutes, during as well.	Deliberate fuelling strategy
ID4	Yes, 100%. I recently started using gels for my runs. Fast carbs, easy to absorb whilst on the run.	Deliberate fuelling strategy. Physiological understanding
ID5	Yes, but I'm not very good at taking gels because I just find them really sticky. Is the truth. I usually have like loads before I go, and then like a jaffa cake, like when I'm like ready to go out the door. Maybe some sweets during a run, but I'm trying to get better at the gels.	Inconsistent implementation of strategies. Practical barrier
ID6	All time. 60 to 70 grams an hour. Nothing more, I can't handle more.	Deliberate fuelling strategy Awareness of evidence-based recommendations
Participant	Quote (Question: Have you had any reservations about increasing your carbohydrate intake for your endurance training?)	Code
ID1	No, never. If anything, I probably need to add more carbs.	Performance motivation
ID2	No, but then when I look at, or when you hear podcasts or whatever, and they say, Oh, I take this much, and they're like, Oh, interesting, but I'm not sure how it would work. I've got the chews that are 60. But then, if I upped it from 70 to 100 that means much more pockets.	Experience-based learning Practical barrier
ID3	I guess subconsciously yes, because of social media growing up. I'd say, yeah, probably	Experience based learning Body-composition concerns

	subconsciously, without realising that it probably has affected how willing I was to increase carbs. So a lot of social media when I was growing up was around like, 'carbs are bad', and 'carbs make you put on weight', or for like athletes going to the gym, or whatever, and that the protein is all you need to eat and the carbs aren't essential.	Carbohydrate restriction beliefs
ID4	Not at all	Performance motivation
ID5	Yeah, because I feel like I need to be better at having them during the run because I don't usually, so I need to improve that, and like before, like be more like structured rather than be like, 'Oh I'll have a bagel and a jaffa cake and this and that' and just like pick.	Inconsistent implementation of strategies
ID6	No, because I've always eaten quite a high carb diet. I've never really reduced carb intake, so no doesn't affect me.	Performance motivation
Participant	Quote (Question: moving on to pre-exercise before an endurance training session or competition lasting over 90 minutes, talk me through your nutrition choices in the 24 to 48 hours beforehand?)	Code
ID1	For example, a four hour long, hard training session, I would be conscious of the carb loading in 24 hours before I would probably look towards 10, maybe 12 grams per kilogram of body weight in the 24 hours before, just to load up the glycogen stores. And then I would look to fuel, if I was just trying to fuel the session, I'd probably look about 90 grams per hour if I was training, trying to train my gut to withstand the amount of carbs that I'm wanting to take on and use. I might try and up that sometimes, as I get close to events, to more 120 grams to train my gut to be able to withstand that amount of carbohydrates during the four-hour session. So, it is a different approach, I guess, for different sessions, but I definitely am aware of the carb intake needed to perform if I am trying to perform over an intense session. Usually 24 hours, if I'm doing an Ironman, it might be for the two days prior, just to make sure that I am fully, you know, fuelled up ready to perform,	Awareness of evidence-based recommendations. Deliberate fuelling strategy Impact on performance Experience based learning

	but yeah, in the past, it was more focuses on that last 24 hours before the event.	
ID2	So say the race is on a Sunday. So, on a Saturday morning, I'd have porridge in the morning, then for lunch, then it would probably just be some sort of carbs. And then it's the supper where I actually think about it most. So, it's usually spaghetti bolognese, garlic bread, chocolate cake and ice cream. So, and that's for even if it's a sub 90 minute or a 90 minute, if it's a race, it's always spag boll.	Deliberate fuelling strategy Limited knowledge of evidence-based recommendations. Experience based learning
ID3	Um, if it's a training session, my diet wouldn't change that much compared to day to day, because a lot of my training is a is over 90 minutes anyway. Um, but pre session or pre workout, it would be something simple, like simple carbs, like white bread or, yeah, usually white bread is my go-to. But if it was over a 90-minute race, I would change it the day before to just eating more in general, and keeping my meals for the day a bit simpler as well, like lower fibre, higher carb, compared to what I'd normally eat in a normal day. But that's, yeah, that's before competition, rather than day to day training.	Limited knowledge of evidence-based recommendations. Deliberate fuelling strategy
ID4	If I'm being honest, it doesn't change with anything. I always try to have a source the carbs with any meal I have, whether that's lunch, dinner, or breakfast. Yeah, it doesn't, it won't change for any event. Like I say, I always try and have source carbs, so I don't really think any more about it. Yeah, I eat carbs. I eat loads of carbs anyway. Like I don't watch how much carbs I eat there.	Lack of awareness for carbohydrate intake and training demands
ID5	Okay, I don't really think 48 hours before. But the day before, I'd probably like have like a normal day, which usually is a lot of carbs anyway, and then in the night I'd have like definitely have like pasta, garlic bread or	Deliberate fuelling strategy Identification of carbohydrate-containing foods

	bread. Okay, doesn't have to be garlic. And then maybe like some toast before bed or something, or like not before bed, like later. And then in the morning, then either like a bagel with banana or like a banana sandwich or like something like that.	
ID6	Um. So, I would have like maybe a day, maybe... because I can't handle a lot of volume, I have like a three-day carb load, sometimes a bit longer. Mostly liquid carbs because I can't handle a lot in my stomach. Can't take it on board. So, then I'll just slowly have, you know depends really on training what I'm doing, it's mostly like juices and smoothies and stuff like that because I can't handle the volume. Yeah, yeah, because I gag when I eat a lot of carbs.	Deliberate fuelling strategy Identification of carbohydrate-containing foods Gastrointestinal barrier
Participant	Quote (Question: And when you are carb loading the day before you said, for 24 hours, how would you structure that in your day?)	Code
ID1	That process combination of both snacks, combination of increasing meal size, and I guess the content of that meal so there is more carb dependent. And then yeah, extra snacks is needed because I am a heavy athlete, and that will require me to, yeah, to continuously be eating carbs throughout the day, basically before, before either big session or a big race.	Deliberate fuelling strategy
ID2	Just load up on the carbs and the potatoes, the rice and try and lack the fibre. I'd have more snacks, which is flapjacks, bagels, and try and get them then every two hours, really two hours.	Deliberate fuelling strategy Identification of carbohydrate-containing foods
ID3	Yes, meals probably being a bit more carb focused, but also snacks, snacking on, like, things that I probably wouldn't usually snack on, that are like bigger and more like a meal, really like mini meals.	Deliberate fuelling strategy Identification of carbohydrate-containing foods
ID4	No, I don't adjust carbs in my training, unless you know, like for example, now I'm training for specifically for a marathon perhaps I'd be	Lack of awareness for carbohydrate intake and training demands

	advised to, but prior to that, no I haven't really.	
ID5	N/A	N/A
ID6	N/A	N/A
Participant	Quote (Question: So, from your understanding, why does carbohydrate loading before those longer sessions or competitions endurance focused help increase your performance?)	Code
ID1	To my understanding, it is to do with the storage of then glycogen around the muscles prior to starting that activity, so that starting that race, if you're loaded up and you've got an increased store of glycogen, then you've got energy there to use when you are in that event, when you are working at intensity that is requiring you to burn carbs and sustain the effort you need that carb storage as well as the intake that you're taking on during the event. Yeah, 100% I think more so is feeling the difference when I haven't carb loaded and knowing that I haven't. And then I try and do a big session in my training plan, and then it doesn't go to plan, because I know I haven't fuelled even though I'm trying to fuel the session with carbs. Sometimes it's almost too late either that I've probably not carb loaded enough and even taken on 100 odd grams per hour within that session. Say it's in a four-hour session, I'm gonna get to like three hours and I have been fuelling with 100 grams, it can still have a negative effect that I haven't pre fuelled for that session. So, yeah, it definitely makes a difference.	Variable physiological understanding; uncertainty. Experience-based learning.
ID2	I think everybody just says, 'Eat your carbs or get your carbs in'. And since then, I've just been like, okay, fine, okay.	Experience-based learning Knowledge deficit
ID3	Maybe because your glycogen stores are maximized, and then you're not playing like catch up during the race or during the training session. So, you can dip into your glycogen stores that have been loaded pre the day, few days before.	Variable physiological understanding

ID4	I don't know the science behind it, but from what I can gather it's stored in your body. So, it's like anything, the tank is full. Yeah, it's like a reserve of energy, I suppose. Already stored in your body.	Variable physiological understanding; uncertainty
ID5	Because I feel like if I did it, and I would just like hit the wall and like not have any energy to like get past like 10k if it was like a half marathon. Like you just need the energy stores.	Experience-based learning. Impact on performance
ID6	Ah, yeah, I think so. I know I need it because if I don't, if I don't eat enough the day before, I feel rubbish. I don't feel great. Don't feel like I've got enough energy to like push as hard as I would, whereas if I eat well for like a day or two before...say now I'm going for like a five hour ride, the night before and I haven't really thought about what I'm eating, then I'll just eat like a little bit, and then I'm like struggling to keep up and stuff. I don't think I need as much, as what I was told I needed because I felt fine for my long distance (triathlon).	Experience-based learning. Knowledge deficit
Participant	Quote (Question: but to your understanding, again, when carbohydrate loading before a competition or long training session, what is the recommended range of carbohydrate intake per day?)	Code
ID1	It's probably between eight and 12 grams per kilogram of body weight.	Awareness of evidence-based recommendations.
ID2	I don't know, per hour, but if I'm racing, it's 70 because I'm 70 kilograms.	Knowledge deficit
ID3	I'm gonna say like, is it 10 to 12 grams per kilogram body weight?	Awareness of evidence-based recommendations.
ID4	300 grams?	Knowledge deficit
ID5	Yeah, no idea. 100? 150? 200? In my head, it's like as much as possible. But like, is that maybe that's detrimental? And then you're stuffed.	Knowledge deficit
ID6	Per kilogram weight, like times 100 or something? So, if I'm 65 kilos, I need 650?	Awareness of evidence-based recommendations; uncertainty

Participant	Quote (Question: Do you consume carbs during exercise of training?)	Code
ID1	I think anything over 90 minutes, for me is a session that I would like to take carbs on, if it's just a two hour easy bike ride, and I've had carb loading prior to it, then maybe I would have a low carb intake for that two hours, so maybe a 40 grams an hour, just to kind of top my carbs up so I don't get too depleted. If it's an intense two hour session, it's not an easy two hours, I would then up at maybe more towards 80 grams an hour, because it is an intense session, not to necessarily fuel the session itself, but more for the recovery effect after that session, because I'm usually training two to three times a day, and I know that I need to just keep on top of my carbohydrate levels during the day.	Experience-based learning. Deliberate fuelling strategy
ID2	So, I tend then to, if I'm eating every 20 minutes and then drinking every 30 minutes, like but then obviously, so if I was on a bike ride, I'd drink a bottle of precision hydration, which is 60 grams of carbs, and then I'd probably have a gel. So, I'd have finished the bottle within the hour, and then, say, on the hour or 20 minutes before I take my gel. Every hour, but I'd mix it up then, even if it's a gel, if it's a chew, if it's a Flapjack, so try and get something different in.	Deliberate fuelling strategy
ID3	If it tends to be over 90 minutes, then yes. Okay, so if it was a session over 90 minutes, if it's something high intensity, like running over 90 minutes, I would start taking gels half an hour in. And I would, I usually aim for 60 grams of carbs an hour. Well, between 60 to 70, taking something in every half hour or every 25 to 30 minutes. If it's lower intensity, like a cycle over 90 minutes, isn't that long a cycle anything over, like, two hours, I'd probably eat them. So, if that was the case, I'd go for something like, again, like, maybe a bit less 40 to 60 grams an hour. But I prefer to eat something on the bike, so I'll have, like, yeah, something solid as and when on the bike. But running, I'm a bit stricter with running, okay?	Deliberate fuelling strategy Awareness of evidence-based recommendations

ID4	I have in the past and long bike ride I'd take a gel or banana or breakfast cereal bars. Yeah, but a bike ride tends to be you know at least two-three hours. So I'll always have some sort of gel, cereal bar, banana in that time. Running, not so much, but last half marathon I did take a gel, I think it was about halfway point. I think I need to start looking at doing it more often. Again, I think no real specific structure behind it. Just when I'm feeling a bit, I suppose hungry. Or say, for example, if I'm going for three hours, I'll try and perhaps space it every hour, depending on how I got if I got a couple of gels and maybe even every half hour. But you know, if I just got one banana, then I'm going to take it the halfway point.	Deliberate fuelling strategy Inconsistent implementation of strategies
ID5	No, but it's something I'm like conscious of that I need to, like, try more. If it's a race, then I'll always take what they've got, like a gel or like a sweet or something or Lucozade. Does that count? Okay, I'm alright with the lucozade, but the gels I always find like they're really hard to open and then I get sticky hands. Well, sometimes I feel like a gel is massive, and I'll have some, and then there's loads left, and I just like can't physically like get it down. But I have in the past, so I just feel like I just need to like get back into it. But I really like the gels that are like watery, so if I had like more access to them, then I probably would. I'm gonna try more now in the in the marathon. Over 90 minutes I'll just have water.	Practical barrier Inconsistent implementation of strategies
ID6	Yeah. I've practiced it, because I didn't want to affect my bowels. Over 90 minutes: So, I'd eat two to three hours before, and then I'd have 30 grams of carbs (gel) before, about 45 minutes before I start yeah, and then I would have 60-70 sometimes a little bit more if I can. Yeah, on the run then I reduced it down slightly. I had four gels on the run, so that's 120 grams. I didn't have that much, but I was drinking coke.	Deliberate fuelling strategy Gastrointestinal barrier
Participant	Quote (Question: Do you have a preference of the type of carbohydrates you consume?)	Code

ID1	I don't necessarily have a preference. I think I find it easy to consume any carbs. I think gels are easy to know the amount that you're taking on each time that you take it on, whereas, obviously, fluid, if you're mixing it up, certain, yeah, you're not, maybe not quite sure at certain points how much you've taken on. So I do like gels, because they do give you that out and out. When you've taken on 40 grams, you've taken on 40 grams. But in terms of ease of taking on carbs, then a liquid form is easy as well. So I mix it up.	Deliberate fuelling strategy Practical reasons
ID2	N/A	
ID3	Okay. For gels, I like the SIS Beta Fuel gels, because of the consistency and flavour, they're easy to get down. And I also quite like the pH gels. They're quite unoffensive and, like, there's not loads in there thing, so you can get it down in like, two mouthfuls. On the bike, I like the beta field chews because it tastes nice. And if I want something more solid, I'll have a banana, or I'll have, like, a bacon roll. Or, like, if there's a coffee, stop, yeah, maybe cake?	Deliberate fuelling strategy Practical reasons
ID4	On the bike, it'd be like a banana, like a cereal bar, biscuits. Running, it would have to be a gel. I'm not going to take a banana on a run.	Deliberate fuelling strategy Practical reasons
ID5	Well, like when we did the half marathon, like our own half marathon at Christmas time, and we stopped, and we had the apple juice, I really liked that. That went down well. Sweets, I feel like sometimes they do, sometimes they don't. Like sometimes, like I can't like chew it. But like sometimes I can, if I like stop. That's it really. Juice is the best, or the the aqua gel.	Practical reasons Individual preference
ID6	So for me, it's to do with what I'm doing. So, if it's the bike, I prefer the chews. If it's a run, I can't chew a sweet, so I have to have a gel. In my carb drink, that was 60 grams of carbs and 1000 of electrolytes, in one bottle. I would use that for training as well. I would take that out with me if I was going on a long ride. Well, I would take one bottle of that and then a bottle of electrolytes because it's a bit gaggy.	Deliberate fuelling strategy Practical reasons Gastrointestinal barrier
Participant	Quote (Question: And do you have a preference of brands?)	Code

ID1	I tend to use SIS. I've used a lot of other brands as well. I'm not that fussy on which brands I use. I guess it comes down to cost of each brand. When you're taking on a lot of gels in the week and in training, you know that makes a big takes a big part in that. But I'm pretty flexible in using High Five, Maurten and any others.	Cost implications Practical reasons
ID2	I was chew person, but now I'm a precision hydration gel and a Flapjack.	Individual preference
ID3	Okay. For gels, I like the SIS Beta Fuel gels, because of the consistency and flavour, they're easy to get down. And I also quite like the pH gels. They're quite unoffensive and, like, there's not loads in there thing, so you can get it down in like, two mouthfuls. On the bike, I like the beta field chews because it tastes nice. And if I want something more solid, I'll have a banana, or I'll have, like, a bacon roll. Or, like, if there's a coffee, stop, yeah, maybe cake?	Individual preference Practical reasons
ID4	SIS. I think they've got more carbs in, 40 grams per sachet.	Individual preference Awareness of carbohydrate content
ID5	N/A	
ID6	Precision Hydration.	Individual preference
Participant	Quote (Question: Following glycogen depleting exercise, so those longer sessions or competitions. What do you prioritise from a nutrition perspective, when it comes to recovery?)	Code
ID1	I do tend to try and carb up after the session, so I know that that's really important, particularly after, say, an Iron Man I would be the next day eating a lot of or trying to eat a lot of carbohydrates, because I know that my body's been depleted of that carbohydrates, not just in the session, but afterwards, in its recovery. So, I do tend to go for carbs. I will also supplement that with protein. But for my sport, I do think it's important to load back up with the carbs, because you don't if you've been depleted, because you don't want that to be affecting your next session or the next day of training. Yeah, I do like a milkshake, straight	Recovery nutrition knowledge Recognition of glycogen depletion Performance motivation Individual preference

	after a race, with a chocolate milkshake, which is usually quite high in in most things, so, carbs, fats, protein, yeah, I do like milkshake or milk or whatever.	
ID2	It depends. If I'm at home, it's easier. Say today. Now I'm an hour away from home. I haven't got any thing with me, so it's basically just drive home, have a shower, and then supper is ready. My first choice would be Strawberry milkshake. Yeah, strawberry milkshake. I do like a strawberry milkshake. I think because the calories as well in a milkshake, say, 400 milliliters, well, that's 200 calories. Ish, I think is it? Yeah, I should be doing more. I should have a protein shake or an apple, something straight away afterwards. But I don't.	Inconsistent implementation of strategies
ID3	Hydration, protein and carbs. Preference would be, if it's been quite an intense workout, a milkshake, just because easy to get down. If it's not been that intense, maybe like eggs on toast. That's my go- to, or a bowl of cereal.	Recovery nutrition knowledge Individual preference
ID4	Protein and carbs. Meal of choice: Any sort of carbs, so rice, pasta, potatoes with any sort of chicken or beef primarily, and veg.	Recovery nutrition knowledge Individual preference
ID5	Milkshake. Yeah, love the milkshake after. First of all, it's like a treat, it goes down well. Like I feel like this is helping. So, like Wednesday, I did my long run on the treadmill, walked home, and like picked up a milkshake on the way. Drank it on the rest of the walk home. So, I got home, I was like having a milkshake. Then I think I had some eggs on toast. Yeah, I feel like in my head it's carbs before, protein after . So, I'm always like, right, I'll have the milkshake, I'll have yogurt, eggs, tuna, like a tuna sandwich.	Recovery nutrition knowledge Individual preference
ID6	Um. I'm gonna tell you something that's gonna sound awful. Okay. I'll have a can of coke. Yeah, a full fat coke. Not all the time. I love coke, but I would only drink it once a year at Christmas. It's really bad for your teeth, really bad for you. It's not you know, it's just full of sugar isn't it. I don't drink it all the time, but I do drink it a lot more since doing endurance. Meal of choice: Just have like, I'll just have like a meat and two veg, something like that. Do you know what I mean? I'll have like a chicken salad with some potatoes or something, you know. Just a normal meal. I	Experience based learning

	make sure I eat pretty soon after. Something savoury then.	
Participant	Quote (Question: How soon after that are you prioritizing that recovery, need or drink of choice?)	Code
ID1	It depends on how my body's feeling. If I'm feeling, yeah, if I'm feeling not that hungry, I try my best today, within the first half hour, to get some liquid, form of carbohydrates, or just any type of food, really, that is going to give me some benefit in that depletion that I've had. And then within the couple of hours, I'm looking at trying to get a proper meal in things that are going to be high, high in carbs, high in protein, and start to take away that depletion in my body.	Performance motivation Recovery nutrition knowledge Awareness of recovery timing
ID2	Should be straight away, but I wait about half an hour, an hour, depends on how I feel. Yeah, I should be more prepared.	Awareness of recovery timing Inconsistent implementation of strategies
ID3	if it's intense, I do struggle to eat straight after, so it's probably like within an hour, less intense, maybe like 90 mins. In terms of what I think it should be, maybe an hour, okay?	Experience based learning
ID4	As soon as conveniently possible.	Awareness of recovery timing
ID5	Straight away because I'm always starving	Experience based learning
ID6	No, I just try. Food is like a big thing for me, so I think about it all the time. So, I would be like 'I need to eat'. It would be straight away. Yeah, more or less, just to get it in. I love food and I'm hungry. I've got a good appetite.	Experience based learning
Participant	Quote (Question: To your understanding following glycogen depleting exercise, how much carbohydrates should you eat after?)	Code
ID1	I haven't actually thought too much about the amount that I need afterwards, but I would have thought if it was, say, an Iron Man, where it is eight hour an event, then it would be towards that eight to 12 grams per kilogram body weight the day after to really get rid of that depletion. If there's a lower, say, something a four-hour event, or a smaller session training session, then it wouldn't be maybe as much, maybe be like five to eight	Awareness of evidence-based recommendations; Uncertainty regarding recovery recommendations

	grams per kilogram of body weight for that kind of recoup of the depletion.	
ID2	I don't know. Is it still the same? Is it still 70, or is it less? I don't know.	Knowledge deficit
ID3	Oh, following? Okay, oh, God, I don't know! If a carb load is 10 to 12, maybe, like, five to six grams per kilogram body weight?	Limited knowledge of evidence-based recommendations; uncertainty
ID4	I don't know	Knowledge deficit
ID5	after? Oh, I don't know. So, if it's 500 before...I don't know. I don't think about it.	Knowledge deficit
ID6	I've no idea that one.	Knowledge deficit
Participant	Quote (Question: And the last question, what do you think are factors that can improve or enhance your glycogen replenishment after exercise?)	Code
ID1	Hydration? Some, yeah, obviously protein as well as the carbs and yeah, rest, electrolytes, potentially, if you've lost electrolytes, yeah?	Recovery nutrition knowledge
ID2	No, trying to eat or drink something straight away, before or within that 20 minutes. I think so.	Recovery nutrition knowledge
ID3	Whether you've been like depleted before, maybe? So like, if you've not eaten enough glycogen or consumed enough glycogen pre and during exercise. So then maybe your body, like, doesn't know what to do with the new glycogen or can absorb it's fast. Don't think type. I think any, any...and time after, like, How long after the exercise you consume it? So if you've left it too long, maybe it wouldn't be as beneficial as having it sooner.	Recovery nutrition knowledge
ID4	Hydration, sleep.	General recovery knowledge
ID5	Like a Lucozade. So, sometimes I'll have a Lucozade. Actually, or a milkshake. I wouldn't have both. Either or. Yeah. Lucozade, some sweets, jelly babies.	Identification of carbohydrate-containing food
ID6	No idea.	Knowledge deficit

Thematic Map

Table E.2: Thematic map showing themes, sub-themes and example codes identified through thematic analysis.

Theme	Sub-themes	Example code
Understanding of carbohydrate fuelling for endurance performance	- Recognition of carbohydrates as an energy source - Variable physiological understanding and uncertainty	Carbohydrates as an energy source, impact on performance
Application of carbohydrate fuelling strategies	- Deliberate fuelling strategy - Experience-based learning - Inconsistent implementation	Inconsistent implementation of recommendations, deliberate fuelling strategy
Knowledge of evidence-based recommendations	- Carbohydrate loading recommendations - Greater awareness of practical fuelling strategies than formal recommendations - Recovery recommendations	Variable physiological understanding; uncertainty, knowledge deficit
Factors influencing carbohydrate intake	- Body composition concerns - Gastrointestinal barriers - Practical barriers - Cost considerations	Practical reasons, gastrointestinal barrier

Appendix F: Ethics documentation

APPLICATION FOR ETHICAL APPROVAL

RESEARCH STUDENTS

This form is to be completed by the student within SIX months for full-time students and TWELVE months for part time students, after the commencement of the research degree or following progression to Part Two of your course.

Once complete, submit this form via the *MyTSD Doctoral College Portal* at (<https://mytsd.uwtsd.ac.uk>).

This document is also available in Welsh.

RESEARCH STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk , with the title 'Ethical Approval' followed by your name.

STUDENTS ON UNDERGRADUATE OR TAUGHT MASTERS

PROGRAMMES should submit this form (and receive the outcome) via systems explained to you by the supervisor/module leader.

In order for research to result in benefit and minimise risk of harm, it must be conducted ethically. A researcher may not be covered by the University's insurance if ethical approval has not been obtained prior to commencement.

The University follows the OECD Frascati manual definition of research activity: "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications". As such this covers activities undertaken by members of staff, postgraduate research students, and both taught postgraduate and undergraduate students working on dissertations/projects.

The individual undertaking the research activity is known as the "principal researcher".

Ethical approval is not required for routine audits, performance reviews, quality assurance studies, testing within normal educational requirements, and literary or artistic criticism.

Please read the notes for guidance before completing ALL sections of the form.

This form must be completed and approved prior to undertaking any research activity. Please see Checklist for details of process for different categories of application.

SECTION A: About You (Principal Researcher)

1	Full Name:	Sara Ffion Thomas			
2	Tick all boxes that apply:	Member of staff:	☐	Honorary research fellow:	☐
	Undergraduate Student	☐	Taught Postgraduate Student	☒	Postgraduate Research Student

3	Institute/Academic Discipline/Centre:	Prifysgol Cymru Y Drindod Dewi Sant
4	Campus:	Caerfyrddin
5	E-mail address:	2312285@student.uwstd.ac.uk
6	Contact Telephone Number:	07787713546
For students:		
7	Student Number:	2312285
8	Programme of Study:	MSc Sport & Exercise Nutrition
9	Director of Studies/Supervisor:	Dr Chris Cashin

SECTION B: Approval for Research Activity

1	Has the research activity received approval in principle? (please check the Guidance Notes as to the appropriate approval process for different levels of research by different categories of individual)	YES	☐	NO	☒
					Date
2	If Yes, please indicate source of approval (and date where known): <i>Approval in principle must be obtained from the relevant source prior to seeking ethical approval</i>	Research Degrees Committee	☐		
Institute Research Committee		☐			
Other (write in)		☐			

SECTION C: Internal and External Ethical Guidance Materials

	Please list the core ethical guidance documents that have been referred to during the completion of this form (including any discipline-specific codes of research ethics, location-specific codes of research ethics, and also any specific ethical guidance relating to the proposed methodology). Please tick to confirm that your research proposal adheres to these codes and guidelines. You may add rows to this table if needed.	
1	UWTSD Research Ethics & Integrity Code of Practice	☒
2	UWTSD Research Data Management Policy	☒
3	[List any other relevant documents here]	☐

SECTION D: External Collaborative Research Activity

If there are external collaborators then you should gain consent from the contact persons to share their personal data with the university. If there are no external collaborators then leave this section blank and continue to section E.

1	Institution					
2	Contact person name					
3	Contact person e-mail address					
4	Is your research externally funded?	YES	☐	NO	☐	
5	Are you in receipt of a KESS scholarship?	YES	☐	NO	☐	
6	Are you specifically employed to undertake this research in either a paid or voluntary capacity?	Voluntary	YES	☐	NO	☐
7		Employed	YES	☐	NO	☐
8	Is the research being undertaken within an existing UWTSD Athrofa Professional Learning Partnership (APLP)?	If YES then the permission question below does not need to be answered.	YES	☐	NO	☐
9	Has permission to undertake the research has been provided by the partner organisation?	(If YES attach copy) If NO the application cannot continue	YES	☐	NO	☐

Where research activity is carried out in collaboration with an external organisation

10	Does this organisation have its own ethics approval system?	YES	☐	NO	☐
	If Yes, please attach a copy of any final approval (or interim approval) from the organisation (this may be a copy of an email if appropriate).				

SECTION E: Details of Research Activity

1	Indicative title:	A comparative analysis of endurance athletes' knowledge of carbohydrate requirements vs their actual intake, and its alignment with recommendations.		
2	Proposed start date:	15 th September 2025	Proposed end date:	March 2026
	Introduction to the Research (maximum 300 words per section) Ensure that you write for a Non-Specialist Audience when outlining your response to the points below: • <i>Purpose of Research Activity</i> • <i>Proposed Research Question</i> • <i>Aims of Research Activity</i> • <i>Objectives of Research Activity</i> Demonstrate, briefly, how Existing Research has informed the proposed activity and explain • <i>What the research activity will add to the body of knowledge</i> • <i>How it addresses an area of importance.</i>			
3	Purpose of Research Activity Ensuring high availability before, during and after endurance exercise is critical for optimising performance and promoting recovery. The purpose of this research is to understand endurance athletes' knowledge on carbohydrate recommendations and compare this to their actual carbohydrate intake. (this box should expand as you type)			
4	Research Question The primary research question is whether endurance athletes' knowledge of their carbohydrate requirements align with their actual intake, and whether either of these align with evidence-based recommendations. (this box should expand as you type)			
5	Aims of Research Activity Compare endurance athletes' knowledge of their carbohydrate requirements with their actual intake, and whether either of these align with evidence-based recommendations. (this box should expand as you type)			
6	Objectives of Research Activity The first objective will be to assess participants' knowledge on carbohydrate intake for training, competition and recovery. The second objective will be to measure participants' actual intake. Following data collection, participants' actual carbohydrate intake will be compared to their self-reported knowledge			

	to determine whether they are under- or overestimating their carbohydrate needs based on their activity levels. (this box should expand as you type)			
	Proposed methods (maximum 600 words) Provide a brief summary of all the methods that may be used in the research activity, making it clear what specific techniques may be used. If methods other than those listed in this section are deemed appropriate later, additional ethical approval for those methods will be needed. You do not need to justify the methods here, but should instead describe how you intend to collect the data necessary for you to complete your project.			
7	This proposed research will use an online survey which will include questions to gain a better understanding of participants' knowledge of carbohydrates and requirements in endurance sport. A food diary will also be sent for participants to complete independently. in female endurance athletes. The survey will be integrated into Microsoft Forms which will be distributed, with consent, to participants. The survey will contain both open and closed question to allow quantitative and qualitative analysis. (this box should expand as you type)			
	Location of research activity Identify all locations where research activity will take place.			
8	Virtual (this box should expand as you type)			
	Research activity outside of the UK If research activity will take place overseas, you are responsible for ensuring that local ethical considerations are complied with and that the relevant permissions are sought. Specify any local guidelines (e.g. from local professional associations/learned societies/universities) that exist and whether these involve any ethical stipulations beyond those usual in the UK (provide details of any licenses or permissions required). Also specify whether there are any specific ethical issues raised by the local context in which the research activity is taking place, for example, particular cultural and/or legal sensitivities or vulnerabilities of participants. If you live in the country where you will do the research then please state this.			
9	N/A (this box should expand as you type)			
10	<table border="1"> <tr> <td></td> <td>NO</td> <td>☒</td> </tr> </table>		NO	☒
	NO	☒		

	Use of documentation not in the public domain: Are any documents NOT publicly available?	YES	☐
11	If Yes, please provide details here of how you will gain access to specific documentation that is not in the public domain and that this is in accordance with the current data protection law of the country in question and that of England and Wales. <i>(this box should expand as you type)</i>		

	Does your research relate to one or more of the seven aims of the Well-being of Future Generations (Wales) Act 2015?	YES	NO
12	A prosperous Wales	☐	☒
13	A resilient Wales	☐	☒
14	A healthier Wales	☐	☒
15	A more equal Wales	☐	☒
16	A Wales of cohesive communities	☐	☒
17	A Wales of vibrant culture and thriving Welsh language	☐	☒
18	A globally responsible Wales	☐	☒
19	If YES to any of the above, please give details:		
	<i>(this box should expand as you type)</i>		

SECTION F: Scope of Research Activity

	Will the research activity include:	YES	NO
1	Use of a questionnaire or similar research instrument?	☒	☐
2	Use of interviews?	☐	☒
3	Use of focus groups?	☐	☒
4	Use of participant diaries?	☒	☐
5	Use of video or audio recording?	☐	☒
6	Use of computer-generated log files?	☐	☒
7	Participant observation with their knowledge?	☐	☒
8	Participant observation without their knowledge?	☐	☒
9	Access to personal or confidential information without the participants' specific consent?	☐	☒

10	Administration of any questions, test stimuli, presentation that may be experienced as physically, mentally or emotionally harmful / offensive?	☐	☒
11	Performance of any acts which may cause embarrassment or affect self-esteem?	☐	☒
12	Investigation of participants involved in illegal activities?	☐	☒
13	Use of procedures that involve deception?	☐	☒
14	Administration of any substance, agent or placebo?	☐	☒
15	Working with live vertebrate animals?	☐	☒
16	Procedures that may have a negative impact on the environment?	☐	☒
17	Other primary data collection methods. Please indicate the type of data collection method(s) below.	☐	☒
	Details of any other primary data collection method: (this box should expand as you type)		

If NO to every question, then the research activity is (ethically) low risk and may be exempt from some of the following sections (please refer to Guidance Notes).

If YES to any question, then no research activity should be undertaken until full ethical approval has been obtained.

SECTION G: Intended Participants

If there are no participants then do not complete this section, but go directly to section H.

	Who are the intended participants:	YES	NO
1	Students or staff at the University?	☐	☒
2	Adults (over the age of 18 and competent to give consent)?	☒	☐
3	Vulnerable adults?	☐	☒
4	Children and Young People under the age of 18? (Consent from Parent, Carer or Guardian will be required)	☐	☒
5	Prisoners?	☐	☒
6	Young offenders?	☐	☒
7	Those who could be considered to have a particularly dependent relationship with the investigator or a gatekeeper?	☐	☒
8	People engaged in illegal activities?	☐	☒
9	Others. Please indicate the participants below, and specifically any group who may be unable to give consent.	☐	☒

	Details of any other participant groups: (this box should expand as you type)		

	Participant numbers and source Provide an estimate of the expected number of participants. How will you identify participants and how will they be recruited?		
10	How many participants are expected?	Approximately 15. (this box should expand as you type)	
11	Who will the participants be?	Associates of lead researcher (this box should expand as you type)	
12	How will you identify the participants?	Participant information sheet prior to completion of survey. (this box should expand as you type)	

	Information for participants:	YES	NO	N/A
13	Will you describe the main research procedures to participants in advance, so that they are informed about what to expect?	☒	☐	☐
14	Will you tell participants that their participation is voluntary?	☒	☐	☐
15	Will you obtain written consent for participation?	☐	☒	☐
16	Will you explain to participants that refusal to participate in the research will not affect their treatment or education (if relevant)?	☒	☐	☐
17	If the research is observational, will you ask participants for their consent to being observed?	☐	☐	☒
18	Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
19	With questionnaires, will you give participants the option of omitting questions they do not want to answer?	☒	☐	☐

20	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
21	Will you debrief participants at the end of their participation, in a way appropriate to the type of research undertaken?	☒	☐	☐
22	If NO to any of above questions, please give an explanation			
	Consent will be obtained virtually, rather than written.			
	(this box should expand as you type)			

	Information for participants:	YES	NO	N/A
24	Will participants be paid?	☐	☒	☐
25	Is specialist electrical or other equipment to be used with participants?	☐	☒	☐
26	Are there any financial or other interests to the investigator or University arising from this study?	☐	☒	☐
27	Will the research activity involve deliberately misleading participants in any way, or the partial or full concealment of the specific study aims?	☐	☒	☐
28	If YES to any question, please provide full details			
	(this box should expand as you type)			

SECTION H: Anticipated Risks

	Outline any anticipated risks that may adversely affect any of the participants, the researchers and/or the University, and the steps that will be taken to address them.					
	If you have completed a full risk assessment (for example as required by a laboratory, or external research collaborator) you may append that to this form.					
1	Full risk assessment completed and appended?	<table border="1"> <tr> <td>Yes</td> <td>☐</td> </tr> <tr> <td>No</td> <td>☒</td> </tr> </table>	Yes	☐	No	☒
Yes	☐					
No	☒					
2	Risks to participants For example: sector-specific health & safety, emotional distress, financial disclosure, physical harm, transfer of personal data, sensitive organisational information					

	Risk to participants: Minimal – some questions may cause emotional distress (e.g. asking about weight) <i>(this box should expand as you type)</i>	How you will mitigate the risk to participants: The survey will include questions relating to food intake, which may cause some anxiety in some participants. In attempt to allay any anxiety, participants will be signposted to public health recommendations for healthy eating. <i>(this box should expand as you type)</i>
3	If research activity may include sensitive, embarrassing or upsetting topics (e.g. sexual activity, drug use) or issues likely to disclose information requiring further action (e.g. criminal activity), give details of the procedures to deal with these issues, including any support/advice (e.g. helpline numbers) to be offered to participants. Note that where applicable, consent procedures should make it clear that if something potentially or actually illegal is discovered in the course of a project, it may need to be disclosed to the proper authorities	
	N/A <i>(this box should expand as you type)</i>	
4	Risks to the investigator For example: personal health & safety, physical harm, emotional distress, risk of accusation of harm/impropriety, conflict of interest	
	Risk to the investigator: Nil <i>(this box should expand as you type)</i>	How you will mitigate the risk to the investigator: <i>(this box should expand as you type)</i>
5	University/institutional risks For example: adverse publicity, financial loss, data protection	
	Risk to the University: Nil <i>(this box should expand as you type)</i>	How you will mitigate the risk to the University: <i>(this box should expand as you type)</i>
6	Environmental risks For example: accidental spillage of pollutants, damage to local ecosystems	
	Risk to the environment: Nil <i>(this box should expand as you type)</i>	How you will mitigate the risk to environment: <i>(this box should expand as you type)</i>

Disclosure and Barring Service				
	If the research activity involves children or vulnerable adults, a Disclosure and Barring Service (DBS) certificate must be obtained before any contact with such participants.	YES	NO	N/A
7	Does your research require you to hold a current DBS Certificate?	☐	☒	☐
8	If YES, please give the certificate number. If the certificate number is not available please write "Pending"; in this case any ethical approval will be subject to providing the appropriate certificate number.			

SECTION I: Feedback, Consent and Confidentiality

1	Feedback What de-briefing and feedback will be provided to participants, how will this be done and when?
	Participant will be provided with feedback and de-brief, which will include thanking them for their participation, following completion of the survey on Microsoft Forms. <i>(this box should expand as you type)</i>
2	Informed consent Describe the arrangements to inform potential participants, before providing consent, of what is involved in participating. Describe the arrangements for participants to provide full consent before data collection begins. If gaining consent in this way is inappropriate, explain how consent will be obtained and recorded in accordance with prevailing data protection legislation.
	Participants will be provided with a participant information sheet prior to commencing the survey. They will be informed on the purpose of the research, the nature of their participation and how the results will be used prior to commencing the survey. They will also be informed of the survey's estimated completion time. This will be outlined at the beginning of the survey along with the emphasis that participants have the right to withdraw from the survey at any point without needing to provide a reason. Participants will finally be asked for their consent before proceeding with the survey. <i>(this box should expand as you type)</i>

3	Confidentiality / Anonymity Set out how anonymity of participants and confidentiality will be ensured in any outputs. If anonymity is not being offered, explain why this is the case.
	Participants' data will be anonymised, and individual results will be assigned a code e.g. P1. <i>(this box should expand as you type)</i>

SECTION J: Data Protection and Storage

	Does the research activity involve personal data (as defined by the General Data Protection Regulation 2016 “GDPR” and the Data Protection Act 2018 “DPA”)?	YES	NO
1	<i>“Personal data” means any information relating to an identified or identifiable natural person (“data subject”). An identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person. Any video or audio recordings of participants is considered to be personal data.</i>	☐	☒
	If YES, provide a description of the data and explain why this data needs to be collected:		
2	 <i>(this box should expand as you type)</i>		
	Does it involve special category data (as defined by the GDPR)?	YES	NO
3	<i>“Special category data” means sensitive personal data consisting of information as to the data subjects’ – (a) racial or ethnic origin, (b) political opinions, (c) religious beliefs or other beliefs of a similar nature, (d) membership of a trade union (within the meaning of the Trade Union and Labour Relations (Consolidation) Act 1992), (e) physical or mental health or condition, (f) sexual life, (g) genetics, (h) biometric data (as used for ID purposes),</i>	☐	☒
	If YES, provide a description of the special category data and explain why this data needs to be collected:		
4	 		

	<i>(this box should expand as you type)</i>
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	Will data from the research activity (collected data, drafts of the thesis, or materials for publication) be stored in any of the following ways?	YES	NO
5	Manual files (i.e. in paper form)?	☐	☒
6	University computers?	☐	☒
7	Private company computers?	☐	☒
8	Home or other personal computers?	☐	☒
9	Laptop computers/ CDs/ Portable disk-drives/ memory sticks?	☒	☐
10	“Cloud” storage or websites?	☒	☐
11	Other – specify:	☐	☒
12	For all stored data, explain the measures in place to ensure the security of the data collected, data confidentiality, including details of backup procedures, password protection, encryption, anonymisation and pseudonymisation:		
	All data will be kept in password protected cloud storage on the University Office 365 system which will not be shared. Any USB sticks used to store or transfer data will be password protected. All participants will be given a unique identifier to ensure confidentiality, and this list will be kept securely in the password protected folder. <i>(this box should expand as you type)</i>		

	Data Protection		
	Will the research activity involve any of the following activities:	YES	NO
13	Electronic transfer of data in any form?	☒	☐
14	Sharing of data with others at the University outside of the immediate research team?	☐	☒
15	Sharing of data with other organisations?	☐	☒
16	Export of data outside the UK or importing of data from outside the UK?	☐	☒
17	Use of personal addresses, postcodes, faxes, emails or telephone numbers?	☐	☒
18	Publication of data that might allow identification of individuals?	☐	☒
19	Use of data management system?	☐	☒
20	Data archiving?	☐	☒

21	If YES to any question, please provide full details, explaining how this will be conducted in accordance with the GDPR and Data Protection Act (2018) (and any international equivalents, where appropriate):		
	All data will be encrypted and kept in password protected cloud storage on the University Office 365/Sharepoint system which will not be shared. Any USB sticks used to store or transfer data will be password protected and will be reformatted at the end of the project to destroy the data. The data will be stored until the completion of the project and then deleted. <i>(this box should expand as you type)</i>		
22	List all who will have access to the data generated by the research activity:		
	Principal researcher and possibly supervisor. <i>(this box should expand as you type)</i>		
23	List who will have control of, and act as custodian(s) for, data generated by the research activity:		
	Principal researcher and possibly supervisor. <i>(this box should expand as you type)</i>		
24	Give details of data storage arrangements, including security measures in place to protect the data, where data will be stored, how long for, and in what form. Will data be archived – if so how and if not why not.		
	All data will be encrypted and kept in password protected cloud storage on the University Office 365/Sharepoint system which will not be shared. Any USB sticks used to store or transfer data will be password protected and will be reformatted at the end of the project to destroy the data. The data will be stored until the completion of the project and then deleted. <i>(this box should expand as you type)</i>		
25	Please indicate if your data will be stored in the UWTSD Research Data Repository (see https://researchdata.uwtsd.ac.uk/). If so please explain. <i>(Most relevant to academic staff)</i>		
	N/A <i>(this box should expand as you type)</i>		
26	Confirm that you have read the UWTSD guidance on data management (see https://www.uwtsd.ac.uk/library/research-data-management/)	YES	☒
27	Confirm that you are aware that you need to keep all data until after your research has completed or the end of your funding	YES	☒

SECTION K: Declaration

	The information which I have provided is correct and complete to the best of my knowledge. I have attempted to identify any risks and issues related to the research activity and acknowledge my obligations and the rights of the participants. In submitting this application I hereby confirm that I undertake to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice which is published on the website: https://www.uwtsd.ac.uk/research/research-ethics/	
1	Signature of applicant:	Sara Thomas Date: 06/09/2025

For STUDENT Submissions:

2	Director of Studies/Supervisor:	Dr Chris Cashin	Date: 12/09/2025
3	Signature:	C. Cashin	

For STAFF Submissions:

4	Academic Director/ Assistant Dean:		Date:
5	Signature:		

Checklist: Please complete the checklist below to ensure that you have completed the form according to the guidelines and attached any required documentation:

☒	I have read the guidance notes supplied before completing the form.
☒	I have completed ALL RELEVANT sections of the form in full.
☒	I confirm that the research activity has received approval in principle
☐	I have attached a copy of final/interim approval from external organisation (where appropriate)
☐	I have attached a full risk assessment (where appropriate) ONLY TICK IF YOU HAVE ATTACHED A FULL RISK ASSESSMENT
☒	I understand that it is my responsibility to ensure that the above named research activity will meet the University's Research Ethics and Integrity Code of Practice.
☒	I understand that before commencing data collection all documents aimed at respondents (including information sheets, consent forms, questionnaires, interview schedules etc.) must be confirmed by the DoS/Supervisor, module tutor or Academic Director.

RESEARCH STUDENTS ONLY

Once complete, submit this form via the **MyTSD Doctoral College Portal** at (<https://mytsd.uwtsd.ac.uk>).

RESEARCH STAFF ONLY

All communications relating to this application during its processing must be in writing and emailed to pgresearch@uwtsd.ac.uk , with the title 'Ethical Approval' followed by your name.

STUDENTS ON UNDERGRADUATE OR TAUGHT MASTERS

PROGRAMMES should submit this form (and receive the outcome) via systems explained to you by the supervisor/module leader.

