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SPEED SUITS AND SWIMMING *t*'s

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The authors examine the impact of high-tech suits on swimmers in the New England Small College Athletic Conference championships in 2009. The effect these high-tech suits had on drop times (that is, the difference between a swimmer's best in-season time prior to the championships and their best time in the preliminaries or finals of the championships) in the backstroke, breaststroke, and butterfly was far greater for men than for women when compared to their drop times in 2010 (the first year of the speed suit ban) and 2008 (one year before the introduction of the speed suits to collegiate swimming).

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During the 2009 school year, college swimming had an international look. Swimmers were observed wearing the same high-tech polyurethane racing suits that were worn by Olympic swimmers the year before in Beijing. In July of 2009, however, Fédération Internationale de Natation (FINA), the organization governing international competition in aquatic sports, banned all body-length high-tech swimsuits. About a month later, the National Collegiate Athletic Association (NCAA) followed FINA's ruling and also banned all "speed suits."

Li and Sommers [1] examined the impact these high-tech suits had on freestyle swimmers in the 2009 New England Small College Athletic Conference (hereafter NESCAC[1]) championships compared to racing times one year before and after the NCAA ban. The key variable of interest was the swimmer's "drop time," that is, the difference between a swimmer's best in-season time (called their "seed time") prior to the championship meet and their best time in the preliminaries or finals at the championships. This difference between seed times and championship times is usually positive, as swimmers "taper" (that is, swimmers gradually shorten the distance they swim to rest their body before championships) and shave their bodies (to reduce drag) the day before the championship meet. In 2009, this difference was further accentuated when swimmers at the championship meet first wriggled into their brand new *Speedo LZR* or *Blue Seventy Nero Comp* high-tech swimsuits. Li and Sommers found that the effects of wearing speed suits were more apparent for men than for women. Drop times in freestyle events (ranging from 50 to 500 yards) for men were greater in 2009 than they were in either 2008 or 2010.

This paper examines what (if any) effect these high-tech suits had on drop times in the three other competitive strokes: backstroke, breaststroke, and butterfly. The backstroke, breaststroke, and butterfly each have their own techniques in which different muscles are used differently. The backstroke (like the freestyle) is considered a long-axis stroke, meaning that the stroke is based on a head-to-toe line that goes through the middle of the body. For the backstroke, the torso is not fully under water during a substantial part of the race. The butterfly and breaststroke are considered short-axis strokes, where the body is propelled through the water from a horizontal pivot point in the hips. The questions this paper will examine are: Did these high-tech suits help swimmers of one stroke compared to another? Did these suits significantly lower racing times for both men and women?

How did racing times in 2010 (the first year of the ban) compare to those times in 2008 (one year before the introduction of the high-tech swimsuits to collegiate swimming)?

Data

The drop times were calculated for all swimmers, men and women, who competed and finished among the top twenty-six in the preliminaries of their event in either (i) the 2008 and 2009 NESCAC championships or (ii) the 2009 and 2010 NESCAC championships [2, 3].[2,3] The data on drop times were paired. For example, we only considered the drop times of individual swimmers in 2009 (when they were allowed to wear the high-tech swimsuits) and the drop times of the *same* swimmers in the same event one year before or after 2009.[4] The drop times were calculated for men and women in six events: the 100 yard and 200 yard backstroke, breaststroke, and butterfly in the 2008, 2009, and 2010 NESCAC swimming championships. For these three strokes, swimmers in NESCAC only compete at the 100 yard and 200 yard distances. All races are short course, meaning that they take place in a 25-yard long pool. In this event there are more turns (seven in a 200-yard race compared to only three in a 100-yard race) and more breakouts, where the swimmer pushes off the wall at the end of his or her lane. Will the high-tech suit help take advantage of streamline breakouts because of the elite swimmers claim that the high-tech suit compresses the body (so that the swimmer displaces far less water)?[5] Did the high-tech suit help backstroke and butterfly swimmers who spend much of their time in a streamlined underwater dolphin kick off the breakouts?

The first null hypothesis is that the average drop time in 2008 (or 2010) was no different from the average drop time in 2009, the year swimmers were allowed to compete in their high-tech suits. The one-tailed alternative hypothesis is that the average drop time was greater in the year 2009 than it was in 2008 or 2010. The second null

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hypothesis is that the average drop time in 2008 (one year before the ban) was equal to the average drop time in 2010 (one year after the ban) against the alternative hypothesis that the two averages were not equal. The third and final null hypothesis is that the average drop time differences for men and women separately were the same between (i) 2008 and 2009 and (ii) 2009 and 2010. To test this third hypothesis, we ran a two-sample *t*-test on the average drop time differences for men and women between years for each of the six events.[6] In this case, the alternative hypothesis was (like for the second set of tests) two-tailed.

Results

Tables 1 and 2 summarize the results for both men and women in the six events: (i) between 2008 and 2009 and (ii) between 2009 and 2010

Table 1: Summary of Paired *t*-Tests for Men, 2008 versus 2009 and 2009 versus 2010

			Average Drop Times (seconds)			
	2008	2009	*p*-value on difference	2009	2010	*p*-value on difference
Backstroke						
100 yards	1.832	1.848	.478 (n = 13)	2.174	2.173	.498 (n = 12)
200 yards	3.846	5.064	*.069*[*] (n = 12)	5.789	4.333	*.056* (n = 12)
Breaststroke						
100 yards	1.947	2.375	.156 (n = 11)	2.750	1.923	**.025** (n = 17)
200 yards	3.765	7.283	**.004** (n = 12)	6.898	6.003	*.056* (n = 15)
Butterfly						
100 yards	1.900	2.590	**.001** (n = 14)	1.986	1.954	.428 (n = 14)
200 yards	3.781	4.618	.117 (n = 13)	5.949	4.473	**.025** (n = 15)

[*]Numbers in *italics* (**boldface**) are significant at better than the *.10* (**.05**) level in a one-tailed test.

Table 2: Summary of Paired *t*-Tests for Women, 2008 versus 2009 and 2009 versus 2010

			Average Drop Times (seconds)			
	2008	2009	*p*-value on difference	2009	2010	*p*-value on difference
Backstroke						
100 yards	1.234	1.004	.679 (n = 8)	1.120	1.762	.981 (n = 13)
200 yards	1.928	3.576	**.013**[*] (n = 17)	4.084	3.900	.368 (n = 14)
Breaststroke						
100 yards	1.198	1.179	.515 (n = 11)	1.126	1.590	.853 (n = 11)
200 yards	1.905	1.099	.717 (n = 13)	0.648	2.430	.878 (n = 8)
Butterfly						
100 yards	1.217	1.749	*.066* (n = 10)	1.470	1.169	.264 (n = 8)
200 yards	1.019	3.609	**<.001** (n = 15)	3.459	3.502	.521 (n = 14)

[*]Numbers in *italics* (**boldface**) are significant at better than the *.10* (**.05**) level in a one-tailed test.

Table 3: Summary of Paired *t*-Tests for Men, 2008 versus 2010, One Year Before and After the Ban

	Average Drop Times (seconds) 2008	2010	*p*-value on difference*
Backstroke			
100 yards	1.626	2.046	.387 (n = 7)
200 yards	2.310	3.790	.183 (n = 7)
Breaststroke			
100 yards	2.287	2.138	.806 (n = 10)
200 yards	4.001	5.745	.291 (n = 8)
Butterfly			
100 yards	1.564	1.659	.765 (n = 8)
200 yards	3.944	4.797	.191 (n = 10)

*The *p*-values are for a two-tailed test.

Table 4: Summary of Paired *t*-Tests for Women, 2008 versus 2010, One Year Before and After the Ban

	Average Drop Times (seconds) 2008	2010	*p*-value on difference
Backstroke			
100 yards	1.415	0.888	.258 (n = 4)
200 yards	2.683	3.886	.102 (n = 8)
Breaststroke			
100 yards	1.305	0.950	.511 (n = 6)
200 yards	3.015	3.040	.987 (n = 6)
Butterfly			
100 yards	0.986	1.902	*.092** (n = 5)
200 yards	1.499	4.368	**.002** (n = 9)

*Numbers in *italics* (**boldface**) are significant at better than the *.10* (**.05**) level in a two-tailed test.

Tables 3 and 4 summarize the results of the various *t*-tests for the same men or women who competed and placed among the top twenty-six in their event's preliminaries in the NESCAC championships in 2008 and again in 2010. For men alone, in all six events, the average drop time in 2008 appears to be no different from what it was in 2010. For the women, however, we observe improvement in 2010, especially in the 100 yard and 200 yard butterfly.

Table 5 shows the average drop differences for men and women in each of the six events and the differences between them in years with and without the high-tech suits. (A negative entry in this table indicates that the average drop time was greater in either 2008 or 2010 than it was in 2009.) These results show that men experienced significantly bigger time drop differences than their female counterparts, especially in the breaststroke (200 yards, from 2008 to 2009 and 100 yards, from 2009 to 2010). In three of the six events between 2008 and 2009, and four of the six events between 2009 and 2010, the average drop times for women increased while those for men decreased. Put another way, the women in 2010 (with the exception of the 100 yard butterfly) shaved more seconds off their best in-season or seed times relative to 2009 while the men recorded smaller time drop differences in 2010 than in 2009.

Table 5: Summary of Two-Sample *t*-Tests, Average Time Drop Differences Between Men and Women, 2008 versus 2009 and 2009 and 2010

Average time drop difference between 2009 and 2008			
Event	Men	Women	*p*-value on difference
100 yard backstroke	.016	-.230	.664
200 yard backstroke	1.218	1.648	.674
100 yard breaststroke	.428	-.019	.501
200 yard breaststroke	3.518	-.806	**.021***
100 yard butterfly	.690	.532	.677
200 yard butterfly	.838	2.591	*.058*

Average time drop difference between 2009 and 2010			
Event	Men	Women	*p*-value on difference
100 yard backstroke	.002	-.642	.120
200 yard backstroke	1.457	.184	.220
100 yard breaststroke	.827	-.464	**.034**
200 yard breaststroke	.895	-1.783	.108
100 yard butterfly	.032	.301	.593
200 yard butterfly	1.476	-.043	.159

*Numbers in *italics* (**boldface**) are significant at better than the *.10* (**.05**) level in a two-tailed test.

Concluding Remarks

The results presented here suggest that the performance-enhancing effects of wearing speed suits were more apparent for men than for women in strokes other than the freestyle, especially in longer events where races include more turns and thus more time spent under water in the streamline position. For men, the speed suit was found to most favorably affect their performance in the short-axis breaststroke, the slowest of the four competitive strokes. The alternating elongation of the body to a coiling upward position is not very hydrodynamic and so results in resistance or as it is called in swimming form drag. Because the high-tech suits compress the body, the suits would understandably help the stroke where form drag is most evident.

Although men posted faster times in the 2010 NESCAC championships than they did earlier in the season, their average drop times in 2010 were not nearly as large as they had been the year before when swimmers were clad in speed suits. Finally, although no records were kept of who in particular did or did not wear a high-tech suit in the 2009 NESCAC championships, the lack of statistical significance among women swimmers between 2009 and 2010 across three different strokes suggests that women adjusted more easily to the ban than did the men, if for no other reason the rates of high-tech suit usage may have been much lower among women.

References

1. J. Li and P. M. Sommers, "Racer Swimsuits Fit to a *t*," *Journal of Recreational Mathematics*, forthcoming.
2. NESCAC men's championships. 2008: www.pjmm.net/results/nescacm08/final-results.html ; 2009: www.pjmm.net/results/nescacm09/final-results.html ; 2010: www.nescac.com/sports/swimdive/2009-10/championship/results_m_2010.htm
3. NESCAC women's championships. 2008: www.pjmm.net/results/nescacw08/final-results.html ; 2009: www.pjmm.net/results/nescacw09/final-results.html ; 2010: www.nescac.com/sports/swimdive/2009-10/championship/results_w_2010.htm
4. H. Moria, H. Chowdhury, F. Alam, A. Subic, A. J. Smits, R. Jassim, and N. S. Bajaba, "Contribution of Swimsuits to Swimmer's Performance," *Procedia Engineering*, Vol. 2(2), pp. 2505-2510, Elsevier, UK, 2010.

Footnotes

1. In swimming, the NESCAC schools are: Amherst, Bates, Bowdoin, Colby, Connecticut College, Hamilton, Middlebury, Trinity, Tufts, Wesleyan, and Williams. These eleven liberal arts colleges and universities are located in Connecticut, Maine, Massachusetts, New York, and Vermont.
2. Unlike most conferences, NESCAC has only one championship meet per season. NESCAC swimmers therefore only taper once, the same time each year in February (when few of these swimmers have yet qualified for nationals). Thus, because it is their only championship meet, swimmers are assured to try their best, be fully tapered, and wear the most advantageous swimsuits. And, since the high-tech speed suits lost some of their drag reduction capability after only a few uses, NESCAC swimmers saved them for their one and only conference championship meet.
3. For each event, the top twenty-four finishers in the preliminaries of the championship meet qualify for the finals. The winner in the finals scores 24 points for his or her team, the second place swimmer scores 23 points, and so forth down to one point for 24th place. The 25th and 26th place finishers in the preliminaries are placed on reserve and may swim in the finals if any of the top twenty-four finishers (for examples, due to illness or injury) cannot swim in the finals.
4. Note that the swimmers from the 2009 championships in the 2008 *v*. 2009 paired comparisons may not be the same swimmers from the 2009 championships included in the 2009 *v*. 2010 paired comparisons.
5. See H. Moria *et al.* [4]
6. All two-sample *t*-tests assume separate or unequal variances.