

PHYSIOLOGICAL RESPONSES OF ELITE-LEVEL GOLFERS IN A HOT/HUMID ENVIRONMENT

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Introduction

Competing in hot/humid conditions is a significant challenge for many athletes. This environmental stress is a common scenario in golf, especially during the summer when most tournaments are played. Additionally, elite-level golfers routinely spend upwards of four hours on the course or play multiple rounds in a single day of competition. Heat stress cannot only diminish performance it can threaten a golfer's wellbeing and safety. The combination of environmental stress, physical workload and compensatory sweat losses of fluid and electrolytes may be too much for some golfers to handle, even if they prepare well and attempt to manage fluid/electrolyte intake optimally. Unfortunately, there is limited data to guide golfers and their support teams on implementing the most optimal hydration strategy. Anecdotal evidence clearly indicates that certain golfers are much less tolerant to playing 18 holes of golf in the heat than their peers and often succumb to the strain of the excessive physiological demands, especially in response to consecutive days of play. Performance decrements due to physiological factors in golfers was examined by Smith et al. who demonstrated that low-handicap golfers with acute mild dehydration suffered both physical and cognitive impairment in sport-specific tasks [1]. With the ongoing popularity of golf across all ages and growing populations and events in hot climates, there is increased need to obtain evidenced-based information about thermoregulatory responses and behavior during play so that golfers can continue to compete effectively and safely.

Methods

Thirteen healthy (injury-/illness-free in the past 7 days), elite-level golfers (19-62 yrs; 3 males, 10 females) completed a 60-minute exercise bout (treadmill walking protocol) in a hot/humid (35°C, 50-60%rH) environment while consuming water ad libitum. During the bout, core body temperature (T_c), heart rate (HR), hydration status, fluid intake, sweat rate, electrolyte loss and selected perceptual measures (i.e., perceived exertion and overall perception of heat stress) were measured. Descriptive statistics were calculated for physiological variables of interest including T_c , peak HR, sodium loss rate, sweat rate, pre/post-exercise hydration status and pre/post-exercise body weight. This study was exploratory in nature and as such, no hypotheses were made or statistically analyzed. The Sanford Health Institutional Review Board approved this retrospective data review.

Results and Discussion

Nine of the thirteen golfers were properly hydrated (urine specific gravity [USG]: 1.005-1.019) prior to the start of exercise, as determined by their pre-exercise hydration status ($\bar{x} = 1.014$). The highest recorded USG was 1.024 (moderately dehydrated). The largest body weight deficit during the one-hour walking protocol was -0.97%, well below 2% body weight deficit threshold that has been shown to negatively influence athletic performance (increased fatigue, elevated HR, diminished concentration, etc.). It is important to note, however, that subjects only exercised for 1 hour and progressive dehydration would be expected over longer durations. Four subjects also gained weight during the 60-minute exercise bout (mean = 0.59%), which is also not recommended. Average sweat rate and sodium loss rate amongst the golfers was 0.95 L/hr (range: 0.57-1.28 L/hr) and 1164 mg/hr (range: 416-1901 mg/hr), respectively. Average RPE amongst the golfers at the end of the exercise bout was 14.6 (6-20 RPE scale). Average peak T_c was 38.59°C with three individuals obtaining T_c s greater than 38.94°C. The average peak HR amongst the group was 165 bpm (range: 128-193 bpm), with one individual reaching a peak HR of 193 bpm. Peak T_c and HR were highly correlated (R-value = 0.67; $P = 0.011$), as was pre-exercise body weight and sweat rate (R-Value = 0.82; $P < 0.001$). These highly correlated variables illustrate that golfers and their support teams may want to monitor HR during a round of golf as a surrogate indicator of heat strain and have a hydration plan developed based on body weight so that appropriate mitigation efforts can be administered to effectively compete in hot/humid environments.

Significance

The findings of this lab-based study provide novel insight into heat strain that golfers may experience while playing golf in similar hot/humid conditions in a natural, outdoor environment. This research has important implications in determining appropriate evidence-based guidelines for maintaining hydration during play and providing knowledge that can be used by golfers (young and old), coaches and golf governing bodies worldwide to develop better heat-illness prevention and performance strategies. Golfers or coaches who want to minimize the risk of heat-related illness or performance impairment should consult with a trained exercise physiologist such that an individualized hydration and performance plan can be implemented in training and competition. Data from this study may also aid in the development of more comprehensive research studies that can further evaluate physiological responses in other environmental conditions and golfing populations (e.g., recreational, youth, collegiate and professional) and explore their potential relationships to performance. The ultimate goal is to reduce the risk of heat-related illness and associated impairment on the course while helping to optimize health and performance for all golfers.

References

[1] Smith MF, Newell AJ, Baker MR. Effect of acute mild dehydration on cognitive-motor performance in golf. *J Strength Cond Res.* 2012 Nov;26(11):3075-80. doi: 10.1519/JSC.0b013e318245bea7. PMID: 22190159.