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The aim of this study was to investigate the effects of a carbohydrate (CHO) gel on performance after prolonged intermittent high-intensity shuttle running. Seven male soccer players performed 2 exercise trials, 7 d apart. On each occasion, participants completed five 15-min periods of intermittent variable-speed running, interspersed with periods of walking (Part A), followed by an intermittent run to exhaustion (Part B). Participants consumed either a CHO gel or placebo (PLA) immediately before exercise (0.89 mL/kg body mass [BM]) and every 15 min thereafter (0.35 mL/kg BM). In addition, water was consumed at a rate of 5 mL/kg BM before and 2 mL/kg BM every 15 min during exercise. Blood glucose levels were higher ($P < 0.05$) at 15, 30, and 60 min of exercise and at exhaustion in CHO than in PLA. During Part B, run time to exhaustion was longer ($P < 0.05$) in the CHO trial (CHO 6.1 ± 1.3 min vs. PLA 4.2 ± 1.2 min). These results indicate that ingesting a CHO gel, along with water, improves performance after prolonged intermittent running in healthy male subjects, possibly by maintaining blood glucose levels during exercise.

Introduction, pages 451-452. (In this case the Introduction it is not labeled as such.)

A common theme across intermittent sports such as soccer is a decrease in performance in the latter stages of a game, with less distance being covered, a lower fractional work intensity, and reduced blood glucose levels (10). The causes of fatigue are multifaceted and can occur as a result of either central or peripheral factors (28). Fatigue during prolonged exercise at intensities of 65–85% maximal oxygen uptake ($\text{VO}_{2\text{max}}$) has been associated with depletion of muscle glycogen (14, 16, 27), hypoglycemia (6, 7), and dehydration (1, 4). In previous well-controlled studies it has been found that ingesting a carbohydrate (CHO) solution immediately before and during exercise can delay fatigue during intermittent high-intensity exercise (9, 21, 28). The potential mechanisms for this effect could be attributed to either a reduction in muscle glycogen utilization (20, 26, 27) or maintenance of blood glucose levels (6, 8) during exercise. Furthermore, it has been reported that blood glucose is an important energy source for the brain (22), and, as such, its levels in the blood could alter neurotransmitter activity (8), subsequently influencing cognition, mood, motivation, and motor-skill performance (28).
Hypothesis, page 452. (In this case the hypothesis included at the end of the introduction, as opposed to separately.)

The aim of this study, therefore, was to examine the effects of ingesting a commonly available CHO sports gel on running capacity after prolonged intermittent high-intensity shuttle running. It was hypothesized that there would be a significant improvement in performance after CHO-gel ingestion compared with control and that this improvement would be associated with maintained blood glucose levels in the CHO trial.

Methodology, pages 446-448. (In this case the Methodology section is clearly labeled as such.)

Methods

Participants

Seven healthy, trained university male soccer players (age 21.3 ± 1.1 y, body mass 65.5 ± 4.6 kg, height 175.4 ± 2.8 cm, percentage body fat 12.9% ± 1.9%, VO₂max 52.3 ± 1.6 ml·kg⁻¹·min⁻¹; mean ± standard deviation) volunteered to participate in the study, which was approved by Napier University’s ethics committee. Before commencement of the study, all participants were required to sign a letter of informed consent, having previously had all possible risks and discomforts fully explained to them in both written and verbal form.

Results, pages 448-451. (In this case the Results are clearly labeled.)

Results

Exercise Time to Fatigue

There was a 45% increase (P < 0.05) in run time to exhaustion during Part B of the L.I.S.T. after CHO ingestion compared with PLA (6.1 ± 1.3 min vs. 4.2 ± 1.2 min, respectively; Figure 1).

Blood Glucose

Blood glucose concentrations were higher (P < 0.05) at the end of 15, 30, and 60 min of exercise during Part A of the L.I.S.T. in the CHO trial (5.8 ± 1.2, 6.9 ± 1.3, and 5.9 ± 0.8 mmol/L, respectively) than in PLA (5.2 ± 1.1, 5.1 ± 0.5, and 5.1 ± 0.4 mmol/L, respectively; Figure 2). Furthermore, concentrations
Data in the form of Tables, Charts, Graphs, etc., contained within the Results.

![Blood glucose concentration graph](image)

**Figure 2** — Blood glucose concentration before (pre) and during the first 15, 30, and 60 min of the Loughborough Intermittent Shuttle Test in the placebo (PLA) and carbohydrate (CHO) trials, mean ± standard deviation. *Significantly different from PLA* $(P < 0.05, N = 7)$.

**Discussion, pages 451-454.** (In this case the Discussion is clearly labeled as such and includes comparison to other studies.)

**Discussion**

The main and novel finding of the present study was that supplementation with an isotonic CHO gel immediately before and throughout prolonged intermittent high-intensity shuttle running delayed fatigue and improved endurance-running capacity by 45% compared with the same volume of artificially sweetened PLA. This improvement in high-intensity-endurance capacity is consistent with previous research investigating CHO ingestion and using running as a mode of exercise (9, 21, 28) but is the first to show an improvement after ingesting CHO in the form of a gel.
Conclusion, page 454. (In this case the Conclusion is presented at the end of the discussion rather than separately.)

In conclusion, ingesting an isotonic CHO gel before and every 15 min during intermittent exercise improved subsequent running capacity by 45% in comparison with an artificially sweetened placebo. We do not think that the differences in performance were caused by a hypoglycemic effect on the CNS affecting force production or perception of fatigue, increased muscle acidity, or dehydration in the PLA trial. Instead, we suggest that the improved performance in the CHO trial is related to a sparing of muscle glycogen after CHO ingestion, which can then be utilized in the latter stages of intense intermittent exercise. Although the current study did not directly compare a CHO liquid drink with CHO gel, the observation of similar improvements in performance between this and previous studies using CHO drinks suggests that isotonic CHO gel could be used as an alternative to liquid CHO solutions during prolonged exercise. The positive findings of the use of CHO gel suggest that further investigation of the effects of CHO-gel intake during different exercise intensities is warranted.

References, pages 454-455. (Continued for a total of 29 References.)

References

Note that the availability of identifying characteristics may vary from article to article. For instance, although this is clearly a Study, the following characteristics are missing in this example:

- Author Credentials
- Publication Credentials
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