

NUTRITION, HYDRATION AND GOLF

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INTRODUCTION

Many recreational and professional golfers spend a lot of money and time playing golf, but simple measures to improve basics such as warm up, nutrition and hydration are very likely to help the golfer be at their best on the course and help prevent injury. Who would not want to improve their score, and spend more time sinking putts and less time on the physio table?

Golf can be considered a high volume, low- to moderate-intensity physical activity played across the world by all ages and abilities¹. An 18-hole round of golf typically involves walking, and playing shots, for 4-6 hours with the typical total playing length of courses being between 5500 to 7500 yards with varying terrains and climates². Over the past decade there has been growing interest into how fundamental sports nutrition applies to golf and how manipulating what a player eats before, during and after a round can influence not only their playing performance but also their long-term athletic goals. Indeed, many elite golfers now employ sport nutritionists on a consultancy basis whilst the major professional tours employ sport nutritionists to design the player menus and provide onsite nutrition support.

Despite the sport's popularity, and the growing interest in sport nutrition by the elite players, there has been limited golf-specific research into the nutrition, hydration and fuelling requirements of the game. Allied to this, although provision at most elite tournaments is now to a high standard, the typical golf facility is more likely to stock sugary bars and drinks as opposed to the sort of food and beverages that can assist players to be at their best.

Within the limited literature, it has been suggested that poor nutrition and hydration can result in impaired golf performance, from both a physical and mental perspective³⁻⁵. Moreover, the extensive travel demands placed upon the modern day elite golfer may compromise their general health by making them more susceptible to upper respiratory tract infections⁶, and therefore many players look to maximise their nutrition in an attempt to support their immune system and reduce the chances of illness. Given the limited golf-specific nutrition literature, this article will be based within the extant golf literature whilst at the same time drawing relevant conclusions from other sports. Moreover, we will include the authors first-hand experiences working as sport nutritionists with recreational and

professional golfers with the overall aim of providing practical nutrition advice for golfers and their support staff.

NUTRITION AND GOLF

Energy Expenditure of Golf

The primary concern when working with any athlete in terms of their nutrition is to understand the energetic demands of the sport itself. This is of particular concern in golf given that at the professional level many players will be performing 4 days per week and, as such, are at risk of being in a chronic state of negative energy balance and/or low energy availability. Over the course of a season, this can compromise health and performance. In a recreational golf setting, it is common for players to feel low in energy, bloated, or dehydrated at some point during their golf game, which can impact their score and enjoyment.

Whilst assessing energy expenditure may sound a simple task, the accuracy of measuring it over several hours in ecologically valid conditions has proven to be somewhat challenging. A recent scoping review described an extremely wide range of 1936 kcal for total energy expended during a round of golf (range 531-2467 kcal, 3.3-8.15 Kcal/min)¹. Given this large variation

in range, we recently used Actiheart® technology, which has been validated in athletic situations, to assess the energy expenditure in high-level golfers during competitive match play⁷. After accounting for resting energy expenditure, we reported the energetic cost of a game of golf to be 3.2-3.6 kcal per minute dependent upon the mode of transporting the golf clubs (carrying, electric or manual trolley). This equates to ~768-864 kcal for a 4-hour game.

Carbohydrates and golf

Given that golf is considered a low-moderate intensity sport for most, and the emerging research on the relatively low energy cost of playing a round of golf⁷, there has been considerable debate on the need for high carbohydrate diets in golf, both in the academic literature and by the players themselves. The reason for this is that although it is well established that carbohydrates are the primary fuel for moderate to high-intensity sports (such as football), with multiple studies showing enhanced performance when carbohydrates are provided before and during this kind of exercise⁸, there is little evidence to suggest that high carbohydrate diets can enhance performance in low-moderate intensity sports such as walking. However, the demands of golf are somewhat unique with players requiring a combination of walking (approximately 7-10 km per round²), short high-speed efforts during the swing⁹, along with a growing emphasis on additional strength training and high-intensity intermittent exercise training. It therefore appears prudent that high quality carbohydrates should be an essential part of the modern golfer's daily diet.

A common complaint amongst golfers during match play are feelings of fatigue and lapses in concentration, particularly towards the latter stages of the round, which could be attributed to a fall in blood glucose following 4-5 hours on course¹⁰. Feelings of fatigue may lead to a decline in physical and mental performance with reports of reduced putting accuracy as the round progresses³. Golfers should therefore commence the round with sufficient muscle and liver glycogen to fuel the round and consequently, like other athletes, they must consider their carbohydrate requirements in the days/hours leading into the game. Based on the best available evidence and taking into consideration the extremely

TABLE 1					
	Breakfast	Snack/On Course	Lunch	Dinner	Pre- Bed
Monday (Rest Day)					
Tuesday (Range, Gym)					
Wednesday (18 Hole Practice, Gym)					
Thursday (Tournament)					
Friday (Tournament)					
Saturday (Tournament)					
Sunday (Tournament)					

Key: Red = CHO <25 g, Amber = CHO 50-75 g, Green = CHO >75 g

Table 1: Example periodisation table of how a tour player may manipulate carbohydrate intake during a tournament week based on activity levels. These examples are of course dependent on the specific training goals of each individual player.

limited golf specific research, we would recommend that both recreational and elite golfers should aim to consume a moderate daily carbohydrate intake leading into play/competition, aiming to consume between 3-5 g/kg body mass (BM) of carbohydrate per day dependent upon the physical activity performed on each day.

An emerging concept in sports nutrition has been termed 'fuel for the work required'¹¹ and this seems particularly important to golf. This idea involves athletes thinking ahead of what the physical demands of the day look like and making carbohydrate choices based on this. By manipulating carbohydrates on a meal by meal and day by day basis, studies have suggested that athletes are able to achieve their training and performance goals whilst at the same time achieving their required body composition goals¹². To simplify this system even further, many teams implement a simple 'traffic light' system to define the meal-by-meal carbohydrate intakes with red, amber and green indicating low, moderate and high carbohydrate meals

respectively. This system could easily be adapted for golf, as seen in Table 1. In this example, on days with low activity (i.e. a rest day or a light practice day on the putting green), carbohydrate intake would be lower in comparison with a day that consisted of higher-intensity activities (an intense gym session combined with a full round of golf).

As well as carbohydrate intakes leading into a game, a golfer must also consider their carbohydrate strategies during the round itself. This will be covered in more detail below. It has recently been suggested that feeding both carbohydrate and carbohydrate plus protein during a round of golf led to significantly lower ratings of fatigue when compared with no nutrition¹³. This intervention was based on 9 holes (half that of a typical round) and it therefore makes sense that this would be even more profound during the full 18-hole course. This highlights a simple opportunity that has an immediate effect on match-day performance by simply developing an on-course eating strategy. This applies to both the recreational and elite player.

2.3 Protein and golf

Proteins are constantly being broken down and re-made in the human body throughout the day, making dietary protein the macronutrient primarily responsible for the growth and repair of skeletal muscle¹⁴. Given the increase in non-golf related activities (including resistance training) to increase club speed and hit the ball further, there has been a growing interest in how maximising a golfers protein intake can help to achieve these goals. The recommended nutrient intake (RNI) for protein for non-athletes is 0.8 g/kg per day, although this is widely accepted as being far too low for athletic individuals, particularly those trying to increase muscle size and strength¹⁵. Research now suggests dietary intakes of around 1.6-2.0 g/kg per day of protein to support an athletes training goals¹⁶. This translates to an increase in protein from around 64 g to 160 g for an 80 kg golfer.

As well as the total amount of protein consumed in a day, it is equally important to consider the timing of protein intake. Research has demonstrated that consuming 0.3-0.4 g/kg body mass (around 20-40 g) of high-quality protein sources at regular intervals throughout the day (3-4 hours) is required to maximise muscle protein synthesis¹⁷. Whilst this can be challenging for golfers due to the demands of their working day, players should aim to follow this strategy as closely as possible including during the round itself, and post round.

In our experiences, there are three areas where golfers could improve their protein intakes.

1. **At breakfast:** often with early tee times players can miss breakfast and/or make inappropriate choices such as coffee and toast rather than consuming protein rich foods such as milk, eggs, salmon, Greek yoghurt, and tofu.
2. **Mid round:** many players either find it hard to eat on the course, forget to eat or do not have the options available to consume protein containing foods during the round. Simply preparing a wrap such as chicken salad or falafel can fix this problem.
3. **Pre bed:** proteins such as casein are typically advised pre- bed due to their slow releasing nature¹⁸. Many players do not consume protein containing foods towards the end of the day, missing out on an opportunity to promote muscle growth and repair.



Figure 1: Typical infographic provided to golfers encouraging the consumption of a wide range of fruit and vegetables.

2.4 Fats and golf

Fats are generally categorized as saturated or unsaturated based on their chemical structure and have often been demonized as the 'bad' macronutrient, with many people believing they are the sole reason for 'weight gain'. We now know that this is not the case with a growing appreciation of the many key roles that dietary fats play in the human body including, but not

limited to, aiding in the absorption of fat-soluble vitamins (A, D, E and K), supporting hormone production, protection of vital organs and being an important fuel during low intensity exercise. Of course, too much dietary fat (like too much of any macronutrient) is problematic for general health and wellbeing. If players are aiming to drop fat mass, they should concentrate on ensuring their energy intake is less than

Vegan Friendly Food Sources

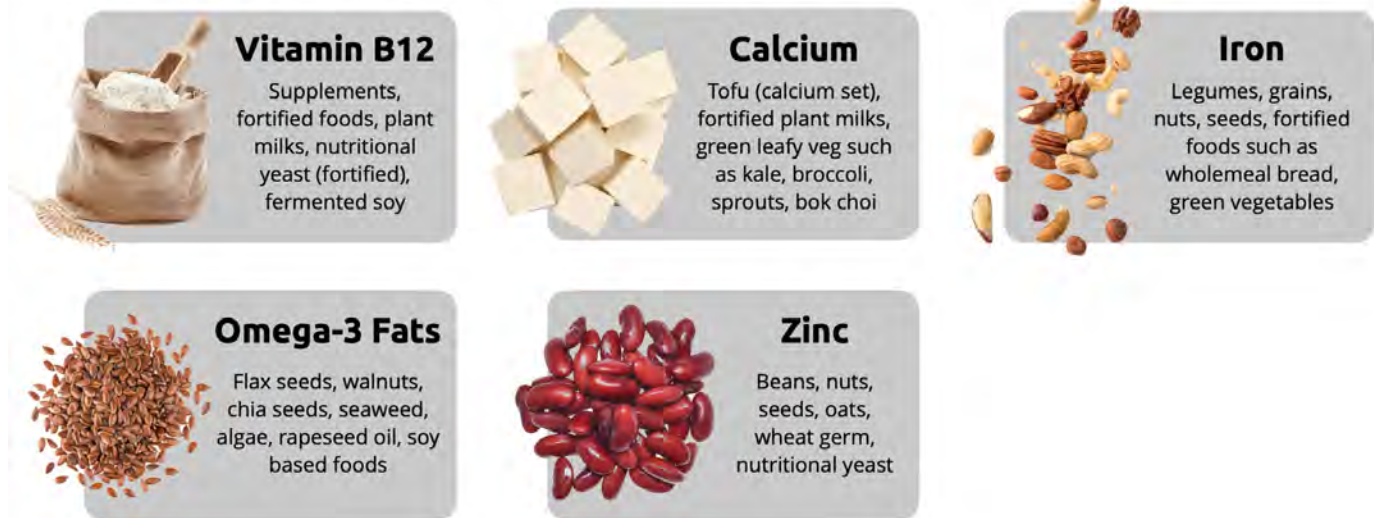


Figure 2: Typical infographic provided to golfers with education around the vegan diet.

their energy expenditure in a sustainable manner (i.e., calorie deficit). It is wise to consume foods rich in unsaturated fats that aid in the absorption of fat-soluble vitamins, supply essential fatty acids (omega 3 and omega 6) and avoid excessive intakes of saturated fats (e.g., deep fried foods). Examples of foods containing unsaturated fats include salmon, nuts, avocado, olive oil, eggs, and seeds. Fat is also the preferred energy source utilized during low intensity exercise and is required when sports exceed 90 minutes, which of course applies to a round which can last longer than 4 hours. To attain the correct amount of dietary fat, we would generally advise that athletes consume ~1-1.5 g/kg body mass per day, making sure the energy coming from fat is between 20-30% of their total energy intake¹⁶.

2.5 Micronutrients and golf

Micronutrients (vitamins and minerals) are essential in aiding disease prevention, general wellbeing, and physiological function. An abundance of micronutrients can be sourced through the diet, especially from various fruits and vegetables, apart from Vitamin D which is mainly obtained from sunlight exposure¹⁹. We would generally advise eating a wide range of different coloured fruit and vegetables daily (aim for greater than 7 portions) to aid digestion, provide fibre and to provide important micronutrients. Visual reminders

can help to encourage these behaviours (Figure 1).

Micronutrients that athletes are more likely to be deficient in are iron (particularly in female golfers), vitamin D, zinc, magnesium and calcium²⁰. Below are factors that have been known to contribute to micronutrient deficiencies:

- Removing food groups from the diet which could be due to allergies, dietary trends, dislikes, intolerances or moral reasons.
- Low calorie diets to lose weight which could lead to low energy availability.
- Very low-fat diets, leading to a reduction in fat soluble vitamins.
- Females may suffer from a lack of iron, contributed to by their menstrual cycle.
- Lack of variation in the diet.
- Lack of sunlight exposure.

In theory, unless a golfer fits into one of the categories above, a micronutrient deficiency is unlikely; therefore, with the exception of vitamin D, we believe that there is no need for dietary supplementation and athletes should follow a 'food first' approach to their diet. There are exceptions to this, for example vitamin B 12 if a golfer is plant based. Visual reminders placed in player areas can help vegan athletes make better food choices (Figure 2).

2.6 Hydration for golf

A golfer's hydration status can be dependent on several factors such as metabolic rate,

environmental conditions and the type of clothing worn, which can cause substantial increases in body temperatures²¹. Sweat losses are the major contributor for heat losses. It is important to remember that sweat is not just water as it also contains electrolytes (e.g., sodium) which when lost can lead to electrolyte imbalances adversely affecting performance^{21,22}. Monitoring strategies, such as checking the frequency and colour of urine (light, odourless and often), may help players identify when they are dehydrated. It is also useful for players to monitor weight losses during rounds to identify the magnitude of weight loss and establish what level of dehydration is typical for them. As little as 2% body mass lost can mean a player is in a state of dehydration²¹ which can impair shot distance, accuracy, judgement, and cognitive function⁴. Further research also states that the mean number of strokes taken over 18 holes were significantly higher in players that started the round dehydrated, rather than euhydrated⁵. It is therefore crucial that golfers commence the round hydrated, try to maintain their hydration status during the round ensuring there is no more than a 2% drop in body mass and then fully rehydrate after the round, especially if there is more golf to be played later in the day or the next day. In simple terms golfers should take on small amounts of fluid regularly, and facilities should ensure fluid is readily available.

PRACTICAL FUELLING AND HYDRATION
SUGGESTIONS FOR GOLF*Pre- and post-round*

Optimal competition-day fuelling can be challenging in golf and is dependent upon tee time. These range from early morning, e.g., 6 am through to late afternoon. The 6 am tee time can be particularly challenging, given that often breakfast has not started at the hotels and the on-course catering may also not be open at this time (players like to arrive at least 90 minutes pre-round to warm up). Despite a round of golf being deemed a sport of low intensity, it is important to consider that a round may last in excess of 4 hours, most players include a warmup of at least one hour before and a cool down/ post recovery period². Table 2 suggests timings and typical food choices in relation to tee times and highlights some

of the challenges of developing optimal fuelling plans for golfers (Table 2).

For players to begin the round in a hydrated state, it is recommended that 5-7 ml/kg of fluid (~0.5L for an 80kg golfer) is consumed within the 4 hours pre-exercise²¹. Furthermore, if urine remains dark or if little urine is being produced, an additional 3-5 ml/kg should be consumed 2 hours prior to exercise. The addition of electrolytes to fluids (especially in hotter environments) may assist players to hydrate during and post exercise.²³. One of the main goals after competing or practising is to replace any fluid and electrolyte losses experienced. Current guidelines recommend 1.5 l of fluid for every 1 kg of body mass lost after exercise²¹, i.e. 1.5 l of fluid if the player loses 1 l in sweat (weight). Fluids should also be consumed

over time rather than in large boluses to optimize fluid retention²⁴.

We strongly recommend a 'food first' approach to sports nutrition²⁵. By 'food first', we mean that, where practically possible, all nutrition should come from standard foods and drinks rather than specific sports supplement products. At times this is not possible, and in this situation, supplements could be considered but only after any benefits and risks are fully considered and a strict risk minimisation strategy has been implemented.

During a round

We suggest that golfers should aim to consume food regularly throughout the round and develop a strategy and routine that suits them and is easy to implement. One common strategy is to eat every 60-

TABLE 2

Tee Time		Food and Timings						
6am	4:30am	5:30am	6-10am	Post Golf	12pm	3pm	6pm	9:30pm
	Breakfast smoothie on the way to the course	Muesli Bar and Banana	Golf* (See 3.2)	Recovery smoothie	Lunch e.g. chicken, rice and vegetables	Greek Yoghurt, muesli & Fresh Berries	Dinner e.g. Salmon, potatoes and vegetables	Yoghurt or milk-based snack
8am	6am	7:15am	8-12pm	Post Golf	2pm	6pm	9:30pm	
	e.g.3 egg Ham & Spinach Omelette, Wholemeal Toast	Muesli Bar and Banana (if needed)	Golf* (See 3.2)	Recovery smoothie	e.g. chicken, rice and vegetables	Dinner e.g. Salmon, potatoes and vegetables	Yoghurt or milk-based snack	
11am	8am	10:15am	11-3pm	Post Golf	6:30pm	9:30pm		
	e.g.3 egg Ham & Spinach Omelette, Wholemeal Toast	Muesli Bar and Banana (if needed)	Golf* (See 3.2)	Recovery smoothie	Dinner e.g. Salmon, potatoes and vegetables	Yoghurt or milk-based snack		
1pm	9am	11:am	1-5pm	Post Golf	6pm	9:30pm		
	e.g.3 egg Ham & Spinach Omelette, Wholemeal Toast	Early Lunch e.g. chicken, rice and vegetables	Golf* (See 3.2)	Recovery smoothie	Dinner e.g. Salmon, potatoes and vegetables	Yoghurt or milk-based snack		

Table 2: Example of various fuelling suggestions in relation to the tee times throughout the course of the day.

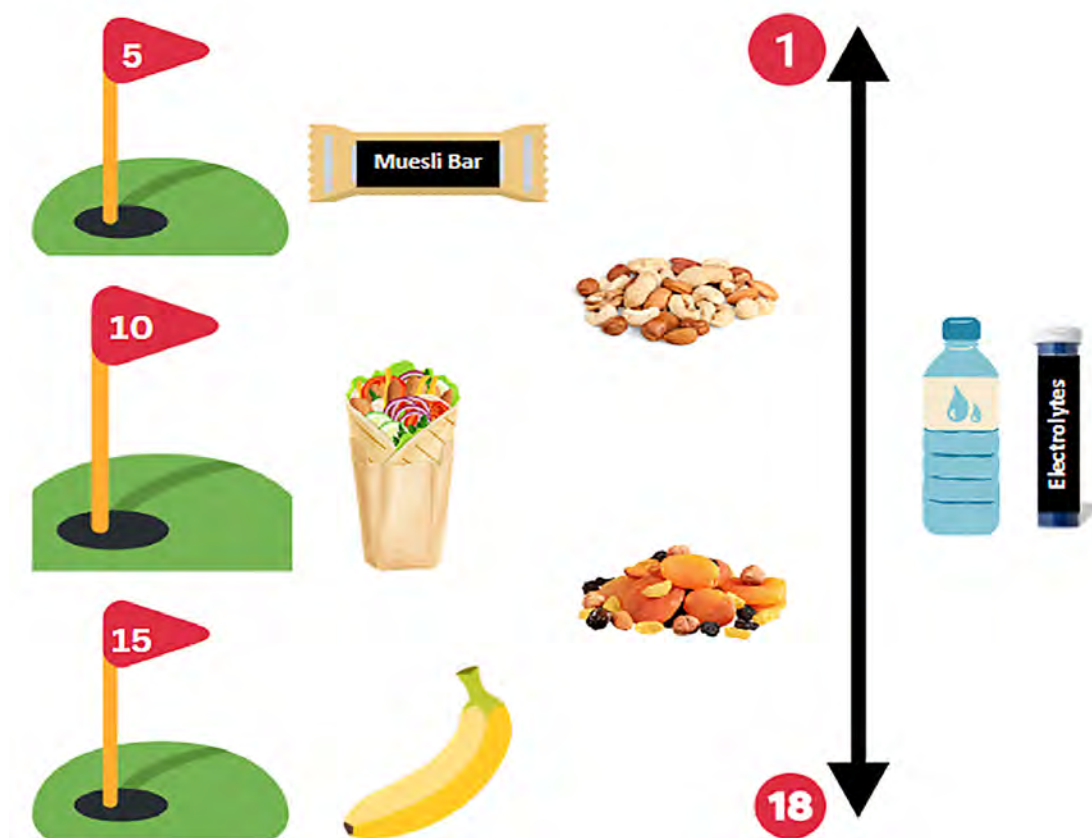


Figure 3: Example of an on-course fuelling and hydration plan with example food & fluid options.

90 minutes, which would equate to eating strategically at holes 5, 10 and 15 with small additional snacks available in between these holes (Figure 3). We strongly recommend that players develop an on-course eating strategy that gives them some consistency and removes the decision making from this process. Accessible snacks such as high-quality muesli bars, bananas, nuts, dried fruit and high-quality sandwiches/wraps are easy to pack in the bag and convenient for travel. These should be brought with the golfer, as reliance on the foods available at the course can result in poor choices being made or even worse no food at all being consumed.

In a typical, 5-10-15 structure, we would suggest that holes 5 and 15 are best focussing on fuel such as oat bars or bananas to top up and sustain energy levels. Hole 10 should contain a mixture of protein and carbohydrate, for example a chicken salad wrap. Marking on the score card where the golfer intends to eat during the round can be a simple way to remind players of their fuelling strategy as a reoccurring complaint by golfers is 'forgetting' to eat despite having the right foods in the golf bag. As well as on course fuelling, on course hydration is equally important and again is often overlooked. Players must ensure that their hydration is maintained whilst

competing, especially if in hot and/or humid climates. Preparing fluids the night before a round and bringing chilled water bottles is essential.

CONCLUSIONS AND FUTURE DIRECTIONS

Despite a lack of golf-specific research, there is lots of appropriate sport nutrition knowledge that if correctly implemented could have profound effects on a golfer's match day performance, recovery, and general health. We strongly recommend that golfers follow the basics of sports nutrition ensuring that protein is consumed regularly throughout the day and that carbohydrates are consumed using the 'fuel for the work required' concept. Despite the round of golf not being as calorific as once thought, it is still crucial that rounds are fuelled correctly and that an appropriate fuelling strategy is developed, giving carbohydrates for energy and protein for growth and repair during the round. Of course, specific nutrition requirements will vary based upon the tournament length, climate, timing of the rounds, travel, and the terrain of the course; therefore, it is important that plans are practiced over time and where possible golfers obtain qualified sport nutrition support. Overall, this may contribute to better performance and in turn lead to better scores.

References

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