Caffeine and sports performance – some updates in knowledge and practice

Louise Burke
Head, AIS Sports Nutrition
Louise has a very modest caffeine habit. She hates coffee, has never tried an energy drink, and her daily caffeine intake consists (to her husband’s annoyance) of half cups of weak black tea. She is committed to practicing her (also very modest) sporting ability. Towards the end of her annual marathon race she consumes caffeinated cola drinks or sports confectionary which seems to help her make it to the finish line with a smile.
Louise has a very modest caffeine habit.

All of the caffeine projects undertaken by Louise (and AIS colleagues) have led to a reduced caffeine use by athletes

- Used by fewer athletes on fewer occasions
- Used in lower doses
“Caffeine is a powerful performance aid, specially suited to the marathon. Here’s some tips on how to use it for your race.

The dose you need is 6 mg/kg body mass - 360 mg for a 60 kg runner or 4 coffees. Drink these about one hour before the race to ensure that your blood fatty acids are high when you’re on the starting line. This extra source of fuel will allow you to run with less reliance on muscle glycogen and avoid “hitting the wall”.

To make caffeine work extra well on race day, you should cut it out from your diet in the week leading up. Since it’s likely to be a hot day, and because caffeine is a diuretic, you will need to drink plenty of fluid during the race to avoid becoming even more dehydrated than usual.

Finally, be aware that caffeine is on the IOC List of Banned Substances when used in competition in large amounts. The dose we have advised you to take will not cause your urine levels to be above the threshold for a doping violation.”
Caffeine in the 1990s
– a typical marathon handout

“Caffeine is a powerful performance aid
1. Caffeine “works” for a wide variety of sporting events with the main effects targeting the brain and central nervous system
   - Achieves fatigue resistance
   - Responses are individual

~ 3% improvement in the performance of....

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<td>Simulation of 23 and 46 km London Olympic cycling Time Trial</td>
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<td>1500 m freestyle swimming</td>
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<td>“Kilo” track cycling race</td>
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2. Caffeine works at low levels of intake – benefits probably max out at 3 mg/kg (150-250 mg)

<table>
<thead>
<tr>
<th>Source</th>
<th>Size</th>
<th>Caffeine content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewed coffee</td>
<td>250 ml</td>
<td>~ 80</td>
</tr>
<tr>
<td>Starbucks Venti brew</td>
<td>600 ml</td>
<td>415</td>
</tr>
<tr>
<td>Black tea</td>
<td>250 ml</td>
<td>25-110</td>
</tr>
<tr>
<td>Coca Cola</td>
<td>375 ml</td>
<td>36</td>
</tr>
<tr>
<td>Red Bull energy drink</td>
<td>250 ml</td>
<td>80</td>
</tr>
<tr>
<td>Stay Alert gum</td>
<td>1 stick</td>
<td>100</td>
</tr>
<tr>
<td>No Doz</td>
<td>1 tablet</td>
<td>100 or 200</td>
</tr>
<tr>
<td>PowerBar caffeinated sports gel</td>
<td>40 g</td>
<td>25-50 mg</td>
</tr>
<tr>
<td>PowerBar caffeinated gel blasts</td>
<td>60 g</td>
<td>75 mg</td>
</tr>
<tr>
<td>5 h energy shot</td>
<td>60 g</td>
<td>Not disclosed, measured at 215 mg</td>
</tr>
<tr>
<td>Pre-workout supplements</td>
<td></td>
<td>Not disclosed</td>
</tr>
<tr>
<td>Fat loss supplements</td>
<td></td>
<td>Not disclosed</td>
</tr>
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3. Lots of different caffeine protocols work – pre-event, during event, towards the end of the event
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<th>30 min TT at end of 2.5 h cycling – study 1</th>
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<tr>
<td><strong>Caffeine</strong></td>
</tr>
<tr>
<td>1.5 mg/kg (Coke) towards end of race</td>
</tr>
<tr>
<td>6 mg/kg @ 1 hour pre-race</td>
</tr>
<tr>
<td>6 x 1 mg throughout race</td>
</tr>
</tbody>
</table>

*Cox et al 2002*
3. Lots of different caffeine protocols work – pre-event, during event, towards the end of the event

### 30 min TT at end of 2.5 h cycling – study 2

<table>
<thead>
<tr>
<th>Caffeine</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 mg/kg, 6% carbs</td>
<td>3.1%</td>
</tr>
<tr>
<td>11% carbs</td>
<td>0.6%</td>
</tr>
<tr>
<td>Coke (11% Carbs, 2 mg/kg caffeine)</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

*Cox et al 2002*
4. Coffee probably isn’t the best way to consume caffeine for sport
   – unknown and variable levels of caffeine

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<tr>
<th>Coffee</th>
<th>Mean caffeine</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short black coffee (variety of outlets)</td>
<td>107 mg</td>
<td>25-214 mg</td>
</tr>
<tr>
<td>250 ml brewed coffee (same outlet different days)</td>
<td>130-282 mg</td>
<td></td>
</tr>
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</table>
5. You don’t need to do a caffeine withdrawal to make it work effectively (Irwin et al. 2010)

– Caffeine withdrawals just make you feel bad
6. The diuretic effect of caffeine is overstated
   – Minimal effect on urine losses or exercise hydration in habitual caffeine users
   – Caffeinated beverages contribute to fluid intake
7. Caffeine was removed from the WADA Banned List on Jan 1 2004. Urinary caffeine levels are monitored in competition for evidence of misuse.
Urinary caffeine.....

- Urinary test measures the amount of caffeine that is excreted non-metabolised (0.5-3% of caffeine dose)
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- The test isn’t standardised
  - Concentration of urine changes with hydration status
  - Different periods between caffeine ingestion and urine sample
Urinary caffeine

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- The test isn’t standardised

**URINARY CAFFEINE IS NOT A RELIABLE MEASURE OF RECENT CAFFEINE INTAKE IN INDIVIDUALS**
issues with caffeine

Role modelling for young people

Misuse and abuse

• Excessive intake
• Vicious cycle of use with sleeping tablets
• Intake with alcohol
• Intake with other stimulants

Explosion of sources of caffeine

• Weight loss supplements
• Pre-workout supplements
• Exotic sources
Many issues of caffeine use for sports performance are similar to “everyday” use

- We should learn more from what we already know
- Athletes and everyday consumers should use caffeine in better ways to improve the upside and reduce the chance of side effects and perception/reality of misuse
Issues for the sports scientists working with caffeine and the elite athlete

– It can be safe, effective and legal when used appropriately
– Most elite athletes already use caffeine and other supplements: your role is to help them improve and individualise their practices
– The perception of your activities may be misconstrued
– It is an emotive area for most people
Anti-doping agencies and rules

The court of public opinion (the punter and the talk-back radio host)

AIS policies and guidelines

Sports science knowledge

2000

Appl Physiol Nutr Metab. 2008 Dec;33(6):1319-34
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Caffeine and sports performance
Louise M. Burke

- Caffeine enhances performance of an incredibly wide number of sports (~2-3%)
- Effects are largely achieved by reducing perception of fatigue
- A variety of dosing protocols work
- Dose response maxes out at 3 mg/kg, but we seem super-responsive at the onset of fatigue
- Responses can be individual but are robust in face of usual intake

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An interpretation of the OMADC
= Caffeine is a banned substance
Urinary threshold is a reporting level

ADRV now include “non-analytical positives”
Evidence or admission of use of a banned substance in competition is an offence

The punter and the Talk-back radio host

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Stop research
Stop caffeine use by athletes

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2000
2001  AIS Workshop on Caffeine in Sport
### Ruling 1

| Caffeine is a prohibited substance in competition in absolute terms (i.e. any amount) | Caffeine is a stimulant; caffeine intake enhances sports performance at very low doses | Caffeine is neither a nutrient nor a necessary part of the diet | Athletes can’t consume many everyday foods around competition

- Lots of doping positives
- Everyday caffeine sources (and sports sponsors) = trafficking |
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<th>Ruling 2</th>
<th>Rationale</th>
<th>Implications</th>
</tr>
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<td>Caffeine is a prohibited substance only when consumed in competition</td>
<td>A urinary caffeine limit can be set that discriminates between social and</td>
<td>Impossible to find such a level</td>
</tr>
<tr>
<td>settings in doses that produce urinary caffeine levels above a certain</td>
<td>intentional use of caffeine</td>
<td>Problems as for Ruling 1</td>
</tr>
<tr>
<td>limit (to be determined).</td>
<td></td>
<td>Looking for individual excretion patterns = controlled doping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education/research about caffeine use construed as encouraging doping</td>
</tr>
<tr>
<td>Ruling 3</td>
<td>Rationale</td>
<td>Implications</td>
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<td>Caffeine is a prohibited substance only when consumed in competition</td>
<td>A urinary caffeine limit can be set that discriminates between social and</td>
<td>More latitude and acceptance of education/research but system isn’t fool proof</td>
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<td>limit (to be determined).</td>
<td>Finding Individual excretion profiles will help to prevent accidental</td>
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<td></td>
<td>high caffeine levels</td>
<td></td>
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<td>Ruling 4</td>
<td>Rationale</td>
<td>Implications</td>
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| The prohibition on caffeine use in sport is removed | Caffeine is so entrenched in normal diet that a ban isn’t practical  
No unfair advantage if the majority of athletes already consume caffeine  
No health problems with small amounts of caffeine  
Benefits occur at the same level of intake as “social” caffeine intake  
The ergogenic benefits of caffeine on performance although worthwhile, are small. | Practical  
Allows strong education and research to find smallest effective doses |
More information for athletes and coaches on caffeine can be found on the AIS Sports Nutrition Website