

# The Science of Fluid Absorption

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## Factors Influencing Fluid Absorption

### Key Points:

There are three main factors that affect absorption of fluids:

1. Volume of fluid: the more fluid ingested, the quicker one can rehydrate
2. Simple carbohydrates will increase the speed of fluid and electrolyte absorption
3. Osmolality, or concentration of particles (carbohydrates and electrolytes), will enhance fluid absorption rates

The concentration of fluids and ingredients found in fluids can have a large impact on how quickly energy is delivered to working muscles, affecting performance. There are three main areas of consideration with fluid replacement that affect the speed at which the body absorbs fluids:

### 1. *Volume of fluid*

The amount of fluid in the stomach at any time is directly proportional to the rate of gastric emptying, or how quickly fluids leave the stomach (very little fluids and nutrients, if any, are absorbed from the stomach).<sup>1</sup> This means that larger volumes of fluid in the stomach will “push” fluid out into the intestines, where it is then absorbed into the bloodstream. Consuming larger volumes of fluid will increase the rate of hydration.<sup>2</sup>

### 2. *Energy content*

Carbohydrates are the fuel of choice for energy replacement in sports beverages.<sup>3</sup> Glucose will enhance water and sodium absorption from the intestines into the bloodstream.<sup>4</sup> Carbohydrates in fluid replacement have two divergent effects in the digestive system. Initially, carbohydrates in fluids will slow gastric emptying; however, these same carbohydrate fluids will be rapidly absorbed in the small intestine.<sup>5,6</sup> There is a net gain in rate of overall uptake attributed to the small intestines that increases with the concentration of carbohydrate. Optimal carbohydrate concentrations of fluid replacement beverages are typically suggested to be 5% to 10% of volume.<sup>7</sup>

### 3. *Osmolality*

Osmolality is defined as the total concentration of solutes (dissolved particles including electrolytes and fuel sources) in a liquid medium. Similar to energy concentration, increasing osmolality will have a slight inhibitory effect on the rate at which fluids leave the stomach, but the overall increased rate of absorption in the small intestine (driven by the carbohydrate solutes in the beverage) offsets the delayed gastric emptying rate.<sup>8</sup> Overall, osmolality exerts little on the total fluid balance.

#### Other Factors Affecting Hydration

- Contrary to popular opinion, type of exercise has little effect on fluid absorption as long as the intensity between activities is the same
- Minimal exertion-type exercise does not affect fluid absorption
- Above 70% maximal exertion, fluid absorption may be slightly decreased
- Taste and temperature have no perceptible effect on fluid absorption, although they can affect the desire to drink and, consequently, the volume of fluid consumed, which is one of three major factors in the realm of hydration and energy delivery

The American College of Sports Medicine's position on fluid replacement suggests ingesting 30 to 60 grams of simple carbohydrates with electrolytes each hour, in liquid form for optimal energy and hydration replenishment.<sup>9</sup>

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<sup>1</sup> Karel, L. (1948). Gastric Absorption. *Physical Reviews*, 28(4), 433-450.

<sup>2</sup> Noakes, T. Rehrer, N. Maughan, R. (1991). The importance of volume in regulating gastric emptying. *Medicine of Science in Sports Exercise*. 23(3), 307-313.

<sup>3</sup> Von Duvillard, S. Braun, W. Markofski, M. Beneke, R. Leithauser, R. (2004). Fluids and hydration in prolonged endurance performance. *Nutrition*, 20(7-8), 651-656.

<sup>4</sup> Leiper, J. (1998). Intestinal water absorption--implications for the formulation of rehydration solutions. *International Journal of Sports Medicine*. 19(Suppl 2:S) 129-132.

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<sup>5</sup> Vist, G. Maughan, R. (1992). Gastric emptying of dilute glucose solutions in man. *Medicine Science Sports Exercise*, 24, S70.

<sup>6</sup> Hunt, J. Smith, J. Jiang, C. (1985). Effect of meal volume and energy density on the gastric emptying rate of carbohydrates. *Gastroenterology*, 89, 1326-1330.

<sup>7</sup> Burke, L. Read, R. (1993). Dietary supplements in sport. *Sports Medicine*, 15(1), 43-65.

<sup>8</sup> Vist, G. Maughan, R. (1995). The effect of osmolality and carbohydrate content on the rate of gastric emptying of liquids in man. *The Journal of Physiology*, 486(Pt 2), 523-531.

<sup>9</sup> Sawka, M. et al. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. *Medicine & Science in Sports & Exercise*, 39(2), 377-390.