

# The Influence of Hydration on *Endurance Exercise*

## Summary of Findings

- **Scientific Definitions:** Hypohydration is the steady-state condition of decreased total body water. Dehydration is the process of losing body water (eg, during exercise).
- Both the American College of Sports Medicine and the National Athletic Trainers Association recommend that minimizing fluid losses (<2% body mass loss) will assist in decreasing the endurance performance decrements associated with increasing levels of exercise-induced dehydration.<sup>1,2</sup>
- Previous studies have shown that when people are dehydrated to ~2% of their body mass and are asked to perform exercise, performance has been shown to be impaired between 7%<sup>3</sup> and 29%.<sup>4</sup>
- Factors that contribute to degradation of endurance performance during exercise while in a hypohydrated state are 1) increased cardiovascular strain, 2) increased heat strain, 3) altered central nervous system function, and 4) altered metabolic function.<sup>5</sup>
- Endurance performance has also been shown to be impaired in those starting an event hypohydrated and further dehydrating during a trail race.<sup>6</sup>
- Although studies have shown that endurance performance is decreased with exercise-induced dehydration, there are a few reviews that have shown no difference in performance time when dehydration levels under <4%.<sup>7,8</sup> These results do not take into account exercise in the heat, performance of elite athletes, and long endurance events.
- Levels of dehydration at a level of 2-3% are shown to reduce maximal aerobic performance and the decrements are further exaggerated when exercising in the heat due to the increased physiological stress placed on the body.
- In order to maximize performance, athletes should make sure they are well-hydrated before exercise and have knowledge of individual fluid needs in order to appropriately replace fluid losses during exercise.<sup>9</sup>
- All athletes, especially recreational athletes, can benefit by drinking according to sensation of thirst to minimize body mass losses of >2%.

Physiological Responses	Cool/Neutral Environment		Hot Environment	
	With Fluid	Without Fluid	With Fluid	Without Fluid
Plasma Volume	↔	↔	↔	↓↓
Internal Body Temperature	↑	↑↑	↑↑	↑↑↑
Heart Rate	↑	↑↑	↑↑	↑↑↑
Stroke Volume	↓	↓↓	↓↓	↓↓↓
Ratings of Perceived Exertion	↔	↑↑	↑↑	↑↑↑
Performance	↑	↓↓	↑	↓↓↓

↔: Negligible Change, ↑: Small Change, ↑↑: Moderate Change, ↑↑↑: Large Change

Evidence shows that restricting fluid during prolonged exercise, both in a cool/neutral environment and in a hot environment, increases internal body temperature, increases cardiovascular drift and decreases overall performance.<sup>10</sup>

## Practical Applications

- Athletes should maintain an appropriate level of hydration prior to the start of an endurance event.
- During an endurance event, athletes should aim to minimize fluid losses by drinking to thirst to attenuate any performance decrements.
- Maintaining an appropriate level of hydration on a daily basis will lead to overall health benefits.
- In events lasting longer than 60 minutes it is recommended that athletes consume a carbohydrate-electrolyte drink in addition to water.
- Ensuring proper hydration during exercise in the heat is of utmost importance as the added heat stress amplifies the performance decrements found with dehydration.
- Competing in sports, which expose athletes to heat stress, it is important that athletes undergo a period of heat acclimatization in addition to maintaining an appropriate level of hydration. Heat acclimatization is a series of physiological adaptations that improves heat tolerance and improves the ability of athletes performing in the heat.
- Dehydration alters exercise heart rate and ratings of perceived exertion (RPE) during exercise, making these feedback mechanisms unable to measure performance when an athlete is dehydrated.

## Looking Ahead

- Further research is needed looking at the effects of endurance performance during real-world endurance events. Conclusions that have been made looking at endurance performance and exercise-induced dehydration lack ecological and external validity.
- Since many studies look at performance in events lasting <60 minutes, field studies or laboratory studies examining endurance performance in events lasting longer than 60 minutes are needed to see what happens to performance as someone sustains body mass losses of >2%.
- A synthesis of the existing literature examining endurance performance with increasing levels of dehydration is needed to examine the magnitude of the effect that dehydration has on endurance performance.

## References

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