Sports Gels

Technical Document
Developed by INDI/SNIG for the Irish Sports Council
2013
Sports Gels

Pubmed (Medline), SPORTDiscus and the Cochrane Library were searched for all human studies published in peer reviewed journals in the last 5 years. The terms: “sports gels”, “carbohydrate gels” and “energy gels” were used as key terms in all databases.

Inclusion criteria
- Human studies published in English
- Original investigations assessing the use of sport gels and exercise
- Incorporated the use of an indistinguishable placebo

Exclusion Criteria
- Studies assessing all forms of topical gels
- Studies assessing CHO effect on the immune system
- Qualitative studies assessing supplement use in both the general and athletic population

After title and abstract review, seven original articles that assessed the use of sports gels in exercise settings that compared a sport gels to a placebo were retrieved for review.

It is well established that carbohydrate (CHO) consumption before and during endurance exercise can reduce fatigue and improve performance (Kreider et al. 2002, Coyle 2004, Jeukendrup 2004). The use of CHO is now common practice among athletes during endurance exercise. During high intensity events lasting ≥1 hour or lower intensity events lasting several hours the ACSM recommends consuming approximately 30-60g/h of carbohydrate to maintain blood glucose levels and exercise performance (Cermak and van Loon, 2013). However, it has recently been suggested that during longer duration (≥2.5 hours) events a high carbohydrate intake of 90g/h may be necessary depending on energy expenditure (Cermak and van Loon, 2013, Jeukendrup, 2010, Jeukendrup and Tipton, 2009). There is a significant body of research investigating the likely benefits of consuming CHO in fluids such as sports drinks before, during and after exercise, yet there is limited scientific data directly assessing the use of sport gels as a means of improving performance and decreasing fatigue during exercise.

Sports gels are concentrated, semi-solid CHO solutions (60-70% CHO), that are sold as a portable form of CHO in individual 30-40g sachets (≈ 25g CHO per sachet) or larger tubes of thick CHO liquid (gel) (Castell et al. 2010). The CHO found in sports gels are generally composed of glucose, sucrose, maltodextrin or
fructose and sometimes contain other ingredients such as protein, medium chain triglycerides (MCT oils), caffeine and electrolytes (sodium and magnesium). (Coyle 2004, Saunders et al. 2007) It is important to bear this in mind when deciding which sports gel to consume.

The studies investigating the use of sports gels have assessed endurance cycling, (Abbiss et al 2008, Campbell et al 2008, Earnest et al 2004, Peake et al. 2008) endurance running (Burke et al. 2005) intermittent endurance running (Phillips et al 2012, Patterson & Gray 2007). A summary of these studies and their impact on performance can be seen in Table 1.

**Sports gels and cycling**

Abbiss et al. (2008) studied the effect of CHO ingestion and ambient temperature on muscle fatigue and power output in a 16.1km time trial after 90 minutes of cycling at 60% of the subjects VO$_{2\text{max}}$. The research group found that carbohydrate ingestion during the heat was beneficial for performance when compared to a placebo.

Ten endurance trained cyclists participated in the crossover design study. The participant’s diets were controlled for the day prior to, and the morning of, testing to standardise CHO consumption. The velotron cycle ergometer was adjusted to the dimensions of each subject’s personal bike and was fitted with their pedals. All subjects were tested at the same time of day for all testing sessions, and all sessions were conducted within a climate chamber.

Subjects consumed 0.24g CHO gel (sucrose)/kg body mass (BM) or an indistinguishable placebo immediately before the warm up, then every 15 minutes during the 90 minute trial. Water was consumed ad libitum throughout the trial. Power output and cycling speed were consistently recorded and perceived exertion (RPE) and thermal sensation were recorded in the time trial. Blood analysis of lactate, plasma glucose, serum free fatty acid concentration, serum prolactin, serum serotonin and plasma dopamine were completed post trial, and skin, rectal and mean body temperature were measured throughout the trial. Muscle activation of vastus lateralis was assessed using surface electromyography (EMG) at the end of each kilometer in the time trial.

The relevant findings from this study include:

1. CHO ingestion attenuated the rise in serum free fatty acid concentration
2. CHO ingestion improved time trial performance
3. CHO ingestion resulted in a greater increase in power output during the final 2km of the time trial
This study contributes to a large evidence base reporting the benefits of consuming CHO during endurance exercise, and more specifically the growing number of studies assessing the use of CHO gels as a means of CHO ingestion. Unfortunately, the water consumed during the trial was not recorded and we are unsure of the subject’s hydration status before, during and upon completion of the trial. Due to the significant impact hydration has on performance, controlling for pre-exercise hydration status and fluid intake during exercise would have strengthened the findings of this study.

Campbell et al. (2008) assessed the use of jelly beans, sports drink and sports gels as a means of improving cycling performance and maintaining blood glucose levels. Sixteen endurance trained males (8) and females (8) cycled for 80-min at 75% \(\text{VO}_2\text{peak}\) then completed a 10km time trial. Subjects received isocaloric (0.6g CHO/kg BM/hour) amounts of sports beans (sucrose and glucose), sports drinks (sucrose and glucose-fructose), sports gels (maltodextrin and fructose) or water. All subjects fluid consumption was kept consistent at 7ml/kg prior to exercise, 3.5ml/kg every 20 min during the 80 minute exercise bout and 7ml/kg within 15 min after the completion of exercise. Though the study stated that fluid consumption was kept consistent, it also notes that subjects were able to drink additional water throughout the exercise.

All subjects were tested on their personal bikes and were asked to consume the same diet the night before and the morning of the testing session. Diet compliance was assessed through a 12 hour recall.

Power output and time to complete the time trial were the primary outcome measures. RPE, heart rate, oxygen consumption, respiratory exchange ratio and 3ml of blood was assessed every 20 minutes throughout the 80 minute bout. Blood lactate, blood glucose, hematocrit and free-fatty-acids were analysed, with the blood lactate concentrations remaining significantly higher in all CHO supplementation trials (assuming all subjects undertook each treatment) compared to water during the time trial. Not surprisingly, blood glucose levels were significantly higher for all CHO supplemented trials when compared to water at all time points.

Exercise performance assessed through power output and time to complete the 10km time trial was enhanced with the consumption of all CHO supplements, with no difference between supplements. It is therefore suggested that when CHO supplements are ingested at the same rates, and contain similar CHO types, performance is enhanced.

This is the only study found that assesses jelly beans as a method of CHO consumption during exercise. Raisins (Kern et al. 2007) and honey (Kreider et al.
2002, Earnest et al. 2004) have previously been compared to commercially available sports gels with no significant differences identified between CHO supplementation. Therefore it appears whole foods such as honey, raisons and jelly beans may provide a less expensive alternative to commercial sports gels.

The final cycling study reviewed was conducted by Earnst et al. (2004), who assessed low and high glycemic index (GI) CHO during a 64km cycling time trial performance. Nine endurance trained amateur cyclists participated in the study and were allocated either a low GI gel (honey), a high GI gel (dextrose) or a placebo.

Each subject participated in three time trials, and received 15g of honey, dextrose or placebo with 250ml of water every 15 minutes throughout the time trial. Average power output, RPE and heart rate were assessed every 16km, as was the time to complete the segment. A blood sample was collected at baseline and every 16km to assess blood glucose. Subjects were asked to record their food consumption for 4 days prior to the trial and consume a high carbohydrate meal 4 hours prior to the testing.

The main relevant findings from this study were:

1. Cyclists who consumed the high GI or the low GI supplements completed the last 16km of time trial faster than the placebo group
2. The consumption of carbohydrate did not affect overall time to complete the 64km
3. The glycemic index of the supplement did not affect the primary outcome measures of the trial
4. The CHO supplement groups exhibited a greater power wattage output in the last 16km of the time trial, the placebo group did not

It was suggested by the research group that carbohydrate consumption, despite GI, improved performance. This was only significant in the last 16km bout of the time trial which was attributed to the small sample size. This study concluded that the GI of a CHO supplement does not negatively impact on performance when constantly feeding every 15 minutes. This finding is similar to that of Kern et al. (2007) in which low and high GI CHO were assessed and no difference was found in regards to performance between high and low GI CHO.

**Sports gels and running**

Three studies have assessed the use of sports gels during running events with conflicting results. The first two assessed the use of gels during intermittent high intensity running (Philips et al. 2012; Patterson & Gray 2007) and the third during half marathon running (Burke et al. 2005).
Phillips et al (2012) investigated the use of sports gels during intermittent endurance running. Eleven team games players performed two trails separated by a minimum of 3 and a maximum of 7 days. The trial had two parts which consisted of 4 bouts of 15 minute interval running (the Loughborough Intermittent Shuttle Test [LIST]) separated by 3 minutes of seated recovery (Part A), followed by an intermittent run to exhaustion (Part B).

Participants consumed either 0.818ml/kg BM of a CHO gel or a placebo during the 5 minutes before commencing the trial and 0.327ml/kg BM during each 15 minute recovery period during Part A of the trial. Additionally, participants were asked to record their food and fluid intake in the 24 hours before the first trial. This diet was replicated prior to the second trial to standardize hepatic glycogen concentrations and hydration status.

Participants ran for significantly longer (21.1%) in the CHO trial compared to the placebo trial. The research group noted that this was the first study that demonstrated that ingestion of a CHO gel immediately before and during intermittent running improved intermittent endurance capacity in adolescents. This finding was statistically significant, and therefore coincides with the findings of the cycling studies reviewed. Phillips et al (2012) also noted a similar time scale of CHO oxidation and peak CHO oxidation rate between CHO gels and research conducted on CHO drinks of the same concentration (Pfeiffer et al. 2010).

Until recently the general consensus within the scientific literature was that carbohydrate oxidation within the body was limited to 1-1.1g/min or approximately 60g/hour (Jeukendrup and Tipton, 2009). The limiting factor in the oxidation of ingested carbohydrate is intestinal absorption. Glucose absorption is limited by the sodium dependent glucose transporter SGLT1 to approximately 1g/min (Jeukendrup, 2010). However, if consumed in combination with a carbohydrate transported by a different mechanism (e.g. fructose, using the sodium independent transporter GLUT5) there is evidence that higher carbohydrate oxidation levels can be achieved which has implications for athletes taking part in prolonged events (>2.5 hours). A range of CHO products now exist delivering these so called ‘multiple transportable carbohydrates’.

Patterson & Gray (2007) also investigated the use of sports gels in intermittent high intensity shuttle running. (Patterson & Gray 2007) Seven trained university soccer players performed two exercise trials seven days apart, which involved five bouts of 15 minute interval shuttle running (LIST) at varying speeds, followed by an intermittent run till exhaustion.
Participants consumed either 0.89ml/kg BM of a CHO gel or placebo immediately before exercise, then 0.35ml/kg BM or placebo every 15 minutes thereafter. The volume of fluid was controlled and standardized throughout the trial. The nutritional guidance prior to the testing was for the participants to monitor their food intake for the 2 days prior to the testing and to refrain from caffeine and alcohol for the 24 hours prior. Participants were then asked to replicate the eating patterns for the second trial.

The research group, as would be expected, reported that blood glucose levels were higher in the CHO gel group at all points in the trial compared to the placebo, and there was no significant difference between the placebo and CHO gel groups for blood lactate. There were no significant differences in BM loss throughout the trial and no abdominal discomfort was reported.

The main finding of this study was a 45% increase in run time to exhaustion after CHO gel ingestion compared to the placebo. Again, this finding was statistically significant, and therefore coincides with the findings of the cycling studies reviewed.

Burke et al. (2005) completed a field study assessing 18 highly trained male distance runners over the course of two half-marathons completed 3 weeks apart. All subjects were provided equivalent volumes of a flavored energy free placebo drink, or water and Powerbar™ sports gels (41g satchel). The gel or placebo was consumed prior to the race, then at two feeding stations positioned at the 7km and 14km points. This protocol enabled athletes consuming the gel to ingest 1g/kg BM immediately before and during the race.

The primary outcome measure of half-marathon performance based on time to complete, failed to find any significant benefit of consuming the sports gel over the placebo in two half-marathons. This finding contradicts the majority of sports gel research in cycling, though the cycling studies have all assessed performance over longer durations.

It was noted that gastrointestinal discomfort was reported by three athletes, which had not been reported in the cycling studies reviewed. This may be due to the mode of exercise or the volume of sports gel that was consumed during the event. Despite no difference in performance, authors of this study suggested further research is required within this field, specifically this mode of exercise, due to the positive findings in the general literature regarding carbohydrate consumption during endurance events.

From this brief literature review we can conclude the following:
• Sports gel ingestion during exercise can significantly impact on cycling and running performance when the exercise is greater than 60 minutes in duration
• Sports gels provide a similar pattern of CHO delivery and rates of oxidation as sports drinks
• Sports gels can provide multiple transportable carbohydrates which can result in higher CHO oxidation rates
• Sports gels can improve performance through preventing fatigue and improving power output
• Sports gels overall are well tolerated and can easily be consumed during exercise
• Sport gels assist with maintaining blood glucose levels throughout endurance based exercise
• In line with other carbohydrate ingestion rates, the studies have demonstrated improved performances with a consumption of between 40-60g of carbohydrate per hour
• The GI of the CHO supplement does not appear to alter the performance response, both high and low GI CHO supplements appear to be of equal benefit when constant feeding is maintained
• Gastrointestinal upset is a possible side effect of sports gel ingestion, therefore trial in training should be implemented before use in competition.
**Table 1: Summary of research.**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Subjects</th>
<th>Dose</th>
<th>Exercise Protocol</th>
<th>Performance Enhancement</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbiss et al. (2008)</td>
<td>10 endurance-trained male cyclists</td>
<td>0.48g/kg BM directly before the warm-up and 0.24 g/kg BM every 15 min during exercise</td>
<td>Cycling * 90-min 80% VT₂ * experimental trial 16.1km time trial</td>
<td>Yes</td>
<td>CHO ingestion improved time trial performance in hot but not temperate conditions</td>
</tr>
<tr>
<td>Burke et al. (2005)</td>
<td>18 highly-trained male distance runners</td>
<td>1g/kg BM immediately before and during the event</td>
<td>Running * Two half marathons held 3 weeks apart</td>
<td>No</td>
<td>Difference between half-marathon times between the two trials was not significant</td>
</tr>
<tr>
<td>Campbell et al. (2008)</td>
<td>16 male (8) and female (8) endurance-trained male cyclists and triathletes</td>
<td>0.6g/kg BM per hour</td>
<td>Cycling *75% VO₂peak for 80 min * 10-km time trial</td>
<td>Yes</td>
<td>Three carbohydrate treatments: sports drinks, sports gels and sports beans all improved exercise performance compared to water</td>
</tr>
<tr>
<td>Earnest et al. (2004)</td>
<td>9 endurance-trained amateur male cyclists</td>
<td>15g every 16km</td>
<td>Cycling * 64km time trial</td>
<td>Yes</td>
<td>CHO ingestion improved time to complete the last 16km of the time trial, but overall time to complete the 64km was not statistically different to that of the placebo group</td>
</tr>
<tr>
<td>Patterson &amp; Gray (2007)</td>
<td>7 trained university soccer players</td>
<td>0.89 ml/kg BM consumed immediately before exercise and every 15 minutes during</td>
<td>Running * Prolonged intermittent running at varying speeds</td>
<td>Yes</td>
<td>Ingestion of the CHO gel improved performance after prolonged intermittent running</td>
</tr>
<tr>
<td>Phillips et al. (2012)</td>
<td>11 adolescent competitive team games players</td>
<td>0.818ml/kg BM &amp; 0.327ml/kg BM every 15 min during Part A of the trial</td>
<td>Running *Part A (4 x 15min blocks of the LIST *Part B (Intermittent run to exhaustion)</td>
<td>Yes</td>
<td>CHO ingestion improved intermittent endurance capacity.</td>
</tr>
<tr>
<td>Saunders et al. (2007)</td>
<td>13 recreationally competitive cyclists: men (8) women (5)</td>
<td>0.146g CHO/kg BM &amp; 0.0365g PRO/kg/BM every 15 min throughout the trial then 0.73g CHO/kg BM &amp; 0.183g PRO/kg BM immediately post</td>
<td>Cycling * &gt;50 rev.min⁻¹ at 75% VO₂peak till exhaustion</td>
<td>Yes</td>
<td>Carbohydrate + Protein gels improve endurance performance compared to a carbohydrate gel</td>
</tr>
</tbody>
</table>
References


