



The South Asian Academic Research Chronicle ISSN 2454-1109

**A Refereed Interdisciplinary Indexed International Open Access Monthly e-Journal
Vol. 12, Issue 5, May 2025**

The South Asian Academic Research Chronicle

ISSN 2454-1109

**A Refereed Interdisciplinary Indexed International Open Access
Monthly e-Journal**

Vol. 12, Issue 5, May 2025

**Editor-in-Chief:
Dr. Rohidas Nitonde**

**Managing Editor:
Ms. Sushama Ingole**



5. A Step Toward Meliorating Athletes' Nutrition Through Carbohydrate Intake During Workout Progressive Approach in Sport Nutrition By Taking Carbohydrate During Exercise

Dr. Santosh Baburao Kokil
Department of Sports
Shri Shivaji College, Parbhani

Abstract

Recent years have seen significant progress in our understanding of how carbohydrates function during intense exercise, allowing us to offer more tailored and individualised guidance on carbohydrate intake during physical activity. The new recommended guidelines take into account the amount (and intensity) of exercise and also provide advice on the types of carbohydrates to consume, along with the quantities. Studies have shown that a mouth rinse or small amounts of carbohydrates can enhance performance during about an hour of exercise. For activities of longer duration, the suggested rate of carbohydrate oxidation is up to 60 g/h from a single carbohydrate source over 2-3 hours. This rate is higher for ultra-endurance events, at approximately 90 g/h. To support high oxidation rates and prevent carbohydrate accumulation in the colon, carbohydrates consumed at such high rates must include a variety of transportable forms. When exercise intensity is low and, as a result, carbohydrate oxidation rates are also reduced, these guidelines may need to be adjusted downwards. The carbohydrate source can be a liquid, semi-solid, or solid. Advice on carbohydrate intake is independent of body weight and exercise level. Consequently, while most athletes should adhere to these recommendations, they largely depend on the nature and duration of the activity. The current general guidelines for carbohydrate intake during endurance exercise may be replaced by these new recommendations.



Keywords: Carbohydrates, Multiple transportable carbohydrates, Physical Endurance, Single transportable carbohydrates

Introduction

In the 1900s, it was discovered that carbohydrate was an important energy source for exercise [1]. The consumption of carbohydrate during exercise could be influenced by diet, and this could affect exercise tolerance [2]. Muscle glycogen was found to play an important and significant role during exercise in 1960, and research from the 1980s showed that eating carbohydrates while exercising boosts exercise capacity [4, 5]. There were no significant developments in the following 20 years until 2004, which marked the beginning of a new era with several important advances in carbohydrate feeding during exercise.

Recommendations for athletes evolved over time as more information about these discoveries and their implications for sports nutrition became accessible. Although guidelines remain somewhat unclear, recent consensus suggests that carbohydrate intake is vital for enhancing endurance performance [6]. Studies have demonstrated that a relatively small amount of carbohydrate (20 g/h) can improve performance [7, 8]. According to a study by Fielding et al. [7], a performance benefit was observable at a minimum of 22 g of carbohydrate per hour. After four hours of activity, the subjects performed a sprint. When 22 g of carbohydrates were consumed per hour, performance improved; however, when half that amount (11 g/h) was consumed, no effects were observed. In contrast to water, the intake of 16 g of glucose per hour increased endurance capacity by 14% in a study by Maughan et al. [8] (which did not include a placebo). This has often been cited as the upper limit for carbohydrate intake during exercise. Meanwhile, other research has shown that exogenous carbohydrate oxidation never exceeded 60 g/h [9]. The most recent recommendations from the American College of Sports Medicine (ACSM) suggest that carbohydrate consumption during exercise should be between 30–60 g/h [6]. This broad range is unaffected by the type, duration, or skill level of the activity. Thanks to research evidence and new insights gained over the past five to ten years,



athletes are now able to receive more specific and prescriptive guidance. Since this topic has already been discussed extensively in recent studies [10–15], it is beyond this review's scope to provide a detailed analysis of all supporting evidence. Nonetheless, the aim of this work is to compile various carbohydrate intake data and translate current knowledge into practical recommendations for athletes participating in different competitions.

Carbohydrate Intake in Real-Life Events

Relatively few studies have examined how much carbohydrate athletes consume during races and whether they meet the recommended guidelines. In a study by Kimber et al. [49], the average carbohydrate intake during an Ironman-distance triathlon was 1.0 g/kg BW/h in female triathletes and 1.1 g/kg BW/h in male triathletes. They achieved these carbohydrate intakes by consuming very large amounts of carbohydrate during cycling (approximately 1.5 g/kg BW/h). Most of the intake occurred during the cycling leg, where intake was almost three times higher than during the running leg. In male athletes, carbohydrate intake was positively correlated with finish time, but this relationship was not confirmed in women. A large study of endurance events by Pfeiffer et al. [50] showed a wide variation in carbohydrate intake reported by athletes both between and within events, with the highest intakes in cycling and triathlon events and the lowest in marathons. In that study, it was also found that in Ironman races, carbohydrate intake was related to finish time, with greater carbohydrate intake correlating with better performance. These findings seem to align with recent dose–response studies by Smith and colleagues [39, 51].

However, neither the exact functions of the different brain areas nor the receptors in the mouth that mediate these effects linked to performance have been identified. It is not taste itself that is truly detected by the taste receptor cells, but rather glucose or energy. To fully understand the distinct taste transduction pathways for various types of carbohydrates and how these differ among mammalian species, especially humans, further research is necessary. Nonetheless, it has been convincingly demonstrated that glucose is recognised by unknown



receptors in the oral cavity, and that this recognition can be linked to improvements in exercise performance. These findings are considered in the new guidelines proposed here.

Table 1: Carbohydrate intake guidelines

Duration of exercise	Carbohydrate (g)	Recommendation type	Additional recommendation
30-75 min	Small amount	Single or multiple transportable carbohydrates	Nutritional training recommended
1-2 hr.	30g/hr.	Single or multiple transportable carbohydrates	Nutritional training recommended
2-3 hr.	60g/hr.	Single or multiple transportable carbohydrates	Nutritional training highly recommended
2.5 hr.	90g/hr.	Only multiple transportable carbohydrate	Nutritional training essential

Practical implications of the mouth rinse studies.

These findings suggest that a mouth rinse containing carbohydrates may be sufficient to enhance performance during exercise lasting from 30 minutes to one hour. There does not seem to be any disadvantage to drinking the solution; however, occasional athletes may experience gastrointestinal discomfort when swallowing larger amounts. In most cases, the performance effects of the mouth rinse are comparable to those of consuming the carbohydrate drink. Carbohydrate plays a vital role as a fuel for longer exercises (two hours or more), and it must be consumed to



prevent performance decline. For longer-duration exercise, additional carbohydrate might be necessary, as discussed in the next two sections.

Prolonged Exercise and Multiple Transportable Carbohydrates

Although different types of carbohydrates used during exercise may be metabolised at varying rates [12], until a seminal paper in 2004 [29], it was believed that regardless of the kind of carbohydrate consumed during exercise, the rate of oxidation could not exceed 1 g/min (60 g/h). This is reflected in ACSM recommendations that athletes consume between 30 and 60 g of carbohydrates during endurance exercise (lasting more than an hour) [30] or 0.7 g/kg per hour [6].

The intestinal absorption of carbohydrates seems to be a limiting factor for exogenous carbohydrate oxidation. It is believed that the sodium-dependent transporter (SGLT1), which saturates at a carbohydrate intake of about 60 g/h, is responsible for glucose absorption. When fructose, a carbohydrate that uses a different transporter, was consumed alongside glucose at this rate, oxidation rates were significantly higher than 1 g/min (1.26 g/min) [29]. Subsequently, further studies were carried out to determine the maximum rate of exogenous carbohydrate oxidation. The types and combinations of carbohydrates used in these experiments varied, as did their consumption rates. Compared to transportable carbohydrates that rely solely on SGLT1, multiple transportable carbs resulted in (up to 75%) higher oxidation rates, according to all studies (for reviews see Jeukendrup [12, 15]). Interestingly, such high oxidation rates may also be achieved by consuming carbohydrates in gels [31] or low-fat, low-protein, low-fibre energy bars [32].

Numerous studies have shown a link between delayed fatigue and improved exercise performance, as well as the increased exogenous glucose oxidation rates observed with various transportable carbs. During five hours of moderate-intensity activity, participants in one study consumed 1.5 g/min of glucose:fructose or glucose. It was found that their perceived exertion was lower when they consumed the mixture of glucose and fructose compared to glucose alone. By the end of the five hours of cycling, the cyclists were also better able to sustain their cadence [33].



Additionally, it was demonstrated that a beverage containing glucose and fructose could enhance physical performance [35]. After two hours of exercise at 54% VO₂max on a cycle ergometer, while consuming either a carbohydrate drink or a placebo, the cyclists completed a roughly 60-minute time trial. Their power output increased by 9% after consuming a glucose drink (at 1.8 g/min) (254 vs. 231 W). Moreover, alongside the increase caused by glucose intake, there was an additional 8% improvement in power output when they drank a beverage containing both glucose and fructose (275 vs. 254 W). This was the first study to indicate a clear performance benefit with glucose: fructose compared to glucose alone [35] and the first to propose that exogenous carbohydrate oxidation rates may relate to performance. Triplett et al. [36] confirmed these findings and observed very similar performance improvements with glucose: fructose over glucose alone.

Different Advice for Different Endurance Sports

The repeated evidence shows that carbohydrate feeding during cycling does not affect muscle glycogen breakdown. However, during running, there are indications that muscle glycogen breakdown, especially in type I muscle fibres, may be reduced [52]. Consequently, carbohydrate feeding enhances performance in both cycling and running, although the precise mechanism might differ. This topic is explored more thoroughly in an excellent review by Tsintzas and Williams [53]. Exogenous carbohydrate oxidation seems similar in cycling and running [54], indicating that the advice for cyclists and runners is comparable.

Conclusion

In summary, there have been significant advances in understanding the role of carbohydrates during exercise in recent years, enabling more specific and personalised advice regarding carbohydrate intake during activity. The new proposed guidelines consider the duration (and intensity) of exercise; they are not limited to the amount of carbohydrate but also provide guidance on the type of carbohydrate. These recommendations are mainly based on studies with trained



and well-trained athletes. Athletes performing at lower absolute intensities will have reduced carbohydrate oxidation rates, and the suggested amounts should be decreased accordingly. Carbohydrate intake can be achieved through drinks, gels, or low-fat, low-protein, and low-fibre solid foods (bars), with selection guided by personal preference. Athletes may adopt a mix-and-match strategy to meet their carbohydrate goals. However, carbohydrate intake should be balanced with a fluid intake plan, and it is important to note that solid foods and highly concentrated carbohydrate solutions can impair fluid absorption. Although using multiple transportable carbohydrates can partly mitigate the slowing of gastric emptying and absorption, athletes need to consider this when developing their nutrition strategy. While further research is necessary, it is strongly recommended that athletes trial their nutrition plan during training to minimise gastrointestinal discomfort and to enhance the intestine's absorptive capacity.

References

- Ali A, Williams C, Nicholas CW. (2007). The influence of carbohydrate-electrolyte ingestion on soccer skill performance. *Medical Science and Sports Exercise*. 39(1):1969-1976.
- Bender G, Veldhuizen MG, Meltzer JA, . Neural correlates of evaluative compared with passive tasting. *Eur J Neurosci*. 2009;30:327-38.
- Bergstrom J, Hultman E. Muscle glycogen synthesis after exercise: an enhancing factor localized in muscle cells in man. *Nature*. 1966;210:309-10.
- Carter JM, Jeukendrup AE, Mann CH, Jones DA. The effect of glucose infusion on glucose kinetics during a 1-h time trial. *Med Sci Sports Exerc*. 2004;36:1543-50.
- Chambers ES, Bridge MW, Jones DA. Carbohydrate sensing in the human mouth: effects on exercise performance and brain activity. *J Physiol*. 2009;587:1779-94.
- Chandrashekar J, Hoon MA, Ryba NJP, . The receptors and cells for mammalian taste. *Nature*. 2006;444:288-94.



Christensen EH, Hansen O. Arbeitsfähigkeit und Ernährung. Scand Arch Physiol. 1939; 81:160-71.

Coggan AR, Coyle EF. Reversal of fatigue during prolonged exercise by carbohydrate infusion or ingestion. J Appl Physiol. 1987;63:2388-95.

Cox GR, Clark SA, Cox AJ. Daily training with high carbohydrate availability increases exogenous carbohydrate oxidation during endurance cycling. J Appl Physiol. 2010;109:126-34.

Coyle EF, Hagberg JM, Hurley BF. Carbohydrate feeding during prolonged strenuous exercise. J Appl Physiol. 1983;55:230-5.

Currell K, Conway S, Jeukendrup AE. Carbohydrate ingestion enhances performance in a reliable new test of soccer performance. Int J Sport Nutr Exerc Metab. 2009;19:34-46.