

## ABSTRACT

Dehydration has been shown to decrease sports performance. However, the exact cause of the decreased performance due to dehydration is still unclear. **PURPOSE:** To compare sport-specific reaction time values between men and women and at different quartiles after a dehydrating protocol to approximately 2% body mass loss. **METHODS:** Ten women and eleven men between the ages of eighteen and thirty-five participated in the study (27 +/- 4yr, 78.7 +/- 14.8 kg, 174.0 +/- 7.5 cm). Subjects reported to the lab in a fasted and normally hydrated state and completed a two-minute, multi-directional sport-specific reaction time test. Subjects then ran on a treadmill at 80% estimated max HR for 30 minutes, followed by multiple 15 minute sessions in a dry sauna at approximately 150 degrees F. After reaching a 2% (+/- 0.4%) reduction in dry body weight subjects completed the same procedures as pre-dehydration. Reaction times were separated into quartiles (each quartile being a 30-second interval of the two minutes) and averaged to examine the data within each test. **RESULTS:** The average total (Q1-Q4) reaction time for women after dehydration (1366 +/- 400 milliseconds (ms)) was significantly higher than before dehydration (1304 +/- 380 ms; p = 0.0048). However, men did not demonstrate a significant change in reaction time from pre (1305 +/- 300 ms) to post-dehydration (1383 +/- 0.0516 ms; p = 0.066). When quartiles were compared, the average reaction time for women was significantly higher in the third quartile of post-dehydration (1404 +/- 245 ms; p = 0.022) and the fourth quartile of post-dehydration (1412 +/- 263 ms; p = 0.019) than the first quartile of pre-dehydration (1272 +/- 198 ms). Regarding men, the average reaction time was significantly higher in the first quartile of post-dehydration (1427 +/- 220 ms) than the first quartile of pre-dehydration (1285 +/- 149 ms; p = 0.040), the second quartile of pre-dehydration (1285 +/- 189 ms; p = 0.012), the third quartile of pre-dehydration (1338 +/- 200 ms; p = 0.018), and the fourth quartile of pre-dehydration (1312 +/- 236 ms; p = 0.013). Additionally, the average reaction time was significantly higher in the second quartile of post-dehydration (1353 +/- 211 ms) than the first quartile of pre-dehydration (1285 +/- 149 ms; p = 0.046). **CONCLUSIONS:** Dehydration appears to affect the sport-specific, total body reaction time performance of athletic men and women differently. Overall, women's average reaction time was significantly greater after dehydration, and men's reaction time trended upward, but did not reach significance. When divided into quartiles, the data suggest that women slowed down (i.e., higher reaction time) within each test and between the pre and post-hydration tests, though significance was only observed when comparing the beginning of pre-dehydration and the end of post-dehydration. Regarding quartiles with men, the slowest time point was the beginning of the post-dehydration test, and their subsequent performances trended upward (i.e. lower reaction time) from quartile to quartile. Future studies could include more subjects or a longer test in order to elucidate the discrepancy of these data. Nevertheless, this study suggests that sex differences exist regarding effects of dehydration, such that women's reaction time performance was significantly affected, whereas men's performance did not change, due to a possible recovery of performance during the test. These data corroborate the importance of hydration in sports, where even a tenth of a second difference in reaction time can mean the difference between success and failure.

## INTRODUCTION

Dehydration is an important aspect of sports and exercise in general. In some cases, extreme dehydration has led to severe illness, or even death. Though the importance of hydrating while exercising for health and safety is well-known, another important factor is how mild or moderate dehydration may affect sports performance. Some of the more common issues related to exercise-induced dehydration are increased fatigue, body temperature, heart rate, and perceived exertion<sup>1</sup>. The most salient issues that arise when discussing dehydration are physical in nature. However, it is also possible that dehydration affects cognitive function as well. Therefore, the focus of the present study was the effect of dehydration on cognitive function.

Results from past studies have been equivocal on the effect of dehydration on cognitive function. Dehydration has been demonstrated to affect certain measures of cognitive function<sup>2</sup>, including pilots' performance and spatial cognition<sup>3</sup>, yet other studies have failed to find a significant decrement in cognitive performance<sup>4</sup>. One confounding factor is that there are multiple ways to define and measure cognitive function.

In the present study, we were interested in how dehydration may affect choice reaction time in male and female athletes differently. Active, sport-specific, reaction time was tested using a 2 minute test on the 3 towers and footplates of a Makoto device. In this way, we sought to determine how young men and women may perform differently when mildly dehydrated (2% of body weight).

## METHODS

### Dehydration Protocol

#### Treadmill:

- 30 minutes at 80% maximum heart rate (206.9 - (0.67 \* Age))
- Subjects wore sweat clothes to enhance sweat rate



#### Sauna:

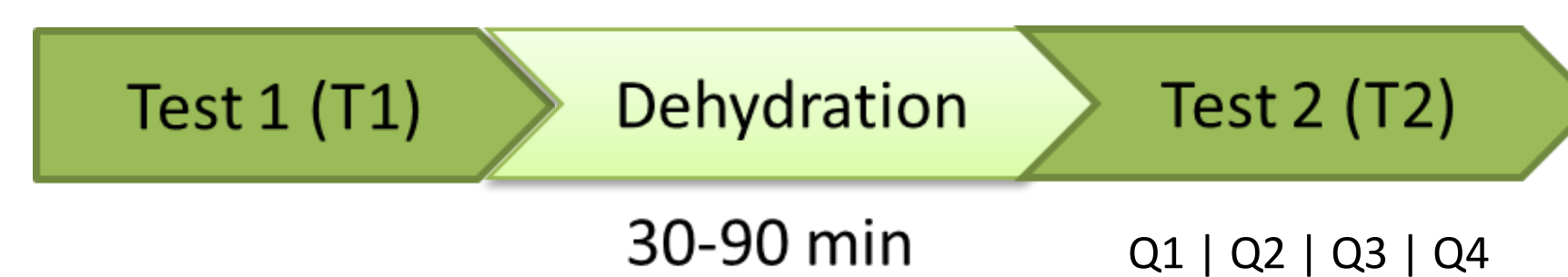
- 15 minute intervals in a sauna at 158 degrees Fahrenheit
- Naked body weight measured on a calibrated scale after every 15min session until 2% body weight loss is reached



### Testing Protocol

#### Timeline:

Q1 | Q2 | Q3 | Q4



#### Active: Makoto Arena II (Makoto USA, Centennial, CO)

- Three tower test with footplates (2 min)



### Subject Characteristics

	n	Age (yrs)	Height (cm)	Weight (kg)
<b>Total</b>	<b>21</b>	<b>27 (4)</b>	<b>174.0 (7.5)</b>	<b>78.7 (14.8)</b>
<b>Men</b>	<b>11</b>	<b>26 (4)</b>	<b>175 (6)</b>	<b>79 (9)</b>
<b>Women</b>	<b>10</b>	<b>29 (4)</b>	<b>171 (6)</b>	<b>78 (34)</b>

## RESULTS

Figure 1. Average Reaction Times for Pre and Post Dehydration.

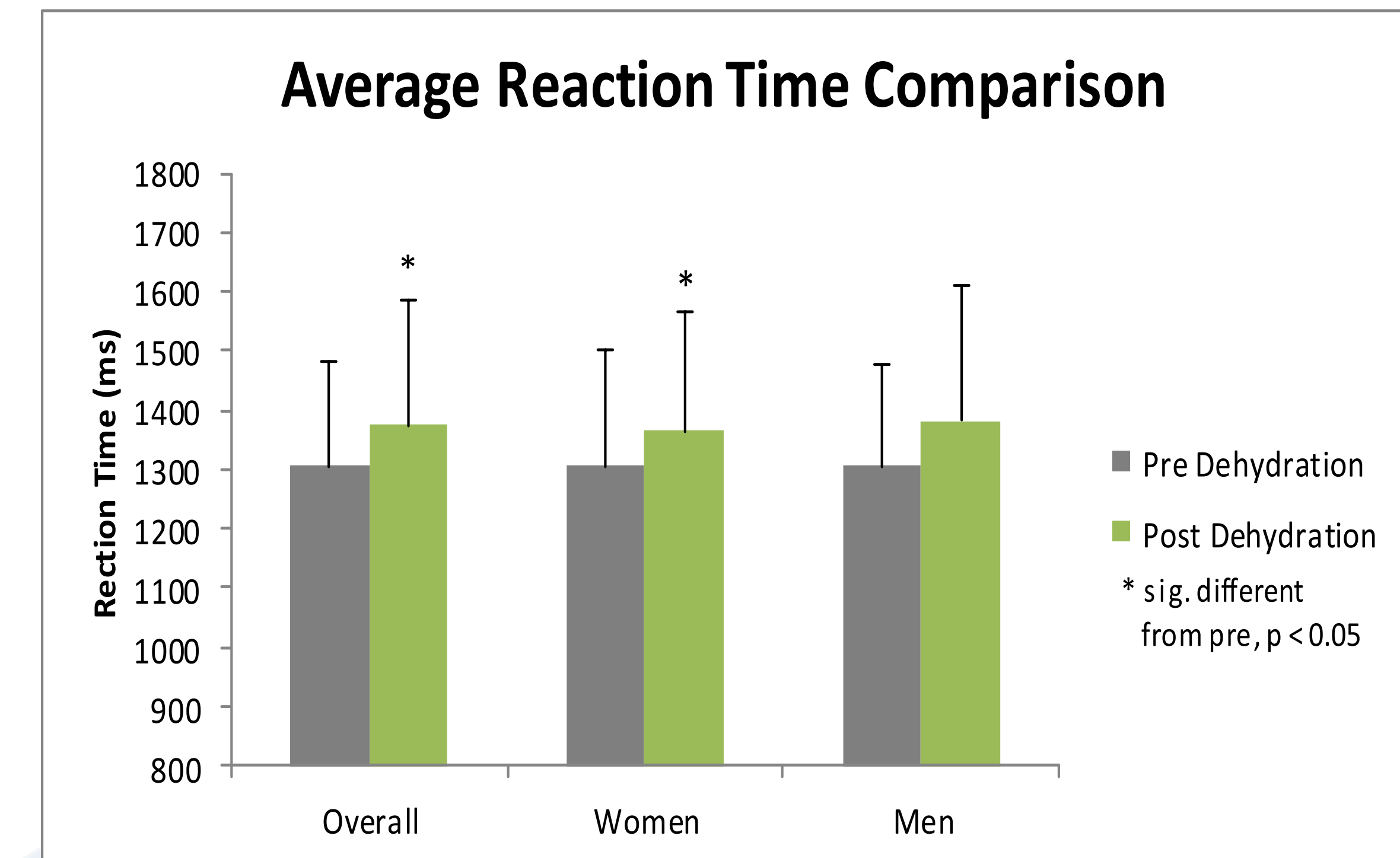


Table 2. Average Reaction Times by Quartile for Men and Women.

Average Male Reaction Times (ms)		
	T1 Mean	T2 Mean
<b>Q1</b>	1285 (149)	1427 (220)
<b>Q2</b>	1285 (189)	1394 (190)
<b>Q3</b>	1375 (206)	1395 (251)
<b>Q4</b>	1335 (235)	1314 (295)
Average Female Reaction Times (ms)		
	T1 Mean	T2 Mean
<b>Q1</b>	1272 (198)	1351 (172)
<b>Q2</b>	1367 (254)	1353 (211)
<b>Q3</b>	1356 (243)	1404 (245)
<b>Q4</b>	1329 (273)	1412 (263)

Table 3. Delta Values to Compare Tests and Quartiles.

Δ Values for Comparison								
	TIQ1	TIQ2	TIQ3	TIQ4	T2Q1	T2Q2	T2Q3	T2Q4
<b>TIQ1</b>		-0.31	52.84	26.79	141.82	109.10	122.90	56.44
<b>TIQ2</b>	94.42		53.15	27.10	142.14	109.42	123.22	56.76
<b>TIQ3</b>	84.19	-10.23		-26.05	88.99	56.27	70.07	3.61
<b>TIQ4</b>	56.80	-37.61	-27.39		115.03	82.32	96.11	29.66
<b>T2Q1</b>	78.22	-16.20	-5.97	21.42		-32.72	-18.92	-85.38
<b>T2Q2</b>	81.04	-13.38	-3.15	24.24	2.82		13.796	-52.661
<b>T2Q3</b>	131.67	37.25	47.48	74.87	53.45	50.63		-66.5
<b>T2Q4</b>	139.91	45.49	55.72	83.11	-61.69	58.87	8.24	

Green = Men Pink = Women Yellow = p < 0.05

## CONCLUSIONS

Dehydration appears to affect the sport-specific, total body reaction time performance of athletic men and women differently. Overall, women's average reaction time was significantly greater after dehydration, and men's reaction time trended upward, but did not reach significance. When divided into quartiles, the data suggest that women slowed down (i.e., higher reaction time) within each test and between the pre and post-hydration tests, though significance was only observed when comparing the beginning of pre-dehydration and the end of post-dehydration. Regarding quartiles with men, the slowest time point was the beginning of the post-dehydration test, and their subsequent performances trended upward (i.e. lower reaction time) from quartile to quartile. Future studies could include more subjects or a longer test in order to elucidate the discrepancy of these data. Nevertheless, this study suggests that sex differences exist regarding effects of dehydration, such that women's reaction time performance was significantly affected, whereas men's performance did not change, due to a possible recovery of performance during the test. These data corroborate the importance of hydration in sports, where even a tenth of a second difference in reaction time can mean the difference between success and failure.

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