The Effects of Low– and High–Glycemic Index Foods on High-Intensity Intermittent Exercise

Jonathan P. Little, Philip D. Chilibeck, Dawn Ciona, Albert Vandenberg, and Gordon A. Zello

The glycemic index (GI) of a preexercise meal may affect substrate utilization and performance during continuous exercise. **Purpose:** To examine the effects of low- and high-GI foods on metabolism and performance during high-intensity, intermittent exercise. **Methods:** Seven male athletes participated in three experimental trials (low-GI, high-GI, and fasted control) separated by ~7 days. Foods were consumed 3 h before (~1.3 g·kg⁻¹ carbohydrate) and halfway through (~0.2 g·kg⁻¹ carbohydrate) 90 min of intermittent treadmill running designed to simulate the activity pattern of soccer. Expired gas was collected during exercise to estimate substrate oxidation. Performance was assessed by the distance covered on five 1-min sprints during the last 15 min of exercise. **Results:** Respiratory exchange ratio was higher and fat oxidation lower during exercise in the high-GI condition compared with fasting ($P < .05$). The mean difference in total distance covered on the repeated sprint test between low GI and fasting (247 m; 90% confidence limits ±352 m) represented an 81% (likely, probable) chance that the low-GI condition improved performance over fasting. The mean difference between high GI and fasted control (223 m; ±385 m) represented a 76% (likely, probable) chance of improved performance. There were no differences between low and high GI. **Conclusions:** When compared with fasting, both low- and high-GI foods consumed 3 h before and halfway through prolonged, high-intensity intermittent exercise improved repeated sprint performance. High-GI foods impaired fat oxidation during exercise but the GI did not appear to influence high-intensity, intermittent exercise performance.

**Keywords:** carbohydrates, preexercise meals, repeated sprint performance, sport nutrition

Athletes are advised that consuming carbohydrate meals before exercise improves endurance;¹⁻⁵ however, the characteristics of the ideal preexercise meal remain largely unknown. The glycemic index (GI) of carbohydrates ingested
before exercise influences substrate utilization during exercise\textsuperscript{6–11} and may affect performance.\textsuperscript{3,6,8,11} High-GI foods are digested quickly, resulting in large increases in blood glucose and insulin.\textsuperscript{12} In contrast, low GI foods are digested slowly, resulting in a slight rise in blood glucose and insulin.\textsuperscript{12} The exaggerated insulin response after consumption of high-GI food may lead to accelerated muscle glucose uptake as well as decreased mobilization and oxidation of free fatty acids during subsequent exercise.\textsuperscript{13} As a result, carbohydrate oxidation is higher and fat oxidation lower during exercise following a high-GI compared with low-GI meal.\textsuperscript{6–11} Increased rate of carbohydrate oxidation after a high-GI meal may be detrimental to performance because depletion of endogenous carbohydrate stores contributes to fatigue during endurance exercise.\textsuperscript{1,14} Low-GI preexercise meals may be beneficial because the ongoing absorption of glucose could provide fuel for exercising skeletal muscle. This has led to the suggestion that athletes consume a preexercise meal with a low GI.\textsuperscript{8,15,16}

Despite the theoretical benefits of low-GI preexercise meals, research in this area is mixed. Thomas et al\textsuperscript{8} showed that cycling time to exhaustion at \( \sim 70\% \) maximal oxygen uptake (\( \text{VO}_2\text{max} \)) was improved over 20\% when low-GI lentils were consumed before exercise compared with high-GI carbohydrates. Subsequent research has produced mixed results, with some reporting improved performance following low-GI meals\textsuperscript{3,6,11} but most reporting no effect of the GI on performance.\textsuperscript{7,9,17–20} The applicability of previous research is limited to endurance cycling and running as the vast majority of studies examined the influence of the GI on continuous exercise of this nature.\textsuperscript{3,6,7,9,11,17–20} Many team sports (eg, soccer, rugby, and hockey) involve prolonged, high-intensity intermittent exercise. The effect of low- and high-GI preexercise meals on this type of exercise has not been studied. The influence of preexercise meals on substrate utilization has important implications for team sports because depletion of endogenous carbohydrate stores (ie, muscle glycogen) contributes to fatigue in the late stages of a game.\textsuperscript{14} Lipids are also an important fuel source during intermittent sprinting\textsuperscript{21} as fat oxidation predominates during the low-intensity rest and recovery periods. A greater relative utilization of fats during low-intensity or rest periods would spare carbohydrates for the high-intensity periods. Therefore, the impact of the GI on substrate utilization could influence fuel availability and affect performance. The purpose of this study was to examine the effects of low- and high-GI foods on metabolism and performance during high-intensity intermittent exercise designed to mimic the activity pattern of a soccer match. We hypothesized that consuming a low-GI food 3 h before and halfway through 90 min of high-intensity intermittent exercise would result in improved maintenance of blood glucose and promote higher fat oxidation during exercise compared with a high-GI food. As a result, performance at the end of exercise would be improved in the low-GI condition because of increased endogenous carbohydrate availability.

### Methods

Seven male athletes (age \( 23.3 \pm 3.8 \) y, body mass \( 76.1 \pm 7.9 \) kg, \( \text{VO}_2\text{max} 56.7 \pm 5.0 \) mL·kg\(^{-1} \)·min\(^{-1} \)) volunteered to participate. All had experience in sports involving intermittent or interval-type exercise (eg, soccer, hockey, and distance running)
and were familiar with treadmill running. Subjects provided written informed consent. The study was approved by the University of Saskatchewan Research Ethics Board.

Each subject made five weekly visits to the laboratory. Visits 1 and 2 consisted of a VO2max test and a familiarization trial with the high-intensity intermittent exercise protocol (details described below). Subjects then participated in three experimental trials (low-GI, high-GI, and control) in a counterbalanced, randomized fashion separated by approximately 7 d. The study was of a single-blind design. All personnel conducting the exercise tests and evaluating results were blinded to experimental conditions, but the subjects knew which food they consumed.

The low-GI food was boiled decorticated unsplit ‘CDC Robin’ red lentils (SaskCan Pulse Trading, Regina, SK) and had a GI of ~29. The high-GI foods were matched for macronutrient profile and consisted of instant mashed potatoes, egg whites, and ketchup, with a GI of ~81 (GI values from Foster-Powell et al22 using the mixed-meal method of Wolever and Jenkins23). Food was consumed 3 h before exercise and a smaller amount was consumed during a 15-min break after 45 min of exercise (designed to mimic halftime of a soccer match). The preexercise feeding was designed to provide 2.0 g of total carbohydrate per kilogram to meet current sport nutrition guidelines for preexercise carbohydrate consumption.1,2 The “halftime” feeding was designed to provide 0.25 g of total carbohydrate per kilogram (ie, ~20 g of carbohydrate), which is slightly below current guidelines for carbohydrate consumption during exercise (30–60 g/h) but was chosen to decrease the chances for gastrointestinal distress. In spite of this, most subjects were unable to consume their allotted food. To match total energy and carbohydrate content, the portion of food consumed on each subject’s first feeding trial was recorded and the subsequent food adjusted accordingly. On average, subjects consumed 64 ± 22% of the pregame food and 79 ± 31% of the “halftime” food. Therefore, the average total carbohydrate consumption was 1.3 ± 0.43 g·kg−1 (range 0.65 to 1.59 g·kg−1) or 78 ± 26 g (range 51 to 118 g) before exercise, and 0.19 ± 0.08 g·kg−1 (range 0.06 to 0.25 g·kg−1) or 14 ± 7 g (range 4 to 22 g) at “halftime” (full macronutrient profiles are listed in Table 1).

Two weeks before the experimental trials began, each subject performed an incremental running test to exhaustion on a treadmill (Vacu Med, Model 13622, Ventura, CA) to determine VO2max, velocity at VO2max (Vmax), and maximal heart rate.24 The test began at a speed of 10 km·h−1 and was increased by 1 km·h−1 every minute until exhaustion. Oxygen uptake (VO2) was measured breath-by-breath using open-circuit indirect calorimetry (Sensor Medics, Vmax Series 29, Anaheim, CA). Heart rate was measured continuously using a Polar 610i heart rate monitor (Polar Electro, Oy, Kempele, Finland). We calculated VO2max as the highest 20-s average for VO2 and maximal heart rate was determined using the highest 5-s average. We defined Vmax as the highest treadmill speed that was maintained for one complete minute.24

Seven days later, subjects completed a familiarization trial for the high-intensity intermittent exercise protocol. This protocol was designed to mimic the activity pattern of a soccer match and consisted of two 45-min exercise periods separated by a 15-min break (ie, halftime). Software (Vacu Med, TurboFit 5.05, Ventura, CA) controlled the speed of the treadmill to alternate between periods of
Table 1  Average energy content and macronutrient profile of the low- and high-GI foods that were consumed before and during exercise. A control condition (no food) was also employed. Glycemic index values for individual foods are from Foster-Powell et al\textsuperscript{22}; GI values for the high-GI feedings were calculated using the mixed meal method of Wolever and Jenkins.\textsuperscript{23}

<table>
<thead>
<tr>
<th></th>
<th>Preexercise</th>
<th></th>
<th>During Exercise</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Low GI</td>
<td>High GI</td>
<td>Low GI</td>
<td>High GI</td>
</tr>
<tr>
<td>Energy (kcal·kg(^{-1}))</td>
<td>7.72 ± 1.88</td>
<td>6.53 ± 2.81</td>
<td>1.08 ± 0.32</td>
<td>1.01 ± 0.52</td>
</tr>
<tr>
<td>Total Carbohydrate (g·kg(^{-1}))</td>
<td>1.42 ± 0.35</td>
<td>1.13 ± 0.49</td>
<td>0.22 ± 0.07</td>
<td>0.18 ± 0.09</td>
</tr>
<tr>
<td>Available Carbohydrate (g·kg(^{-1}))</td>
<td>1.15 ± 0.28</td>
<td>1.09 ± 0.47</td>
<td>0.18 ± 0.06</td>
<td>0.17 ± 0.09</td>
</tr>
<tr>
<td>Protein (g·kg(^{-1}))</td>
<td>0.57 ± 0.14</td>
<td>0.45 ± 0.19</td>
<td>0.09 ± 0.03</td>
<td>0.07 ± 0.04</td>
</tr>
<tr>
<td>Fat (g·kg(^{-1}))</td>
<td>0.04 ± 0.01</td>
<td>0.03 ± 0.01</td>
<td>0.006 ± 0.002</td>
<td>0.005 ± 0.002</td>
</tr>
<tr>
<td>Glycemic Index (GI)</td>
<td>29</td>
<td>81</td>
<td>29</td>
<td>81</td>
</tr>
<tr>
<td>Portion Size (grams)</td>
<td>403 ± 139</td>
<td>679 ± 235</td>
<td>73 ± 28</td>
<td>124 ± 67</td>
</tr>
</tbody>
</table>

Values are mean ± SD. There were no differences between low and high GI on any variable.
rest, walking, jogging, running, and sprinting. The proportion of time spent at each speed was based on a time-motion analysis of professional soccer players that found that players spend ~7% of the game standing still, ~56% of the game walking (~5 to 6 km·hr⁻¹), ~30% of the game jogging (~10 to 11 km·hr⁻¹), ~4% of the game running (~15 to 17 km·hr⁻¹), and ~3% of the game sprinting (~21 to 23 km·hr⁻¹). The speed of the treadmill was adjusted if these speeds were too fast or slow, and the speeds chosen were kept constant for each experimental trial. The treadmill simulation was based on the protocol of Drust et al with slight modifications to account for the treadmill and software package used in our laboratory. The protocol was administered in standardized 15-min blocks consisting of six walking intervals, six jogging intervals, three running intervals, and eight sprints. The average time spent during each interval, including speed transitions, was 75 s (walking), 40 s (jogging), 20 s (running), and 12 s (sprinting). A 90-s standing period was incorporated into the protocol at the end of each 15-min block for blood sampling. The first 45 min of the protocol included three identical 15-min blocks, and the second 45 min included two identical 15-min blocks and a repeated sprint test during the last 15 min. The repeated sprint test consisted of five 1-min sprints with 2.5 min of walking recovery between each sprint. At the start of each sprint, the speed of the treadmill was immediately increased to individual V_max and the subject was allowed to select the speed for the remainder of the sprint by instructing a researcher to increase or decrease the speed. Subjects were kept blind to the treadmill speed and distance covered but allowed to see the time display. The distance displayed on the treadmill console was recorded by a researcher who was blinded to the experimental condition. The coefficient of variation for the repeated sprint test was 3.3% when a sample of six subjects completed two repeated sprint tests separated by 7 d.

Subjects reported to the laboratory at 0700 after an overnight (≥10 h) fast. A baseline finger prick blood glucose sample was obtained using a commercial monitor (Precision Q.I.D. Blood Glucose Monitoring System, MediSense, Bedford, MA). After the baseline blood sample, subjects had 20 min to consume one of the pregame foods. Blood glucose was measured at 15, 30, 45, 60, 120, and 180 min after completion of the feeding. In the first trial, subjects were allowed to drink water ad libitum during this period and the volume of water consumed was matched in subsequent trials. In the event that a subject could not consume the entire pregame food in their first trial, the portion consumed was recorded and the subsequent feeding was adjusted to keep the macronutrient and total energy content the same. Three hours after completion of the feeding, subjects were fitted with a heart rate monitor and completed a 5-min warm-up on the treadmill at 8 to 10 km·hr⁻¹. A blood sample was collected after each 15-min block and expired gas samples were collected during the last 3 min of each standardized 15-min block. Carbohydrate and fat oxidation rates were estimated according to the equations of Jeukendrup and Wallis, which are adapted for higher intensity exercise. Ratings of perceived exertion (RPE; 6-to-20 scale) were obtained at the end of each 15-min block. A small amount of food from the same source as the pregame feeding was consumed during the 15-min break after 45 min of exercise. Water was provided ad libitum during the break in the first trial and was matched in subsequent trials. The same procedures were followed for the first and second 45-min sections of
high-intensity intermittent exercise except that expired gas was not collected during the repeated sprint test.

To limit any influence of nutrition and physical activity habits on exercise performance, subjects kept a 24-h diet and physical activity record on the day before the first testing day. These records were photocopied and given back to the participants with instructions to follow the same dietary and physical activity patterns for the 24-h period before each testing day. Subjects were instructed to maintain their typical training schedules throughout the study.

Performance data were analyzed using magnitude-based inferences. Confidence limits of 90% were calculated for the difference between low GI and control, high GI and control, and low and high GI using a spreadsheet available online (www.newstats.org/xcrossover.xls). An improvement in sprinting performance that could influence the outcome of a soccer match is likely quite small; however, determining a value for this improvement is inherently difficult and we are unaware of any data in this regard. A significant 5.5% increase in the distance covered during a high-intensity intermittent running test is observed when soccer players consumed a high- versus low-carbohydrate diet. We therefore used a 5.5% increase in the distance covered as a conservative estimate for calculating the practical significance of an improvement in performance. Blood glucose, RPE, respiratory exchange ratio (RER), and carbohydrate and fat oxidation were analyzed with a two-factor (food condition × time) repeated-measures ANOVA with Tukey’s post hoc tests. Significance was set at $P \leq .05$. All results are presented as means ± SD. Statistical analyses were carried out using Statistica, version 5.0 (StatsSoft Inc., Chicago, IL).

Results

Total distance covered on the repeated sprint test is presented in Figure 1. The mean difference between low GI and fasted control was 247 m; 90% confidence limits ±352 m. Compared with fasted control, there is an 81% (likely, probable) chance that the low-GI condition improved performance, a 12% chance (unlikely, probably not) chance that there is a trivial effect of the low-GI condition, and a 6% (unlikely, probably not) chance that the low-GI condition has a negative effect. The mean difference between high GI and control was 223 m; 90% confidence limits ±385 m. Compared with fasted control, there is a 76% (likely, probable) chance that the high-GI condition improved performance, a 15% (unlikely, probably not) chance that there is a trivial effect of the high-GI condition, and a 9% (unlikely, probably not) chance that the low-GI condition has a negative effect. There were no differences between low and high GI (mean difference = 24 m; 90% confidence limits ±62 m; 91% [likely, probably] chance of a trivial effect).

Oxygen uptake averaged ~58% of VO$_{2\max}$ during the soccer match simulation with no differences between conditions ($P > .05$). There was a main effect of food condition for RER ($P = .039$), with the high-GI condition (0.98 ± 0.03) resulting in a higher RER compared with control (0.94 ± 0.05). There were no differences between low GI (0.97 ± 0.02) and high GI or low GI and control. Estimated rate of fat oxidation was lower in the high-GI condition compared with control ($P = .042$; Figure 2a). A food condition × time interaction was seen for rate of carbo-
hydrate oxidation \( (P = .043) \), with a greater rate in the high-GI condition compared with control at all time points and a greater rate in the low-GI condition compared with control at 15, 75, and 90 min (Figure 2b).

A time main effect \( (P = .032) \) was evident with RPE higher at 90 compared with 15 min and higher at 105 min (ie, after the repeated sprint test) compared with all other time points. There were no differences between food conditions for RPE. Heart rate averaged \(~70\%\) of maximum during the soccer match simulation with no differences between food conditions.

Blood glucose rose after the high-GI feeding such that it was greater than low GI and control from 165 to 135 min before exercise \( (P < .001, \text{Figure 3}) \) and also greater compared with control at 120 min before exercise. Blood glucose was not different between high GI, low GI, or control at any other time point.

Most subjects were unable to consume their allotted food. On average, subjects consumed 64\% of their pregame food and 79\% of their halftime food. Therefore, the average amounts of carbohydrate, protein, and fat consumed were \(1.3 \pm 0.43, 0.5 \pm 0.17,\) and \(0.03 \pm 0.01\) g·kg\(^{-1}\), respectively for the pregame food. The halftime food provided, on average, \(0.19 \pm 0.08, 0.08 \pm 0.03,\) and \(0.005 \pm 0.002\) g·kg\(^{-1}\) of carbohydrate, protein, and fat. The amounts of low-GI and high-GI foods

![Figure 1](image-url) — Distance covered (meters) on the repeated sprint test in the control, low-GI, and high-GI conditions. *90\% confidence limits for the mean difference between low GI and control and high GI and control indicate a “likely, probable” improvement in performance. Data are means ± SEM.
Figure 2 — Rate of fat oxidation (panel A) and rate of carbohydrate oxidation (panel B) throughout high-intensity, intermittent exercise. Expired gas was collected for the last 3 min of each standardized 15-min block. *High GI significantly different from control ($P < .05$). †Low GI significantly different from control ($P < .05$). Data are means ± SEM. Data points are offset slightly for clarity.
consumed (Table 1) were not different within subjects ($P = .29$ and $P = .45$ for pregame and halftime foods, respectively).

There were no differences in the amounts of carbohydrate ($4.8 \pm 1.2 \text{ g-kg}^{-1}$), protein ($1.5 \pm 0.9 \text{ g-kg}^{-1}$), fat ($1.4 \pm 0.3 \text{ g-kg}^{-1}$), and total energy ($37 \pm 8 \text{ kcal-kg}^{-1}$) consumed in the 24 h before each trial.

**Discussion**

Consuming low- and high-GI carbohydrates before and during prolonged high-intensity intermittent exercise improved repeated sprint performance compared with a fasted control condition. Although it is widely accepted that endurance capacity improves following high-carbohydrate preexercise meals,\textsuperscript{3-5} this study is
the first to examine the effects of preexercise carbohydrate foods of different GIs on prolonged high-intensity intermittent exercise performance. Similar to moderate-intensity, continuous exercise, high-GI carbohydrates impaired fat oxidation during intermittent exercise. Despite these effects on metabolism, the GI did not affect repeated sprint performance at the end of prolonged, intermittent exercise characteristic of a soccer match.

High-GI foods impair fat oxidation during continuous, moderate-intensity endurance exercise, and our results show that this is also the case during high-intensity intermittent exercise (Figure 2a). High-GI foods result in a greater increase in postprandial blood glucose concentration (Figure 3) and presumably a larger insulin response. A large increase in insulin inhibits adipose tissue lipolysis, limiting the availability and oxidation of free fatty acids. Impairing fat oxidation following high-GI carbohydrate ingestion may increase reliance on muscle glycogen. This may have been the case in our study because there was an increased carbohydrate oxidation at all time points in the high GI compared with control (Figure 2b), with no difference in blood glucose levels during exercise between conditions. Minor alterations in carbohydrate oxidation during exercise were apparent in low GI compared with control, but there were no effects of the low-GI food on fat oxidation, indicating that there was a greater metabolic perturbation in the high-GI condition.

Muscle glycogen availability is important for high-intensity exercise. Compared with players with low glycogen, players with high glycogen before and at halftime of a soccer match covered more distance and performed more high-speed running and sprinting, especially during the last 15 min of the match. Therefore, strategies that delay muscle glycogen degradation may enhance soccer-related performance. Carbohydrate consumption during high-intensity, intermittent exercise decreased net muscle glycogen utilization and improved sprinting performance. We hypothesized that the slow release of glucose following ingestion of low-GI food may act in a similar manner to improve repeated sprint performance during the late stages of exercise. The mechanism by which low-GI foods improved performance over fasting control cannot be ascertained in the current study, but it is possible that sustained release of glucose may have increased carbohydrate availability, reduced reliance on muscle glycogen, and delayed the development of fatigue.

When compared with low-GI preexercise meals, high-GI meals increase muscle glycogen utilization during exercise, likely because of insulin-mediated impairment in fat oxidation and increased reliance on carbohydrate. We hypothesized that sustained release of glucose and lower insulin following low-GI feeding would improve performance compared with high-GI foods. This was not the case, as there were no differences in repeated sprint performance between the low- and high-GI conditions. A previous study examined the effects of low- and high-GI recovery diets consumed over 22 h following a bout of exercise on subsequent performance during intermittent shuttle running and found no effect of the GI. However, this study did not examine the effect of the GI of foods consumed immediately before, or during, intermittent exercise, as subjects exercised in the morning following an overnight fast.

In contrast to studies examining low- and high-GI meals before continuous, moderate-intensity exercise, there were no differences in substrate oxidation or
blood glucose concentration \textsuperscript{6,8} during exercise between low- and high-GI conditions in our study. The high-intensity exercise may have overridden small differences in the metabolic environment experienced after low- and high-GI meals. The slight impairment in fat oxidation during exercise in the high-GI condition versus fasting was likely compensated for by greater carbohydrate availability, increasing performance in high GI compared with fasted control. Our experimental design, which included a small amount of food midway through exercise, may have masked any benefit that the low-GI preexercise food might have conferred during prolonged exercise. Consuming a high-GI carbohydrate source during exercise would have provided a more rapidly accessible energy source for exercising skeletal muscle and might have offset any increase in muscle glycogen utilization during the initial stages of exercise. However, the small amount of carbohydrate consumed during exercise (~14 g) was likely not enough to have a significant effect on metabolism or performance.

**Limitations**

Despite following sport nutrition guidelines, most subjects were unable to consume their allotted food portions. To match energy and carbohydrate intake, the proportion of food consumed on a subject’s first trial was recorded and matched on the subsequent trial. A few subjects did not match their consumption exactly between conditions but there were no significant differences between high and low GI for energy or carbohydrate consumed (see Table 1). Despite this limitation, our findings highlight the benefit of carbohydrate consumption on intermittent exercise, as performance improvements were seen in both GI conditions even when the amount of carbohydrate failed to meet guidelines.

Since we provided food before exercise and at halftime, it cannot be determined if one or both led to the performance improvements. We chose this design because the effects of pregame foods on soccer performance have not been addressed, and soccer players are able to consume carbohydrates during halftime. We felt the practicality of our results would be improved if a halftime meal were included. The halftime feedings were small in an attempt to prevent gastrointestinal distress associated with running after eating but it would be more practical for athletes to consume sports drinks or gels at halftime to enable ingestion of more carbohydrate. Since subjects consumed such a small amount of carbohydrate at halftime (~14 g), it is likely that the foods consumed before exercise had a more substantial effect on performance and metabolism.

Sports that involve halftime or intermissions present a unique situation for carbohydrate ingestion. It is thought that carbohydrates ingested during exercise should be high GI to provide an immediate source of energy.\textsuperscript{15,16,33} There are no differences between low- and high-GI preexercise meals when high-GI carbohydrate drinks are consumed during exercise.\textsuperscript{17} However, subjects in this study also ingested a high-GI beverage 15 min before exercise, raising the possibility that the “preexercise” high-GI drink masked any effect of the preexercise meals.\textsuperscript{17} Since athletes rest during halftime or intermissions, ingestion of high-GI carbohydrate sources could act similarly to a preexercise meal, resulting in increased insulin, decreased free fatty acid availability and oxidation, and increased reliance on muscle glycogen.\textsuperscript{10} We chose to match the GI of the “halftime” food with the
pregame food to eliminate the possibility of the carbohydrates ingested during exercise masking the effects of the preexercise foods. Because subjects were unable to consume a substantial amount of carbohydrate in this form, it is difficult to draw conclusions about the affect of the halftime foods. Future research should investigate combinations of low- and high-GI carbohydrate foods or gels consumed before and during high-intensity, intermittent exercise, especially in sports involving rest periods.

A final limitation is our use of 1-min sprint intervals as a performance measure. Although this test was reproducible, it most likely does not simulate the shorter sprint lengths of actual soccer matches.34

Conclusions

This is the first study to examine the performance and metabolic effects of low- and high-GI foods on long-duration, high-intensity intermittent exercise. Consuming low- and high-GI carbohydrate foods 3 h before and halfway through exercise designed to simulate the activity pattern of soccer matches improves repeated sprinting performance compared with fasted control. High-GI foods impaired fat oxidation compared with fasting but there were no differences in performance between low and high GI.

Practical Applications

The ability to cover more distance during the later stages of a soccer game is important34 and can be limited by carbohydrate availability.14 Carbohydrate consumption should be considered a crucial element of a soccer player’s match preparation. Soccer players and other team sport athletes primarily rely on nutrition information from studies involving continuous endurance exercise.2 This study shows that consuming low- and high-GI carbohydrates before and during high-intensity intermittent exercise improves repeated sprint ability during the late stages of exercise. Soccer players and team sport athletes should consume a carbohydrate-rich meal approximately 3 h before competition and during breaks or intermissions. The GI of the carbohydrates does not influence performance; therefore, both low- and high-GI carbohydrates can be consumed.

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