

GASTROINTESTINAL FUNCTION IN ATHLETES



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OVERVIEW

- Gastrointestinal Function
- Exercise-Induced GI Distress
- Nutritional Strategies to Reduce GI Issues
- All-Day Dietary Strategies to Reduce GI issues



GASTROINTESTINAL FUNCTION

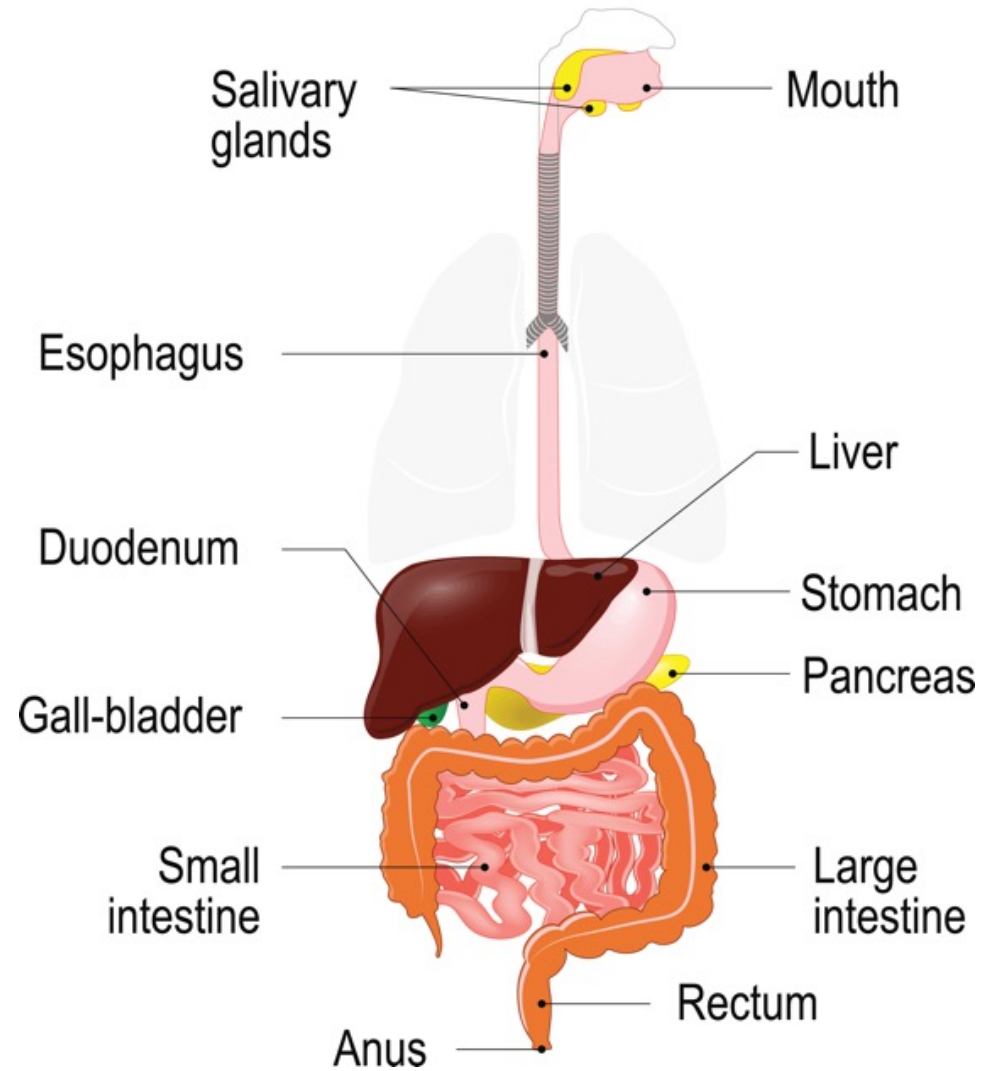
GASTROINTESTINAL HEALTH



The Gastrointestinal system is one of the gatekeepers to overall health:

- Energy and fluid intake and uptake
- Macronutrient digestion and absorption
- Micronutrient digestion and absorption
- Barrier to pathogens and bacteria
- Beneficial microbiota

NUTRIENT TRANSPORT



Digestion – Throughout the GI tract

Mechanical

Physical movement to make food smaller:

- Chewing
- Peristaltic contractions

Chemical/Enzymatic

Chemical reactions to make food smaller:

- Enzymes specific to certain macronutrients (e.g. salivary and pancreatic amylase to digest starches).
- Changes in pH at various points in digestion activates enzymes (e.g. gastric acid release in stomach converts inactive Pepsinogen to active enzyme Pepsin).

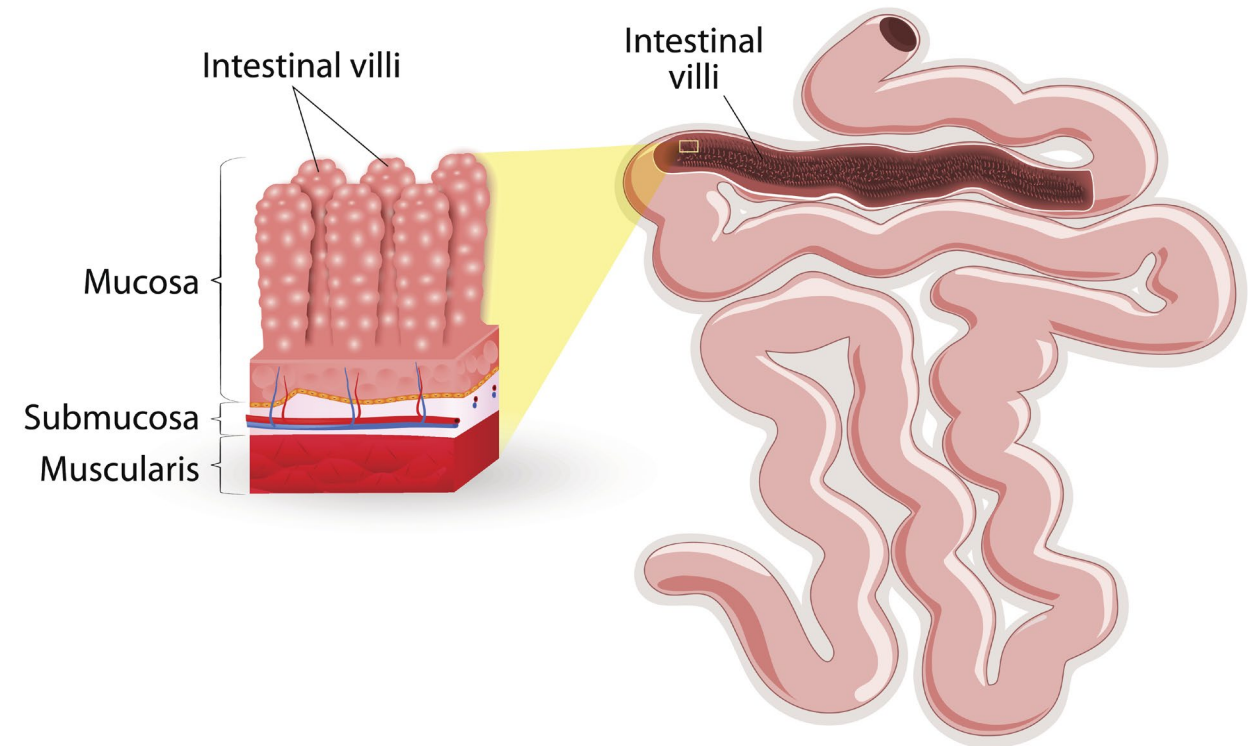
ABSORPTION: SMALL INETESTINE

Principal function is to breakdown food and absorb fluid, macro- and micronutrients.

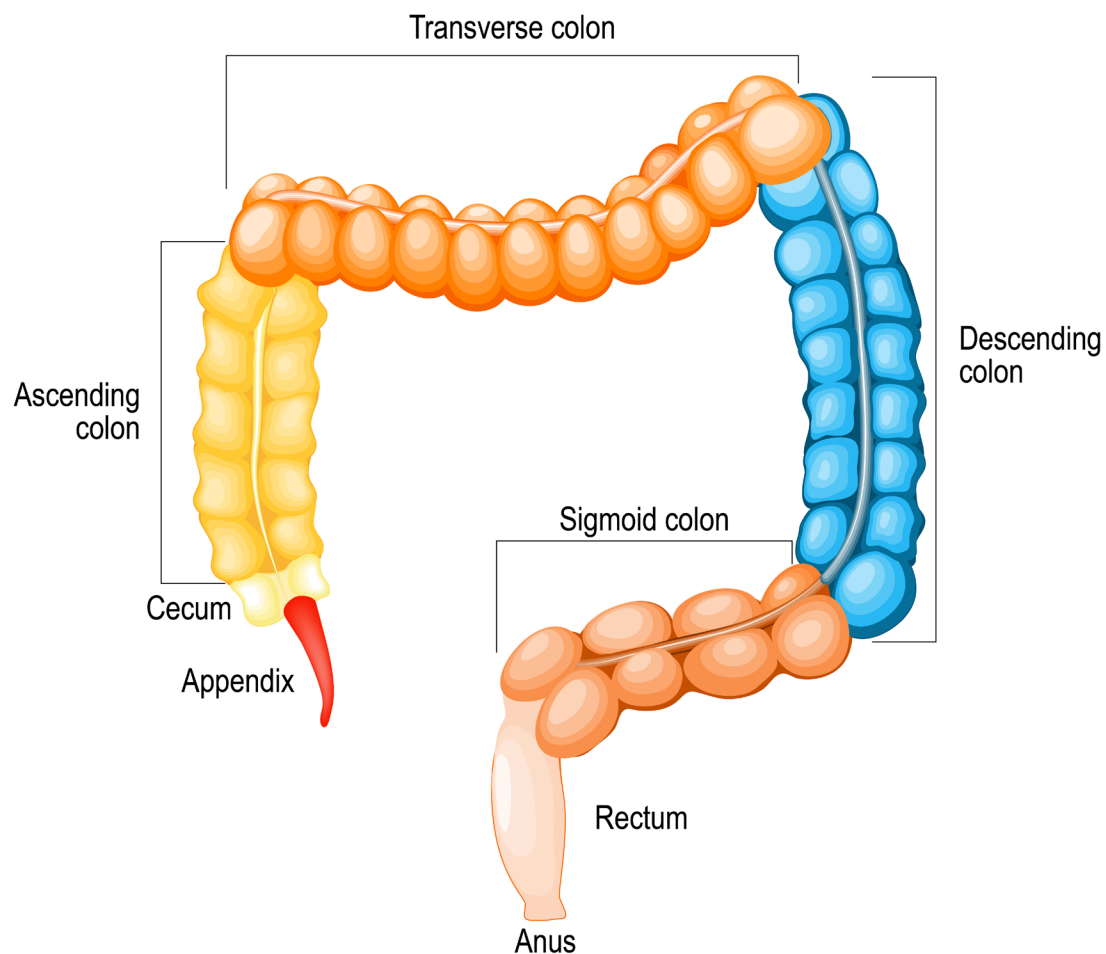
Fingerlike projections called villi, covered with microvilli, increase the surface area of the small intestine to facilitate absorption of nutrients.

Moves non-digestible or non-absorbed components through to the large intestine.

Parts: Duodenum, Jejunum, Ileum



ABSORPTION: LARGE INTESTINE



Principle functions are to absorb water and electrolytes, produce and absorb certain vitamins, and form feces to be excreted.

Parts: Cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anus.

GUT MICROBIOTA: BACTERIA IN THE INTESTINES

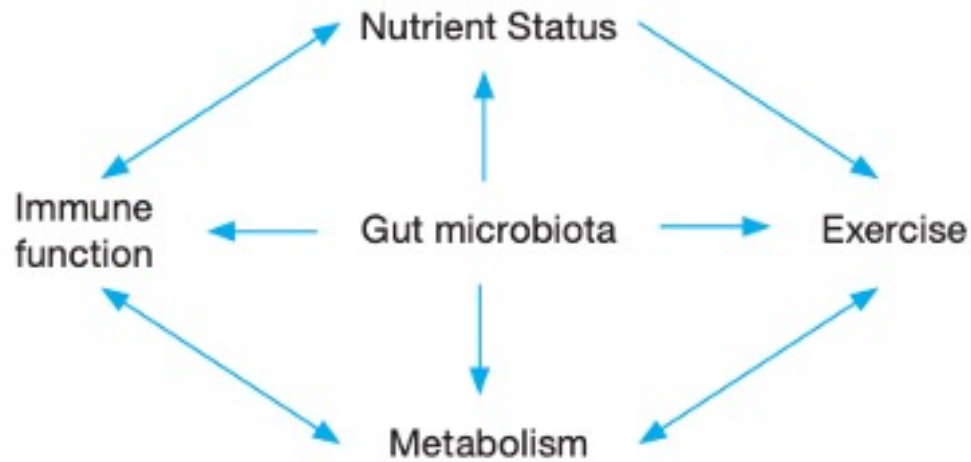


Figure 1. A schematic of the way that the gut microbiota may contribute to sporting performance. The microbiota exerts strong influence over the immune system, which in turn is also dependent on nutrient status and metabolism, to reduce the risk of infection. Specific microbial species produce short chain fatty acids that act as fuel for colonocytes along with other nutrients that exert an anti-inflammatory influence on immune system and energy for exercise. Digestion of starches and the liberation of energy via the microbiota may impact on metabolism and subsequent energy for exercise. The response of the microbiota to dietary macronutrients further suggests that changes in the composition of microbial species to high protein or high carbohydrate diets may have direct implications for exercise metabolism.

Gut health and immune function are central to preventing illnesses that negatively impact performance.

Recent evidence suggests that gut health and immune function may play a role in promoting adaptation to exercise.

Gut bacteria, or the microbiota, perform several vital functions, including regulating immune activity, modulating metabolic activity, producing short chain fatty acids, and protecting against intestinal infection.

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DIET, GUT HEALTH & IMMUNE FUNCTION

- Dietary manipulation may enhance gut bacteria composition and metabolic activity and promote optimum immune function.
- **Probiotics** have been a primary focus of research into nutritional modulation gut bacteria, with some studies showing that supplementation reduces gastrointestinal and upper respiratory symptoms.
- Dosages in commercial applications are consistent with the dosage used in research trials. Consuming greater amounts than recommended should be approached with caution and trialed before travel and competition.
- Dietary modification should be addressed to improve gut health and immune function before supplementation is considered, particularly in relation to increasing the diversity of the microbiota with dietary fibers.
- Sports dietitians can work with their athletes to modify their diet and determine whether supplements, such as probiotics and prebiotics, may be useful during prolonged exercise, periods of heavy training, and during competition and travel.



DIETARY ALLERGIES

A **food allergy** is when an individual has an **abnormal immune response** to specific proteins found in foods.

This allergic reaction can range from mild to severe depending on the individual:

Mild: rashes, hives, itching, swelling

Severe: trouble breathing, wheezing, loss of consciousness – potentially life threatening

Dietary allergens cause inflammation in the digestive tract which can impact permeability, allowing in larger molecules rather than acting as a barrier.

DIETARY INTOLERANCES

Food intolerances (or sensitivity) occur when a person has difficulty digesting a particular food.

Impact up to 20% of the population.

Symptoms

Gastrointestinal

Abdominal distention & pain

Gas

Diarrhea

Related to increased osmotic activity & fermentation of nutrients

Extra-Intestinal

Anemia

Dermatitis

Headaches/Migraines

Joint or Muscle Pain

Related to poor absorption of nutrients

DIETARY INTOLERANCES

Common Food Intolerances

- FODMAPs
- Wheat
- Histamines
- Enzyme deficiency (e.g. lactase or sucrase-isomaltase deficiency)
- Caffeine
- Sulfites
- Food additives or coloring



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EXERCISE INDUCED GI DISTRESS

GASTROINTESTINAL ISSUES DURING EXERCISE

UPPER ABDOMINAL SYMPTOMS	LOWER ABDOMINAL SYMPTOMS
Reflux/heartburn	Intestinal/lower abdominal cramps
Belching	Side ache/stitch
Bloating	Flatulence
Stomach pain/cramps	Urge to defecate (urgency)
Vomiting	Diarrhea
Nausea	Intestinal bleeding



GASTROINTESTINAL ISSUES DURING EXERCISE

- GI problems are very common, especially in endurance athletes, and often impair performance or subsequent recovery.
- Three main causes of GI symptoms: **physiological** (reduced blood flow to the gut), **mechanical** (bouncing effect of running, for example) or **nutritional**.
- The information that is available suggests that gut permeability can be compromised in athletes; however, this has not yet been linked conclusively to GI symptoms.
- GI symptoms among athletes vary enormously, and some athletes are more prone than others.
- Avoiding NSAIDs, protein, fat, fiber and milk products can reduce the risk of developing GI symptoms during exercise.



GI TRACT DURING EXERCISE

Blood Flow to the GI Tract During Exercise



During moderate to high-intensity activity blood flow is redistributed away from the GI tract in order to supply oxygen and other nutrients to the working muscles and facilitate heat loss.



Gastric emptying and overall transit time of food/beverages moving through the GI tract may be delayed due to increased activity of the neuroendocrine-gastrointestinal pathway and elevated sympathetic nervous system activation.



NUTRITIONAL STRATEGIES TO REDUCE GI ISSUES

TIMING OF NUTRIENT INTAKE

Timing of Nutrient Intake – Pre-Exercise

- Rule out dietary sources of inflammation.
- If athlete has a history of GI upset, the pre-training meal can be moved further from the start time of exercise but shouldn't be avoided entirely:
 - Limit fat, fiber and protein the closer to exercise the athlete is
 - Avoid NSAIDs prior to and during exercise
 - Monitor if caffeine intake impacts GI upset
 - Find the amount of carbohydrate and timing that works best for the athlete
- Is there a psychological component? Does the athlete only experience symptoms on competition days?

TIMING OF NUTRIENT INTAKE

Timing of Nutrient Intake – During Exercise

- Evaluate current intake habits to identify what nutrients the athlete is currently taking in – this may be a contributing factor:
 - Products with protein, fat and fiber may contribute to GI issues by slowing digestion and absorption.
 - High volumes of carbohydrate may be overwhelming transport mechanisms in the intestines, causing backup in the small intestine and shifts in fluid.
 - Is the athlete taking in large boluses of fluid vs spacing throughout training and competition?
- What fueling opportunities does the athlete have? Can volume taken in be spaced across each hour vs. one large bolus per hour?
- Is there a psychological component? Does the athlete only experience symptoms on competition days?

Fluid Replacement During Exercise

Gastric emptying

- Emptying contents of the stomach into the small intestine.
- Liquids empty faster than solids.
- Solutions with low energy density empty faster than those of high energy density.
- Higher gastric volume supports faster gastric emptying.
- Hypohydration of >3% slows gastric emptying.

Intestinal absorption

- Absorption of fluid occurs primarily in the duodenum and jejunum.
- Solutions with higher energy density are absorbed slower than those with lower energy density.
- Water is absorbed through passive diffusion as well as active (sodium dependent) transport.
- Water follows the solute load, if the solute load is greater in the GI tract, fluid will be pulled into the GI tract vs. transported across the intestinal membrane.

CARBOHYDRATE INTAKE

Carbohydrate intake – gastric emptying

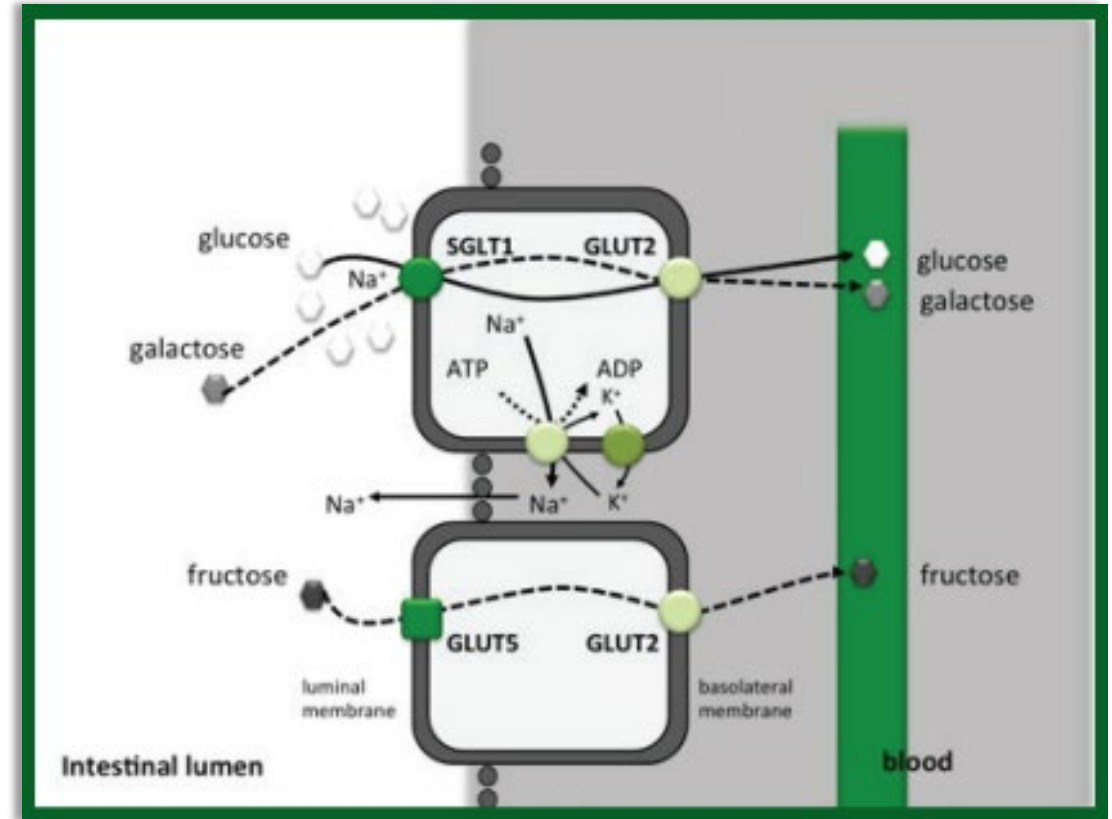
- Carbohydrate within a food or beverage contributes to the energy density and/or osmolality of a product.
- Products with higher osmolality and energy density empty from the stomach at a slower rate than those that are lower osmolality.
- Carbohydrate intake is recommended for exercise lasting >1 hour, so should be included in a fueling plan.
- Relatively dilute carbohydrate solutions (up to 6% or 60 g/L) are emptied from the stomach at a similar rate to an equal volume of water.

CARBOHYDRATE INTAKE

Carbohydrate – Intestinal Absorption

Less GI distress has been found in most studies with multiple transportable carbohydrates compared to an isoenergetic amount of a single carbohydrate source.

Multiple Transportable Carbohydrates = consuming both glucose and fructose to take advantage of both transporters in the intestine.



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The Stomach is an Organ and a Muscle. You Can Train It.

The GI tract plays a critical role in delivering carbohydrate and fluid to the blood during exercise, so can be a determinant of performance.

GI problems are common in endurance athletes and might be prevented by adapting the gut during training.

The GI tract, and the transport proteins within it, adapt with changes in diet in a nutrient-specific way.

“Nutritional Training” can improve gastric emptying and absorption, and likely reduce the chances and/or severity of GI problems, thereby improving endurance performance and providing a better experience for the athlete.

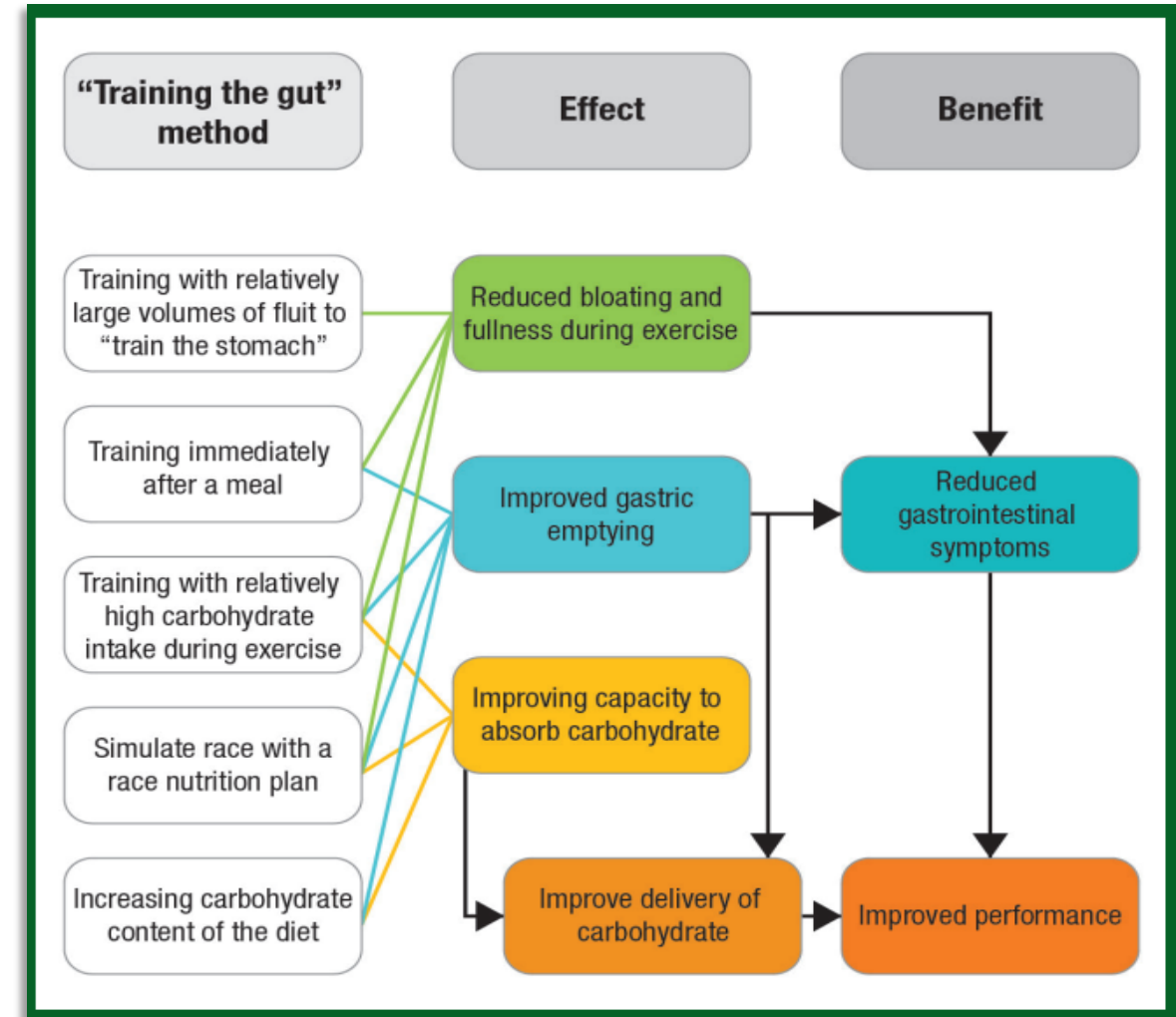
When starting “Nutritional Training, make changes slowly to avoid GI upset.



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A summary of methods to “Train the Gut”, the adaptations that may occur in the gut, and implications for performance.



OTHER NUTRIENTS & GI ISSUES

Avoid delaying gastric emptying and intestinal absorption:

- Protein is not a preferred source of fuel during exercise and should be limited.
- Fat stores are adequate to provide fat as a fuel during low to moderate exercise, there is no need for additional fat intake.
- Fiber can slow gastric emptying and ultimately absorption of carbohydrate.



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ALL-DAY DIETARY STRATEGIES TO REDUCE GI ISSUES



DIETARY STRATEGIES

Dairy or Lactose-Free Diet

Beneficial for those with intolerances or allergies to dairy and/or lactose.

While avoidance of these foods may help reduce incidence of GI issues, it is still important to know the difference between an allergy and an intolerance.

Dairy or Lactose-Free Diet

Lactose intolerance

- Inability to digest the carbohydrate lactose due to inadequate production of the digestive enzyme lactase.
- May be able to tolerate milk, whey and casein protein isolates due to the removal of lactose during the production/processing of the protein product.

Dairy Allergy

- Allergic response to a protein found in milk protein – whey or casein.
- Symptoms can range from mild to severe depending upon the individual's immune response.

DIETARY STRATEGIES



Dairy or Lactose-Free Diet

Products or ingredients containing milk proteins and/or lactose

Milk

Cheese

Yogurt

Keifer

Butter

Cream sauces

Ice cream

Sour cream

Casein

Calcium caseinate*

Sodium caseinate*

Whey

Lactalbumin

Lactose

Lactulose



DIETARY STRATEGIES

Dairy-Free Sources of Calcium & Vitamin D

Calcium	Canned salmon with bone, Chinese cabbage, bok choy, broccoli, kale, TVP, calcium set tofu, fortified soymilk, fortified orange juice, nuts, seeds and beans
Vitamin D	Cold water fatty fish, Vitamin D fortified cereals, margarine, plant-based milks

DIETARY STRATEGIES

GLUTEN-FREE DIET: A strict GFD eliminates all sources of gluten, a storage protein composite, with the alcohol-soluble gliadins defined as prolamins and the alcohol-insoluble glutenins as glutelins. There are several clinical conditions requiring a gluten-free diet. These include celiac disease, wheat allergy, gluten ataxia and non-celiac gluten sensitivity (Newberry et al., 2017; Vici et al., 2016).

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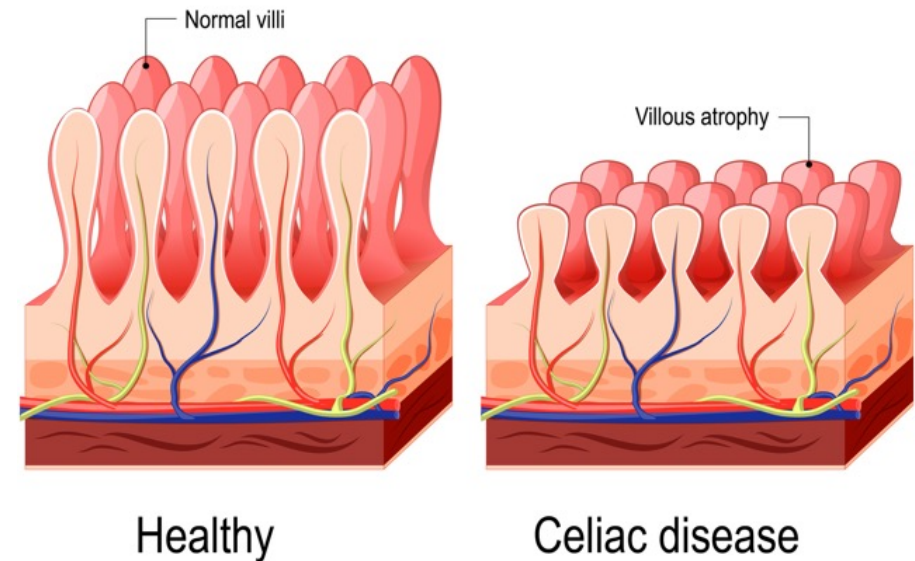
Gluten-Free Diet

Beneficial for those with Celiac disease or gluten sensitivity.

Celiac disease - immune response to eating foods containing the protein gluten.

- Symptoms: diarrhea, bloating, gas, fatigue, weight loss, iron-deficiency anemia, constipation.
- Long term exposure causes permanent damage to the villi of the small intestine occurs, reducing the surface area of the small intestine for absorption of nutrients.

Non-celiac gluten sensitivity – individuals may test negative for celiac or a wheat allergy but still experience symptoms.



Gluten-Free Diet: Beneficial for Non-Celiac Athletes?

- **No overall effect** of a short-term gluten-free diet in non-Celiac athletes.
- Adoption of this diet is largely driven by perception and not a medical diagnosis.
- Primary sources of information on a gluten-free diet are not medical professionals.

Gluten-Free Diet for Athletes: Potential Positive and Negative Effects

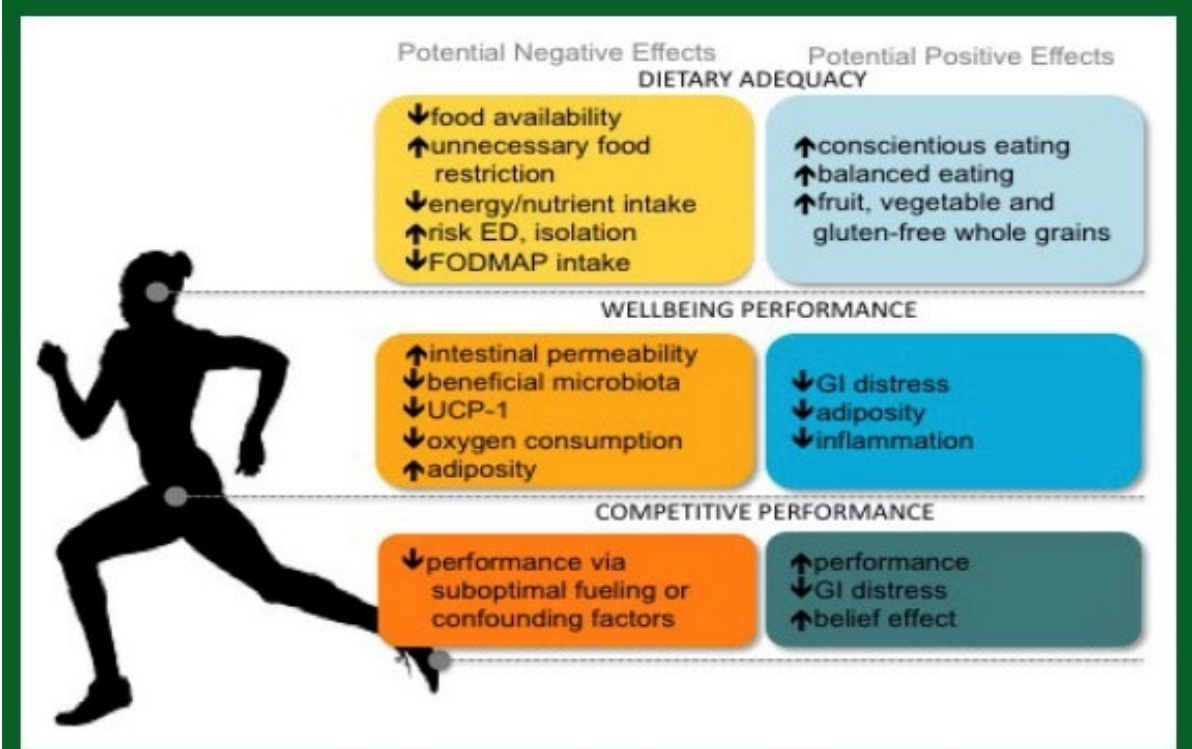


Figure 1. Schematic overview of the potential negative and positive effects/interactions of a gluten/gluten-free diet in athletic performance or health performance. ED, eating disorder; UCP-1, uncoupling protein; GI, gastrointestinal; FODMAP, Fermentable oligosaccharides, disaccharides, and monosaccharides and polyols; Isolation, athlete becomes or feels isolated. Figure redrawn with permission (Lis et al., 2016c).

DIETARY STRATEGIES

Developing a Gluten-Free Diet Plan

**Avoid
Wheat, Barley,
Rye**

**Watch
Hidden Sources,
Cross-
contamination**

**Include:
Fruits, starchy vegetables, rice,
dairy, cereals, oats*, gluten-
free alternatives**

FODMAP: Fermentable oligo-, di- and monosaccharides and polyols (FODMAPs) are short-chain carbohydrates that are variably absorbed in the small intestine. They are widespread in the diet and comprise a monosaccharide (fructose), a disaccharide (lactose), oligosaccharides (fructans and galactans) and polyols. FODMAPs are variably/poorly digested, increasing delivery of readily fermentable substrate and water to the distal small intestine and proximal colon, which are likely to induce luminal distension and induction of functional gut symptoms (Gibson & Shepherd, 2010).

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FODMAPs and Exercise

Strenuous exercise in conjunction with poorly or non-digested FODMAPs can exacerbate lower-GI symptoms during exercise, often resulting in bloating, lower abdominal pressure or pain, loose stools or diarrhea.

Focusing on a low FODMAP diet reduces the presence of these non-digested carbohydrates in the large intestine/colon, where bacteria ferment or breakdown the carbohydrate resulting in the above symptoms.

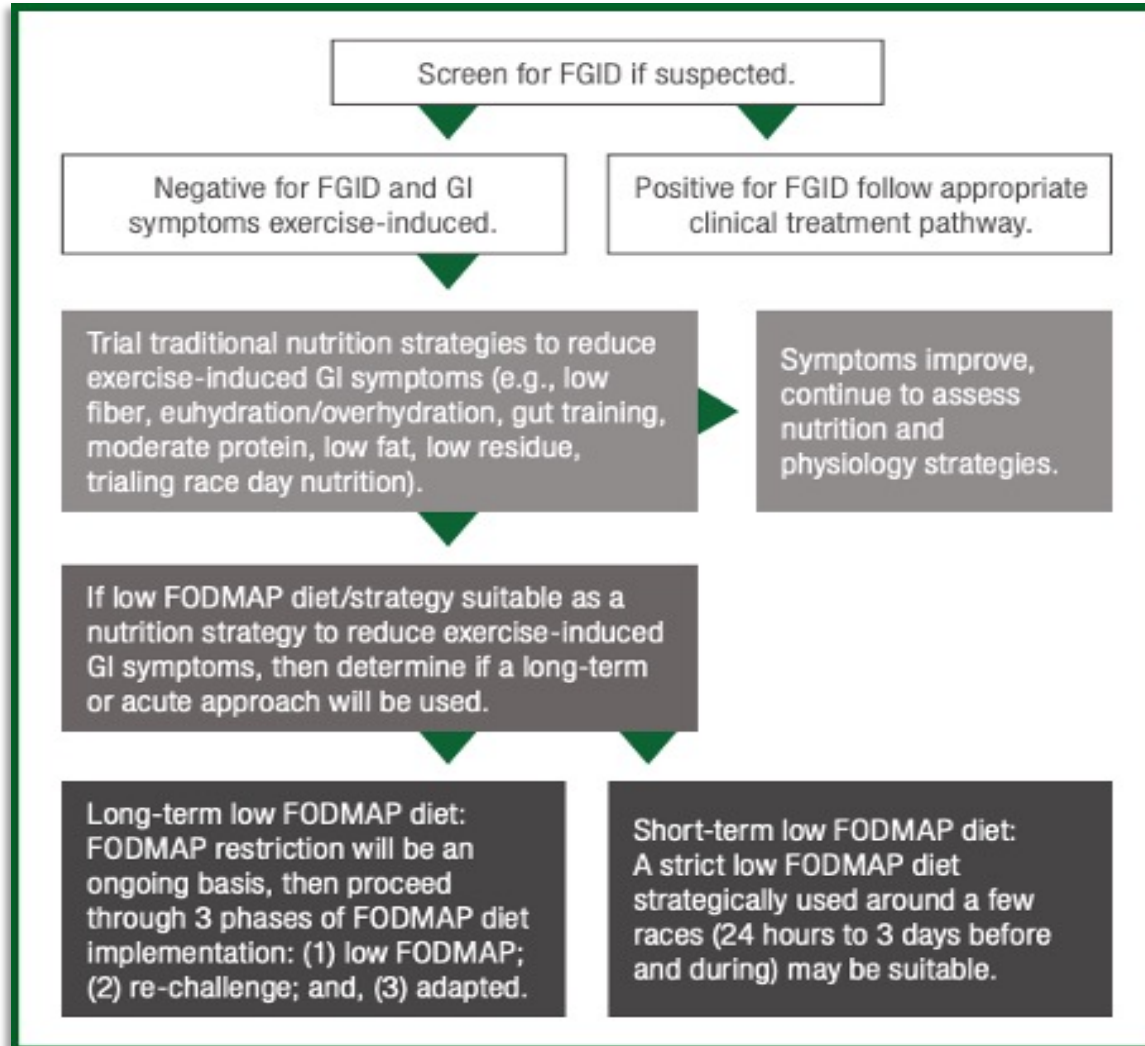
DIETARY STRATEGIES

FODMAP Categories	High FODMAP Foods	Low FODMAP Food Exchanges
High lactose	Yogurt, cow's milk	Lactose-free milk, soy milk (from soy protein)
Excess fructose	Apples, figs, watermelon, cherries, agave, honey, many fruit juices, beetroot juice with apple juice included/whole beetroot	Oranges, berries, banana, grapes, kiwi fruit, cantaloupe, strawberries, blueberries, raspberries, blended vegetable juice, canned or pickled beets
High fructans, galactooligosaccharides	Dates, cashews/pistachio nuts, breads/bagels, onions, wheat-based energy bars**	Gluten-free, spelt, special sourdough spelt breads, rice cakes, corn tortillas, wheat and/or gluten-free energy bars
High polyols	Protein bars and powders, some electrolyte tablets, sugar-free gum/candies	Protein bars with alternative sweeteners, limit intake of sugar-free gum/candies or choose sugar-containing brands

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DIETARY STRATEGIES



Proposed Decision Pathway for Use of a FODMAP Restriction Diet in Athletes for Management of Exercise-Induced GI Syndrome.



KEY TAKEAWAYS

- ✓ Gastrointestinal function, from intake to output, is important to overall health and well-being.
- ✓ Allergies and intolerances to specific foods can significantly impact GI health.
- ✓ During exercise, some athletes are more prone to GI upset than others.
- ✓ Three main causes of GI symptoms are physiological, mechanical or nutritional.
- ✓ Athletes can adapt training and fueling plans to address causes of GI symptoms before and during exercise.
- ✓ Overall dietary interventions to address potential dietary allergies or intolerances may help reduce GI symptoms throughout the day and during exercise; however, restriction of any food or food group should be strategic and athletes must ensure they are getting adequate macronutrient and micronutrient intake from other sources.



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