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Nutrition for winter sports

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Abstract
Winter sports are played in cold conditions on ice or snow and often at moderate to high altitude. The most important nutritional challenges for winter sport athletes exposed to environmental extremes include increased energy expenditure, accelerated muscle and liver glycogen utilization, exacerbated fluid loss, and increased iron turnover. Winter sports, however, vary greatly regarding their nutritional requirements due to variable physiological and physique characteristics, energy and substrate demands, and environmental training and competition conditions. What most winter sport athletes have in common is a relatively lean physique and high-intensity training periods, thus they require greater energy and nutrient intakes, along with adequate food and fluid before, during, and after training. Event fuelling is most challenging for cross-country skiers competing in long events, ski jumpers aiming to reduce their body weight, and those winter sport athletes incurring repeated qualification rounds and heats. These athletes need to ensure carbohydrate availability throughout competition. Finally, winter sport athletes may benefit from dietary and sport supplements; however, attention should be paid to safety and efficacy if supplementation is considered.
Keywords: Altitude, cold, skiing, skating, energy

Introduction

Winter sports are pursuits played during the winter season on snow or ice. The Olympic movement included winter sports for the first time in Chamonix in 1924, with 258 participants from 16 nations. Today, winter sport Olympians are outnumbered by about one to four by summer Olympians. Nevertheless, the 2010 Vancouver Olympics reported the highest number of athletes and events at any one Winter Olympiad. This paper will first discuss the winter sport specific environment, altitude and cold, followed by an applied section emphasizing the specific nutrition issues faced by winter sport athletes. Nutritional implications of altitude and cold Winter sport athletes often encounter altitude and cold during competition or training. These athletes may also use a variety of strategies to promote acclimatization to higher elevations or to improve sea-level performance (Chapman, Stickford, & Levine, 2010). Winter sports conducted in an outdoor environment experience temperatures ranging from –25 to þ58C, while those performed indoors on ice have average temperatures of 5– 108C. Many winter sports are dependent on permanent snow located at higher altitude (glacier) or the southern hemisphere for sport-specific training in the summer and fall and for early season competition. Glacier environments are located at moderate (2000–3000 m) to high (3000–5000 m) altitudes. In the winter, cold, altitude, and changing snow/ice conditions are characteristic of most competitive venues, as competitions typically occur at northern latitudes and altitudes between 500 m and 2000 m. For several winter sports, the most challenging period of training occurs when athletes perform high intensity training in the cold at altitude, on-snow or on-ice in late summer and early fall. Training

under these conditions results in a compounding of environmental stresses and metabolic challenges that carry a number of nutritional implications.

Winter Sports and Cold Temperature Nutrition

If you have an overall balanced nutrient intake, your pre, during, and post workout fuel and hydration can make a huge impact on your performance, recovery between workouts, and injury prevention. Your overall training diet is more important than any pre, during, and post workout meal or snack!

If you haven't been practicing your fuelling like you have been training your body, it doesn't matter what nutrition course you choose for your workout or training session. This overall nutrition approach is also important with colder temperature activities when we may forget to consider the increased importance of hydration. The focus of this article will cover cold temperatures and high altitude along with your pre, during, and post training nutrition needs.

Cold temperature acclimation is not as well understood as that of hot and humid climates. **Hypothermia** is one of the major concerns of cold temperature exposure. Hypothermia is when your body temperature drops below 98.6 degrees (or lower than your normal body temperature). With a lower body temperature, circulation to your extremities decreases and stays more centrally located in the abdomen to keep the vital organs warm. Mild hypothermia can decrease performance due to the lower blood flow to the working muscles.

Cold temperatures can offer their own sports nutrition challenges (as we discuss in our **Nutrition Curriculum).** Nutrition to prepare for cold temperatures includes consistently consuming adequate carbohydrates throughout your training. Include carbohydrates at meals, snacks, and before, during and after exercise as well. Eating both before workouts and after is essential for feeling your best during the workout as well as achieving goals of improved performance.

Between thirty and sixty minutes before training is the time to eat a snack. This snack should be carbohydrate-rich to top off muscle glycogen stores and may include a small amount of protein (depending on individual stomach tolerance). Protein helps build and repair muscle tissue, and adequate protein before exercise may help reduce post-exercise soreness.[1]

General sports nutrition fuel timing guidelines for pre workout or training:

- 3 hours – 300 calories (High carbohydrate, moderate protein and small amount of fat. For example, whole grain cereal with fruit and Greek yogurt.)
- 2 hours – 200 calories (Carbohydrate and protein. For example, an egg and whole grain toast.) Plus two cups of fluid.
- 1 hour – 100 calories (Carbohydrate like fruit.)
- 15-20 minutes half to one cup of fluid.[2]

[1] https://blog.nasm.org/nutrition/winter-sports-and-cold-temperature-nutrition
[2] https://stillmed.olympics.com/media/Document%20Library/OlympicOrg/IOC/Who-We-Are/Commissions/Medical-and-Scientific-Commission/Encyclopaedia/2014_Maughan_002.pdf

During a workout your fuel intake will vary depending on how you're training. Under one hour, fluid intake for hydration will be your main focus. Consuming 2-4 ounces of fluid every 15 minutes is recommended. Thirst is not a good indicator of hydration needs.

Training beyond one hour your fuel source should consist of 30 to 60 grams of carbohydrate per hour, evenly dispersed in 15-minute intervals with 2-4oz of fluid. The type of carbohydrate may be in the form of sports drinks, gels, blocks, and beans; or whole foods or homemade sources such as date bars. For fluids, if cold temperatures are particularly a concern with your performance, try warm fluids.

Vitamins, minerals and anti-oxidants for training and staying well Strenuous bouts of prolonged exercise and heavy training, particularly aerobic exercise, stress the body. Adequate intakes of energy, protein, iron, copper, manganese, magnesium, selenium, sodium zinc, and vitamins A, C, E, B6 and B12 are particularly important to health and performance. These nutrients, as well as others, are best obtained from a varied and wholesome nutrient-rich diet based largely on vegetables, fruits, beans, legumes, grains, animal meats, oils and carbohydrate energy. Dietary surveys show that most athletes are well able to meet the recommended intakes for vitamins and minerals by eating everyday foods. Those at risk of sub-optimal intakes of these micronutrients include:

Athletes who restrict their energy intake, especially over long periods, especially to meet weight loss goals athletes who follow eating patterns with restricted food variety and reliance on foods with a poor nutrient-density[3]

The best way to correct this situation is to seek advice from a sports nutrition expert such as a sports dietitian. When food intake cannot be adequately improved – for example, when the athlete is travelling in a country with a limited food supply – or if an individual is found to be suffering from a lack of a particular vitamin or mineral, then supplementation can be warranted. This should be undertaken with the advice of a qualified sports nutrition expert. In general, a broad-range multivitamin/mineral supplement is the best choice to support a restricted food intake, although targeted nutrient supplements may be necessary to correct an established nutrient deficiency (e.g. iron deficiency). Anti-oxidant nutrients It is not known whether hard training increases the need for dietary antioxidants, as the body naturally develops an effective defence with a balanced diet. Supplementation with antioxidants cannot be recommended because there is little evidence of benefit, while it is known that over-supplementation can diminish the body's natural defence system.[4]

Ideas for promoting dietary variety and nutrient-rich eating

- Be open to trying new foods and new recipes
- Make the most of foods in season
- Explore all the varieties of different foods
- Mix and match foods at meals
- Think carefully before banishing a food or group of foods from your eating plans

[3] https://stillmed.olympic.org/media/Document%20Library/OlympicOrg/IOC/Who-We-Are/Commissions/Medical-and-Scientific-Commission/EN-Nutrition-for-Athletes.pdf
[4] https://stillmed.olympic.org/media/Document%20Library/OlympicOrg/IOC/Who-We-Are/Commissions/Medical-and-Scientific-Commission/EN-Nutrition-for-Athletes.pdf

- Include fruits and vegetables at every meal. The strong colours of many fruits and vegetables are a sign of a high content of various vitamins and other food anti-oxidants. Aim to fill your plate with highly coloured foods to ensure a good intake of the range of these health-promoting dietary compounds

Advances in sports food: Sports nutrition, food manufacture, opportunities and challenges

Section snippets

Nutrients in sports food

When humans exercise, the metabolism and consumption of nutrients increases as does the body's demand for these nutrients. Generally, the basic nutrients of sports foods include protein, carbohydrates, lipids, water, vitamins and minerals. These nutrients play an important role in the regulation of the human body during physical activity. It is worth noting that sports foods can provide targeted nutrients, which is conducive to improving the nutritional status of sports people and reducing the

Functional performances of sports foods

Sports foods play an auxiliary role in exercise through the supplementation of functional ingredients. This section describes the role of different functional factors in sports foods consumed during exercise.

Sports drinks

Sports drinks are typically consumed during exercise to replenish water and energy, improving sports performance by delaying fatigue (Scrivin & Black, 2018). Currently, the more well-known sports drink brands include Gatorade, BodyArmor SuperDrink, Red Bull, Pulse, Baomine Lishuite, Scream and Lucozode. Representative sports drinks are shown in Fig. 4. Sports drinks usually contain water, carbohydrates, inorganic salts, vitamins and other anti-fatigue substances, such as L-carnitine, caffeine,

Opportunities

As a result of economic growth and continuous improvements in the quality of life, health management has attracted increasing attention. In parallel, sports have become increasingly popular, with sports foods also receiving much attention. The improvement of consumption level and the change of people's consumption habits will promote the innovation and change of the sports food industry. In addition, in recent years the development of modern biotechnology such as fermentation engineering[5]

Winter Nutrition for Athletes: Why does it Matter?

Dark evenings and colder temperatures… it's safe to say that winter is here. The transition in weather is often associated with an increased risk of respiratory tract infections [1] e.g.,

[5] https://www.sciencedirect.com/science/article/abs/pii/S0963996922003155

catching a cold. Combine this with a congested fixture list (usually seen over the Christmas and New Year period) and, if you look after a team, you may find a quick reduction in player availability due to the increased susceptibility to illness [2]. It is therefore important, both as a club and if you're a player, to make extra considerations over the winter period to help keep you – and your players – on the pitch. How to Support Your Immune System in winter.

Consuming a wide variety of fruit and veg will provide the body with micronutrients; vitamins and minerals that are essential for immune health. An easy way to increase micronutrient intake during the winter months, when supporting the immune system is vital, is to 'eat the rainbow' by consuming a wide range of coloured fruit and veg (table 1).[6]

Best Food for Your Immune System:

Table 1: Sources of micronutrients

Colour	Benefits	Sources
Reds	Blood cells & anti-inflammatory	Tomatoes, strawberries, peppers, watermelon, raspberries
Greens	Tissue healing, anti-inflammatory, muscle function, blood cells	Spinach, kale, broccoli, asparagus, kiwi
Whites	Heart health & muscle function	Turnips, onions, garlic, pears, cauliflower
Purples & Blues	Brain health, enhances exercise adaptations	Blueberries, blackberries, purple grapes, plums, aubergine
Orange & Yellows	Boosts immune function, reduces muscle-damage	Carrots, sweet potatoes, pumpkins, pineapple, mangoes[7]

There has been a recent move towards differentiating between immune resistance and immune tolerance. Simply put this is the difference between stopping yourself getting ill (resistance), and helping you to recover faster and display less symptoms if you do get ill (tolerance).[8] Whilst the evidence around nutrition supplements and immune resistance is somewhat mixed, there are a number of supplements that show exciting promise for immune tolerance [3] . If we can lesson the symptoms and speed up recovery this has to be a good thing for athletes. It may therefore be appropriate at this time of year to consider supplementation, for example with Vitamin D (find out more about the benefits of Vitamin D in our What is Vitamin D article). Geographical location can affect UVB exposure during the darker winter months and so many people may not be able to synthesise enough vitamin D naturally e.g., in the UK between October – March. But before taking a supplement, it's

[6] https://blog.nasm.org/nutrition/winter-sports-and-cold-temperature-nutrition
[77] https://www.nutritionx.co.uk/nutrition-hub/nutrition/keeping-players-on-the-pitch-an-athletes-guide-to-winter-nutrition/
[8] https://www.tandfonline.com/doi/abs/10.1080/02640414.2011.574721

important to consider the possible risk associated with using supplements e.g., anti-doping concerns (check out our supplement safety page for more information: Informed Sport - Nutrition X). There needs to be a clear and concise rationale; figure 3 can help provide some practical guidance.

Another product that may be considered for supplementation at this time of year is a probiotic; common winter supplements as they promote friendly bacteria to help your body to fight pathogens, in turn helping to defend against upper respiratory tract infections. In addition to this, there is also evidence that probiotics can help to lessen exercise-induced gastrointestinal discomfort during heavy training periods. We should also consider Vitamin C (500mg day) and Omega 3 (1-3 g per day) as again both of these have been shown to offer benefits when it comes to immune tolerance. Find out more about why we love Omega 3 in our X-Change Article on Omega 3, and the benefits of Vitamin C for athletes in our Athlete's Guide to Vitamin C.

Why is sleep important to athletic performance?

An often-overlooked area of performance is sleep. Sleep disruption during the Christmas period may occur due to an increase in midweek and evening games, and it's not uncommon for games during this time to kick off at 1945 / 2000h. Factor in the use of caffeine (for performance benefits), and it becomes apparent how easy it is to have a disrupted sleeping pattern.[9]

Usually, players have the day after a game off to recover, therefore extending sleep the following day may seem logical. However, having a regular wake time is an essential part of creating good sleeping habits, meaning that sleeping in for too long on recovery days should be avoided. Instead, daytime naps could be implemented to help reach recommended sleep targets (>7h each night). Away from games, having a routine is important. As discussed, having a regular bedtime and wake time is essential, but other factors such as having a cool environment (18 degrees) and avoiding screens (television, mobile phone & computers) can also benefit sleep quality [4].

Key points for optimal winter nutrition:

1. Consume >50% daily energy intake as carbohydrate
2. Ensure adequate protein intake (1.2−1.6 g/kg body mass per day)
3. Eat the rainbow
4. Consider supplementation
5. Aim for > 7 h sleep each night[10]

Nutrition Status of Female Winter Sports Athletes

[9] https://www.nutritionx.co.uk/nutrition-hub/nutrition/keeping-players-on-the-pitch-an-athletes-guide-to-winter-nutrition/
[10] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7873521/

Eating disorders, especially restrictive eating, are common among female athletes [1]. Frequently, they report low energy intake due to high training demands and a sports culture that is often focused on aesthetics from which winter sports are not exempt [2].

There are two main types of winter sports. On the one hand, those that are practiced outdoors on snow, such as alpine skiing or snowboarding, expose athletes to cold temperatures ranging from −25 to +5 °C and high-altitude conditions above 2500 m. On the other hand, those that are practiced indoors on ice, such as figure skating and ice hockey, also expose athletes to cold conditions, with average temperatures of 5–10 °C but at low altitudes [3,4]. Ice hockey is a contact team sport with intermittent bouts of high intensity [5,6], in which players are characterized by both muscle strength and endurance muscle power [2,7,8]. Thus, this sport requires aerobic and anaerobic metabolism as energy sources [9]. Figure skating requires aerobic and anaerobic endurance as well [10]. Currently, female athletes incorporate higher and more frequent jumps, spins, spiral elements, and steps that require relatively low body weights and good athleticism [10,11]. Alpine skiing and snowboarding, for their part, are considered intervallic strength-endurance sports performed at medium-high intensity [12].

These cold and altitude conditions, as well as the specific requirements of each sport, result in a combination of environmental stress and metabolic challenges that accelerate the onset of fatigue, decrease performance, and have several nutritional implications [3,13]. Moreover, most winter sports athletes undergo periods of highly intensive training, requiring increased energy and nutrient intakes, as well as adequate nutrition and hydration before, during, and after training [9].

Altitude exposure induces diuresis, reduces thirst, and increases ventilation in an environment of low humidity, resulting in a reduction in total body water and, with it, a possible state of dehydration [3,14]. In the case of alpine skiing, muscle damage induced by muscular ischemia, hypoxia, and increased utilization of glycogen can be minimized by maintaining hydration with carbohydrate–protein beverages [15]. Ice hockey, despite the cold and low-altitude environment, is a high-intensity sport that results in a high sweat rate and a subsequent loss of sodium and other electrolytes, particularly during match sessions [16]. Staying hydrated by ingesting a sports drink containing carbohydrates and electrolytes helps preserve performance while reducing thermal and perceptual strains [5,17,18]. Upon ascent to altitude, energy expenditure increases, and weight loss frequently occurs, averaging ~1.4 kg per week, which is explained by appetite suppression, the increase in energy requirements to maintain core temperature, and, at the same time, the use of protein as a metabolic fuel [3]. Therefore, one of the goals for winter sports athletes is to ensure that energy and fluid intakes are appropriate [19].[11]

The adverse conditions in which winter sports are practiced condition the intake of micronutrients, mainly increasing the needs for vitamin D since it is a key regulator of calcium homeostasis and iron for its importance in oxygen transport and energy metabolism [19,20].

Despite the popularity of winter sports, there are no defined nutrition guidelines, and there are only a few reviews and research papers about this topic [19]. It is necessary to deepen both

[11] https://www.frontiersin.org/articles/10.3389/fspor.2021.599118/full

the requirements and the dietary habits of winter athletes to improve their health and optimize performance.

Nutritional deficiencies in female athletes cause numerous health problems, as well as a worsening of sports performance, because of these nutritional deficiencies. Awareness of these deficiencies and their prevention should be a major aspect for any sports manager [21,22].

Accordingly, the aim of this research was to identify the nutritional status and potential risk of female athletes practicing winter sports, considering the altitude of training.[12]

Conclusion

The basic nutrients contained in sports foods can meet the body's energy needs during exercise. According to the different functional factors in sports food, the roles of each nutritional component can be divided into: the protection of articular cartilage, improving muscle quality, regulating endocrine, weight control, prevention of sports anemia, increasing energy storage and utilization, enhancing immune function, and enhancing immune function. Therefore, people can selectively supplement.

Winter sports are unique in that they are undertaken under environmental extremes, which must be considered when planning nutrition programmes for the athletes' periodized training and competition season. Athletes at greatest risk for suboptimal nutrition are those with very high energy demands (e.g. cross-country skiing, Nordic combined, biathlon, and speed skating), those exposed to environmental extremes (e.g. alpine and freestyle skiing, snowboarding, cross-country skiing, biathlon, Nordic combined), and those focused on low body mass and fat (e.g. ski jumping, freestyle aerials, cross-country skiing).

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