NEW KNOWLEDGE FROM WSER RESEARCH: GI SYMPTOMS DURING ULTRAMARATHON RUNNING

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“The hardest part about an ultrarun isn’t the running. It’s getting my stomach to cooperate.”

-Ann Trason, 14-time women’s winner of WSER.
GI DISTRESS

• 37- 96% of runners in 161 km races

• 161 km races:
  ➢ Non-finishers: 1st reason for dropping out
  ➢ Finishers: 2nd issue impacting performance
GI Distress at WSER

- Characterization of symptoms
- Potential causes
WSER 2013 GI DISTRESS STUDY

[Western States Endurance Run logo]
PURPOSE

To examine the incidence, severity, and timing of upper and lower GI symptoms in finishers and non-finishers of a 161-km ultramarathon
POST-RACE WEB-BASED SURVEY

- All starters
- Finishers and non-finishers
- GI distress and no GI distress
- GI symptoms during WSER 2013
- Previous GI symptoms
<table>
<thead>
<tr>
<th>Upper GI Symptoms</th>
<th>Lower GI Symptoms</th>
</tr>
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<tbody>
<tr>
<td>• Reflux/heartburn</td>
<td>• Intestinal cramps/pain</td>
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<td>• Flatulence</td>
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<td>• Side ache/stitch</td>
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<td>• Urge to defecate</td>
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<td>• Nausea</td>
<td>• Loose stool/diarrhea</td>
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<tr>
<td>• Vomiting</td>
<td>• Intestinal bleeding/bloody feces</td>
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</table>
BODY WEIGHT

0 m 30 m 56 m 78 m 100 m

Start Robinson Flat Michigan Bluff Rucky Chucky/River Crossing Finish
SUBJECTS

383 Starters

277 Finishers

106 Non-Finishers

Survey
n=212 (76.5%)
25.8 ± 3.3 h

Survey
n=60 (56.6%)
18.0 ± 6.1 h

Survey
n=272
96% reported GI symptoms!
If

• Flatulence
• Belching
• Nausea
• Stomach bloating

➢ In the past while running

Then

• Flatulence
• Belching
• Nausea
• Stomach bloating

➢ During the WSER 2013
If

Then

Females more likely to have stomach bloating
If Finishers more likely to experience belching
Then
FINISHERS, GI SYMPTOMS AFFECTED PERFORMANCE
(44%; n = 93)
NAUSEA FREQUENCY AND SEVERITY BY SEGMENT

(n = 80)

* Frequency > Segment 1
† Frequency > Segment 2
Cumulative Body Mass Change (%)

-6 -5 -4 -3 -2 -1 0 1

Without Nausea
With Nausea

* < Start
† Segment 1
§ Between Groups
NON-FINISHERS, GI SYMPTOMS REASON FOR DROPPING OUT

(36%; n = 21)
NON-FINISHERS NAUSEA FREQUENCY BY SEGMENT

Segment 1 (0-30 m)
Segment 2 (30-56 m)
Segment 3 (56-78 m)
SUMMARY

• GI symptoms experienced by most runners (96%)

• Flatulence (66%), belching (61%), and nausea (60%) most common

• Finishers: GI symptoms affected performance in 44%
  ➢ Nausea most common (86%)

• Non-Finishers: GI symptoms reason for dropping out in 36%
  ➢ Nausea most common (91%)
CONCLUSION

- GI symptoms common during ultramarathon running
- Nausea most common in:
  - Finishers whose performance was affected by GI distress
  - Non-finishers who dropped out because of GI distress
GI Distress at WSER

• Characterization of symptoms
• Potential causes
Causes:

- Physiology
- Mechanics
- Nutrition
GI hypoperfusion!
GI BLOOD FLOW

Exacerbated by:

- ↑ Exercise intensity
- ↑ Exercise duration
- ↑ Core body temperature
- Dehydration

Mitigated by:

- Food and fluid ingestion
GI BLOOD FLOW CONSEQUENCES

- **↓ Motility**
- **↓ Absorption**
- **↑ Permeability**
MOTILITY

Esophagus

- ↓ Peristalsis
- ↓ LES sphincter tone
- Reflux/heartburn

Stomach

- ↓ gastric emptying
- Stomach bloating
- Stomach cramps
- Nausea
- Vomiting
Intestines

- Carbohydrate and water
- Intestinal cramps/pain
- Diarrhea
PERMEABILITY

Intestines
↓ GI blood flow
↓ GI ischemia
↓ Mucosal damage
↑ permeability
↓ Endotoxemia
Endotoxemia

- Bacteria or their toxic compounds (endotoxins) move from intestinal lumen into blood
- Example: LPS
LPS

- Elevated blood levels following:
  - Marathon (Camus 1997)
  - 89-km ultramarathon (Brock-Utne 1988)
  - Triathlons (Bosenberg 1988, Jeukendrup 2000)
- LPS correlated with nausea, vomiting, diarrhea (Brock-Utne 1988)
- LPS not correlated with GI symptoms (Jeukendrup 2000)
- LPS cleared from blood within minutes
LPS AND CD14

- LPS stimulates production of receptor CD14
- CD14 membrane bound (mCD14) or soluble (sCD14)
- sCD14 stable marker for LPS
- ↑ sCD14 following marathon (Nielsen 2004)
INFLAMMATORY MARKERS: IL-6 AND CRP

Endotoxemia

Immune response

Intestinal inflammation

↑ IL-6 and CRP
INFLAMMATORY MARKERS: IL-6 AND CRP

Exercise

↓

Immune response

↓

Inflammation

↓

↑ IL-6 and CRP
INFLAMMATORY MARKERS: IL-6 AND CRP

Following a 161-km ultramarathon:
- ↑ IL-6 (Neiman 2003, 2005, 2006)
- ↑ CRP (Neiman 2006)

Endotoxemia
↓
Immune response
↓
Intestinal inflammation
↓
↑ IL-6 and CRP

Exercise
↓
Immune response
↓
Inflammation
↓
↑ IL-6 and CRP
Causes:
- Physiology
- Mechanics
- Nutrition
Repetitive, High-Impact Pounding

GI Symptoms: flatulence, urge to defecate, diarrhea, bloody feces
Causes:
- Physiology
- Mechanics
- Nutrition
NUTRITION

Food, Fluid, and Electrolyte Consumption

• No association with GI symptoms (Glace 2002, Rehrer 1992))

• Association with GI symptoms (Stuempfle 2013)
  ❖ Runners with no symptoms: ↑ fluid intake rate
  ❖ Runners with no symptoms: ↑ fat intake rate

• More research is needed
WSER 2014 GI DISTRESS STUDY
PURPOSE

To explore possible contributing factors to GI distress, including endotoxemia, nutrition, hyperthermia, and dehydration during a 161-km ultramarathon
SUBJECTS

376 Starters

296 Finishers
Study
  n = 20

80 Non-Finishers
Study
  n = 10

Study
  n = 30
GI DISTRESS INTERVIEWS

0 m 30 m 56 m 78 m 100 m

Start Robinson Flat Michigan Bluff Rucky Chucky/River Crossing Finish
## GI SYMPTOMS

### Upper GI Symptoms
- Reflex/heartburn
- Belching
- Stomach bloating
- Stomach cramps/pain
- Nausea
- Vomiting

### Lower GI Symptoms
- Intestinal cramps/pain
- Flatulence
- Side ache/stitch
- Urge to defecate
- Loose stool/diarrhea
- Intestinal bleeding/bloody feces
GI SYMPTOM SEVERITY

None  Mild  Moderate  Severe  Very Severe
RACE DIET INTERVIEWS

0 m Start
30 m Robinson Flat
56 m Michigan Bluff
78 m Rucky Chucky/River Crossing
100 m Finish
WEIGHTS

Start  Robinson Flat  Michigan Bluff  Rucky Chucky/River Crossing  Finish

0 m  30 m  56 m  78 m  100 m
CORE TEMPERATURE
BLOOD DRAW

- Endotoxemia marker: sCD14
- Inflammatory marker: IL-6
- Inflammatory marker: CRP
80% reported GI symptoms!
NAUSEA FREQUENCY AND SEVERITY BY SEGMENT
ENDOTOXEMIA MARKER: sCD14

<table>
<thead>
<tr>
<th>sCD14 (ug/mL)</th>
<th>Without Nausea (n = 8)</th>
<th>With Nausea (n = 12)</th>
<th>Interaction Effect, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-race</td>
<td>1.0 ± 0.1</td>
<td>0.9 ± 0.2</td>
<td>0.02</td>
</tr>
<tr>
<td>Post-race</td>
<td>1.5 ± 0.2*</td>
<td>1.6 ± 0.3*</td>
<td></td>
</tr>
</tbody>
</table>

*p < 0.05 compared with pre-race values
NAUSEA SEVERITY AND $\Delta$ sCD14

$r = 0.652$, $p = 0.005$
# INFLAMMATORY MARKERS: IL-6 AND CRP

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<tr>
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<th>With Nausea (n = 12)</th>
<th>Interaction Effect, p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IL-6 (pg/mL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-race</td>
<td>0.9 ± 0.4</td>
<td>1.0 ± 0.7</td>
<td>0.33</td>
</tr>
<tr>
<td>Post-race</td>
<td>105.7 ± 53.6*</td>
<td>78.6 ± 62.5*</td>
<td></td>
</tr>
<tr>
<td><strong>CRP (ng/mL)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-race</td>
<td>323 ± 487</td>
<td>1,686 ± 2,607</td>
<td>0.23</td>
</tr>
<tr>
<td>Post-race</td>
<td>31,448 ± 13,149*</td>
<td>46,361 ± 29,708*</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05 compared with pre-race values
CORE TEMPERATURE

Core Temperature (°C)

Without Nausea

With Nausea

Segment 1  Segment 2  Segment 3  Segment 4
BODY MASS CHANGE

Cumulative Body Mass Change (%)

-6 -5 -4 -3 -2 -1 0

Without Nausea
With Nausea
## OVERALL RACE DIET

<table>
<thead>
<tr>
<th>Variable</th>
<th>Without Nausea (n = 8)</th>
<th>With Nausea (n = 12)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Rate, kcal/kg/h</td>
<td>3.2 ± 1.3</td>
<td>2.6 ± 1.1</td>
<td>0.21</td>
</tr>
<tr>
<td>Proportion as Carbohydrate, %</td>
<td>80.6 ± 7.9</td>
<td>83.2 ± 10.0</td>
<td>0.54</td>
</tr>
<tr>
<td>Carbohydrate Rate, g/kg/h</td>
<td>0.7 ± 0.3</td>
<td>0.6 ± 0.2</td>
<td>0.36</td>
</tr>
<tr>
<td>Proportion as Fat, %</td>
<td>13.5 ± 5.9</td>
<td>11.7 ± 7.3</td>
<td>0.56</td>
</tr>
<tr>
<td>Fat Rate, g/kg/h</td>
<td>0.05 ± 0.02</td>
<td>0.03 ± 0.03</td>
<td>0.30</td>
</tr>
<tr>
<td>Proportion as Protein,%</td>
<td>5.9 ± 3.5</td>
<td>5.1 ± 3.0</td>
<td>0.60</td>
</tr>
<tr>
<td>Protein Rate, g/kg/h</td>
<td>0.05 ± 0.03</td>
<td>0.03 ± 0.02</td>
<td>0.22</td>
</tr>
<tr>
<td>Fluid Rate, ml/kg/h</td>
<td>7.33 ± 1.86</td>
<td>6.58 ± 2.20</td>
<td>0.44</td>
</tr>
</tbody>
</table>
SUMMARY

- GI symptoms experienced by most runners (80%)
- Nausea most common (60%)
- Runners with nausea had greater endotoxemia
- Significant positive correlation between nausea severity and endotoxemia
- Inflammatory response, core temperature, hydration level and nutrition similar between runners with and without nausea
CONCLUSION

• Endotoxemia linked to nausea in ultramarathon runners

• Other possible contributing factors (hyperthermia, dehydration, nutrition) did not appear to play a role in nausea
THANK YOU