Asian J Sports Med. 2018 March; 9(1):e60900. doi: 10.5812/asjsm.60900.

Published online 2018 February 27. Research Article

Gastrointestinal Bleeding Following a 161-Km Cycling Race in the Heat: A Pilot Study

J D Adams,[1] Stavros A Kavouras,[1,2,*] Evan C Johnson,[3] Matthew S Ganio,[4] Michelle Gray,[4] Brendon P McDermott,[4] Amy L McKenzie,[5] Elaine C Lee,[5] and Lawrence E Armstrong[5]

[1]Hydration Science Laboratory, University of Arkansas, Fayetteville, Arkansas, USA
[2]Division of Endocrinology, University of Arkansas for Medical Sciences, Little Rock, Arkansas, USA
[3]Human Integrated Physiology Laboratory, University of Wyoming, Laramie, Wyoming, USA
[4]Center for Exercise Science Research, University of Arkansas, Fayetteville, Arkansas, USA
[5]Human Performance Laboratory, University of Connecticut, Storrs, Connecticut, USA

[*]*Corresponding author*: Stavros A Kavouras, PhD, FACSM, FECSS, Hydration Science Lab, Department of Health, Human Performance and Recreation, Fayetteville, Arkansas, USA. Tel: +1-4795756762, Fax: +1-4795755778, E-mail: kavouras@uark.edu

Received 2017 March 02; **Revised** 2017 August 26; **Accepted** 2017 October 06.

Abstract

Background: Occult (i.e., non-visible) gastrointestinal (GI) bleeding is a well-recognized complication that can occur during vigorous endurance physical exertion, especially in the heat.

Objectives: The purpose of this study was to investigate the incidence of GI bleeding during a non-impact (cycling) prolonged race (161-km) in the heat.

Methods: Twenty-five experienced cyclists (21 males and 4 females, 49 ± 9 y, 83.7 ± 14.8 kg) were completed a summer 161-km cycling event. Following the race, participants were given a fecal occult blood test and were instructed to retrieve their first bowel movement.

Results: Mean race dry air and wet bulb globe temperature (WBGT) were 36.0 ± 5.2°C, and 31.8 ± 3.6°C, respectively. Of the 25 subjects, two (8%) produced positive results for fecal occult blood while an additional two (16%) experienced constipation, hard stools, diarrhea or vomiting.

Conclusions: These data showed a low incidence of GI complaints and occult bleeding during a prolonged cycling event in the heat, indicating the low-impact exercise such as cycling may lessen some of the occult GI bleeding previously reported in distance running in the heat.

Keywords: Body Temperature Regulation, Thermoregulation, Occult Blood, Anemia, Endurance Exercise

1. Background

Occult (i.e., non-visible) gastrointestinal (GI) bleeding is a well-recognized complication that can occur during vigorous endurance physical exertion, such as running in marathons and ultra-marathons (1). Some of the proposed causes of GI bleeding and distress during exercise are ischemic damage, carbohydrate ingestion, environmental and ergogenic heat stress, high, and most notably, high-impact exercise (i.e., running, hiking) (2).

Ischemic damage has been proposed as a causal mechanism of GI bleeding during and after exercise (3). During high intensity exercise, blood flow to the gut is reduced as much as 80%. Transient post-exercise lesions from the stomach to the colon have been observed in athletes and the histological picture indicates ischemic damage (4). Critical ischemic levels may also be reached under extreme exercise conditions when hyperthermia, hypohydration, hypoglycemia, or a combination of these factors are present (3).

This decreased blood flow and intestinal absorption can also cause excessive strain on the GI tract when ingesting highly concentrated carbohydrate (CHO) during long endurance events, such as ultra-marathons (5). These concentrated CHO sources can delay gastric emptying, resulting in nausea and vomiting, and can cause fluid shifts into the intestines, resulting in abdominal cramping and diarrhea (6). However, even low CHO consumption may result in hypoglycemia and nausea, causing GI distress (7). Further, heat stress, independent of exercise, has been shown to increase the risk of GI distress, specifically inflammatory bowel disease (IBD) and infectious gastroenteritis (8). This can be due to the increased physical stress and elevated environmental bacterial growth that are associated with elevated ambient temperatures.

Lastly, red blood cell hemolysis has been suggested as one of the main causes of GI bleeding during exercise (9). Conventionally known as "foot-strike" hemolysis, whereby the repeated and forceful impact of the feet with the ground is thought to cause direct injury to the erythrocytes within the capillaries. As a result, the hemoglobin and associated iron held within the red blood cells are released into the surrounding plasma. The effective contribution of this mechanism to sports anemia, thus attributing to GI bleeding, has been the object of several studies (10, 11).

Although the mechanical impact of exercise during running has been suggested as one of the factors that affects GI bleeding, there have been no studies examining the effect of non-impact exercise, such as cycling, on GI bleeding.

2. Objectives

The aim of this pilot study was to investigate the incidence of GI bleeding during a non-impact (cycling) prolonged race (161-km) in the heat. We hypothesized that the prevalence of occult GI bleeding would be minimal during the prolonged race due to the low impact nature of cycling.

3. Methods

Fifty experienced cyclist were recruited prior to a 161-km road cycling event (Hotter 'n Hell Hundred; Wichita Falls, TX), however twenty-five (21 males and 4 females; 49 $\pm$ 9 y; 1.77 $\pm$ 0.07 m; 83.7 $\pm$ 14.8 kg) completed the race and provided post-exercise sample. Inclusion criteria for participation were: a, age of 21-65 y; b, successful completion of a previous 161-km road cycling event; c, no history of hemorrhoids, and d) absence of menses at the time of the race for the females. Subjects were recruited at a booth set-up at the Exposition Hall during the 2 days prior to the event start, as well as through paper and email flyers sent out prior to the event. Prior to the study, all participants signed informed consent, which conformed to the guidelines contained in the 1975 Declaration of Helsinki, and the study was approved by the both the University of Arkansas' and University of Connecticut's institutional review boards.

The Hotter n' Hell Hundred is a 161-km road cycling event over flat, rolling hills terrain. Throughout the course, there are aid stations, with the biggest aid station at the 96-km mark. Aid stations have medical staff, restrooms, and a wide assortment of food (i.e., fruits, gels, and snacks) and fluids. Each volunteer completed a medical history questionnaire and was briefed on the proper sample collection for the fecal occult blood test (FOBT; Beckman Coulter™ Hemoccult™ ICT). The FOBT was specifically intended for measuring lower GI bleeding and the ingestion of food or pharmaceuticals during the race would not have had an effect on the test result (10). Percent dehydration was calculated from differences in body mass pre-and post-event measurements. Dietary intake records were produced from participant recall at pre-arranged stops along the course and upon completion. Macronutrient calculations were completed with the use of Nutritionist Pro dietary analysis software (version 1.2; Nutritionist Pro, N-Squared Computing, Salem, OR).

Following the event, participants were reminded that upon their next bowel movement to retrieve two samples from two different sections of the stool and apply them to the collection card with a provided spatula. All fecal samples were analyzed in the laboratory within seven days of collection in accordance with manufacturer's instructions. One week following the race, participants were asked via e-mail or phone the following questions: 1, "Did you experience any GI problems in the week after the event?" 2, "Were you sick following the event?" 3, "Did you experience any fever in the days after the event?" Means and standard deviations are displayed below for all independent variables, however, due to the low incidence of GI bleeding, statistical comparisons between groups were not possible.

4. Results

Of the 25 cyclists who completed the study, two tested positive for fecal occult blood and GI distress. Two additional cyclists experienced either constipation, hard stools, diarrhea or vomiting within 24 hours following the race. During the race, average dry air temperature was 36.0 $\pm$ 5.2°C with a range of 25.1 - 43.7°C. Average wet bulb globe temperature (WBGT) collected throughout the race period was 31.8 $\pm$ 3.6°C. Environmental conditions (wet bulb globe temperature, dry bulb temperature, and relative humidity) were recorded every hour (Kestrel 4400, Kestrel Meters, Birmingham, MI) at the 96-km aid station.

All participants completed the entire event in an average time of 6.6 $\pm$ 1.2 hours. Average finishing time for those that experienced GI bleeding was 5.8 $\pm$ 1.1 hours with an average speed of 27.7 km/h, while those that did not experience GI bleeding finished in 6.7 $\pm$ 1.1 hours with average speed of 24.7 km/h, respectively. Calculation of relative intensity as metabolic equivalent task (MET) revealed both groups rode at approximately 12 METs (12). Body mass losses were similar between those who experienced GI bleeding versus those who did not (-1.7 $\pm$ 0.8% vs. -2.0

Table 1. Overall Race Diet in Cyclists with and Without Gastrointestinal (GI) Bleeding[a]

Variable	Without GI Bleeding	With GI Bleeding
Energy, kcal.kg^{-1}.h^{-1}	2.4 ± 1.1	2.6 ± 0.9
Carbohydrate, %	83.6 ± 13.6	90.4 ± 2.9
Carbohydrate, g.kg^{-1}.h^{-1}	0.5 ± 0.2	0.6 ± 0.2
Fat, %	11.9 ± 10.9	7.6 ± 2.3
Fat, g.kg^{-1}.h^{-1}	0.03 ± 0.04	0.02 ± 0.01
Protein, %	7.3 ± 4.6	3.9 ± 1.5
Protein, g.kg^{-1}.h^{-1}	0.04 ± 0.03	0.03 ± 0.02

[a]Values are expressed as mean ± SD.

± 1.5%). In the present study, riders without GI bleeding consumed diets of similar caloric content, macronutrient composition, and rate of macronutrient consumption (Table 1).

5. Discussion

The purpose of this study was to observe the incidence of GI bleeding during a 161-km cycling event in the heat. To our knowledge, this is one of the first studies to observe occult GI bleeding during a non-impact activity, such as cycling. Previous studies have found that a higher impact activity, such as marathon or ultra-marathon running, has an incidence rate between 13% - 85% (1, 13, 14). These incidence rates are much higher compared to the 8% (2 out of 25) incidence observed in the current investigation.

Previous research has observed elevated ambient conditions may lead to a high incidence of GI bleeding via elevated core temperature and injury to the epithelium (8). Despite elevated environmental temperatures during this cycling event, the incidence of GI bleeding was low. Exercise intensity has also been listed as a contributing factor to GI bleeding, via bowel ischemia (3). If this was a factor in the present study, exercise intensity (i.e., finishing time) would have been different between those that experienced GI bleeding and those that didn't. When relative intensity was calculated with METs, the exercise intensities were similar between those that experienced GI bleeding and those that did not. Lastly, these MET values are similar to studies where runners experienced GI bleeding during marathons with metabolic demands of 11 - 14 METs (13, 14).

It has been suggested that some foods can delay gastric emptying, (i.e., highly concentrated CHO solutions), by osmotically driving fluids into the intestinal lumen, thereby causing GI disturbances. In this study, the CHO intake is similar between those that experienced GI bleeding and those that did not (Table 1), thereby possibly ruling out macronutrient intake as a cause. This CHO intake was also consistent with CHO intake normally shown by runners (5).

These findings are subject to several limitations. First, the sample size of the participants was not large enough to claim that the low incidence of GI bleeding was caused by the low impact nature of the cycling event. Second, there was no control group to compare the participants to, such as a group that did an impact exercise (i.e., running). Another limitation could be related to the absence of baseline FOBT test to exclude any other condition that could be associated with hemoglobin presence in the stools. Even though subjects with history of hemorrhoids were excluded from the study, it is possible that some subjects might have undiagnosed internal hemorrhoids. In that case, even if one of the two subjects with positive FOBT had undiagnosed internal hemorrhoids, the incidence of GI bleeding would have been even lower and the conclusion of the present study would not have changed.

In conclusion, the data in this observational pilot study provided some preliminary indication that a relatively low incidence of GI complaints and occult bleeding can occur during prolonged cycling event even in the heat. Despite elevated temperatures, high intensities, and high-CHO intake, this low incidence was probably associated with the low-impact nature of cycling. Future studies should investigate GI bleeding in a direct comparison of low-impact exercise (i.e., cycling) to a high-impact exercise (i.e., running) of the same distances.

Acknowledgments

We thank the participants who volunteered for the study. We also thank Ashley Binns, Nicole Moyen, Dr. Keith Williamson, and all other medical and volunteered staff associated with the Hotter N' Hell race.

Footnotes

Authors' Contribution: Author J D Adams participated in protocol planning, data collection, sample analysis, data analysis, and was the primary author of the manuscript. Author Stavros A Kavouras initiated the research question, participated in protocol planning, data collection, sample analysis, data analysis, and manuscript revision and approval. Authors Matthew S Ganio, Michelle Gray, Brendon P McDermott, Elaine C Lee, and Lawrence E Armstrong participated in protocol planning, data collection, and manuscript revisions and approval. Authors Evan C Johnson and Amy L McKenzie participated in protocol planning, crafting of consent and review documents, subject recruitment, data collection, and manuscript revisions and approval.

Financial Disclosure: The authors state no conflict of interest or financial involvement related to the material in the manuscript.

Funding/Support: The authors of this study declare that they have no conflicts of interest in terms of support for this study.

References

1. Thalmann M, Sodeck GH, Kavouras S, Matalas A, Skenderi K, Yannikouris N, et al. Proton pump inhibition prevents gastrointestinal bleeding in ultramarathon runners: a randomised, double blinded, placebo controlled study. *Br J Sports Med*. 2006;**40**(4):359–62. discussion 362. doi: 10.1136/bjsm.2005.024463. [PubMed: 16556794].
2. Moses FM. The effect of exercise on the gastrointestinal tract. *Sports Med*. 1990;**9**(3):159–72. doi: 10.2165/00007256-199009030-00004. [PubMed: 2180030].
3. Brouns F, Beckers E. Is the gut an athletic organ? Digestion, absorption and exercise. *Sports Med*. 1993;**15**(4):242–57. doi: 10.2165/00007256-199315040-00003. [PubMed: 8460288].
4. Gisolfi CV. Is the GI System Built For Exercise?. *News Physiol Sci*. 2000;**15**:114–9. doi: 10.1152/physiologyonline.2000.15.3.114. [PubMed: 11390892].
5. Stuempfle KJ, Hoffman MD, Hew-Butler T. Association of gastrointestinal distress in ultramarathoners with race diet. *Int J Sport Nutr Exerc Metab*. 2013;**23**(2):103–9. doi: 10.1123/ijsnem.23.2.103. [PubMed: 23006626].
6. de Oliveira EP, Burini RC. The impact of physical exercise on the gastrointestinal tract. *Curr Opin Clin Nutr Metab Care*. 2009;**12**(5):533–8. doi: 10.1097/MCO.0b013e32832e6776. [PubMed: 19535976].
7. Pfeiffer B, Stellingwerff T, Hodgson AB, Randell R, Pottgen K, Res P, et al. Nutritional intake and gastrointestinal problems during competitive endurance events. *Med Sci Sports Exerc*. 2012;**44**(2):344–51. doi: 10.1249/MSS.0b013e31822dc809. [PubMed: 21775906].
8. Manser CN, Paul M, Rogler G, Held L, Frei T. Heat waves, incidence of infectious gastroenteritis, and relapse rates of inflammatory bowel disease: a retrospective controlled observational study. *Am J Gastroenterol*. 2013;**108**(9):1480–5. doi: 10.1038/ajg.2013.186. [PubMed: 23939628].
9. Lippi G, Schena F, Salvagno GL, Aloe R, Banfi G, Guidi GC. Foot-strike haemolysis after a 60-km ultramarathon. *Blood Transfus*. 2012;**10**(3):377–83. doi: 10.2450/2012.0167-11. [PubMed: 22682343].
10. Rudzki SJ, Hazard H, Collinson D. Gastrointestinal blood loss in triathletes: it's etiology and relationship to sports anaemia. *Aust J Sci Med Sport*. 1995;**27**(1):3–8. [PubMed: 7780774].
11. Stewart JG, Ahlquist DA, McGill DB, Ilstrup DM, Schwartz S, Owen RA. Gastrointestinal blood loss and anemia in runners. *Ann Intern Med*. 1984;**100**(6):843–5. doi: 10.7326/0003-4819-100-6-843. [PubMed: 6609656].
12. Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DJ, Tudor-Locke C, et al. 2011 Compendium of Physical Activities: a second update of codes and MET values. *Med Sci Sports Exerc*. 2011;**43**(8):1575–81. doi: 10.1249/MSS.0b013e31821ece12. [PubMed: 21681120].
13. Halvorsen FA, Lyng J, Ritland S. Gastrointestinal bleeding in marathon runners. *Scand J Gastroenterol*. 1986;**21**(4):493–7. doi: 10.3109/00365528609015168. [PubMed: 3487825].
14. McCabe M3, Peura DA, Kadakia SC, Bocek Z, Johnson LF. Gastrointestinal blood loss associated with running a marathon. *Dig Dis Sci*. 1986;**31**(11):1229–32. doi: 10.1007/BF01296525. [PubMed: 3490362].