

# WHO WAS $z$ -BEST OLYMPIAN IN 2008 AND 2012?

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The authors examine athletes' performances in swimming, track, and gymnastic events during the 2008 Beijing Olympics and 2012 London Olympics with the purpose of discovering the most dominant performance. By standardizing great athletic performances using a  $z$ -score (the number of standard deviations from the average performance in the finals of a particular event), winners were compared amongst the three sports. The most dominant athlete (with the highest  $z$ -score, calculated with or without the last place finisher) was neither celebrated swimmer Michael Phelps nor sprinter Usain Bolt, but rather American LaShawn Merritt in the 400 meter run.

Keywords:  $z$ -scores; 2008 and 2012 Summer Olympics; best performances

Who were the most dominant athletes at the 2008 Beijing Olympics and 2012 London Olympics? Multiple gold medal winners Michael Phelps (swimming), Usain Bolt (track), and Kai Zou (gymnastics)?<sup>1,2,3</sup> In swimming, how would one decide whether the woman who won the 200 meter backstroke was more dominant than the man who won the 50 meter freestyle? And, how would one compare a gold-medal-winning time in swimming or track to a golden score in gymnastics?

In general, how might one compare great athletic performances in different sports? The question was posed in a *Wall Street Journal* article titled "The Best Olympic Performances So Far" by Matthew Futterman (February 24, 2010). In order to compare performances across sporting events at the 2010 Vancouver Winter Olympics, Futterman converted the winning scores to a common measurement scale,  $z$ -scores. A synonym for a standardized score is a  $z$ -score, namely, the number of standard deviations above or below the average performance in the finals of a particular event.

The purpose of this brief research note is to find the winner's  $z$ -score in the finals of individual events in swimming, track, and gymnastics in Beijing 2008 and London 2012. The method used is to determine how many standard deviations the winner of each event finished above the mean. Detailed event results can be viewed at [www.olympic.org/sports](http://www.olympic.org/sports). All individual events included in this study involved eight finalists, save for the occasional athlete who either was disqualified or failed to complete required elements in his or her gymnastics routine. For each

winner, we also report his or her "adjusted"  $z$ -score, that is, the winner's  $z$ -score is recalculated after dropping the finalist who finished in last place (and hence had the lowest  $z$ -score). For example, in a swimming event where the last place finisher badly trails the pack, the standard deviation of the times of all eight finalists will be much larger than when the last place finisher is excluded from our calculations. In such an event, the winner's  $z$ -score which is equal to  $(\text{winner's time} - \text{average time}) \div (\text{standard deviation of all times})$  will be smaller with the eighth-place finisher's slow time than without his/her time.<sup>4</sup> Since fast (or low) times are preferred to slow (or high) times and high scores are preferred to low scores, the winner's (as well as the winner's adjusted)  $z$ -score will always be reported as a positive number; the last place finisher's or the lowest  $z$ -score will always be reported as a negative number.

## Swimming

Thirteen individual swimming events were selected for women and men: 50m(eter) freestyle (hereafter, free); 100m free; 200m free; 400m free; 800m (1500m) free for women (men); 100m butterfly (hereafter, fly); 200m fly; 100m backstroke (hereafter, back); 200m back; 100m breaststroke (hereafter, breast); 200m breast; 200m individual medley (hereafter, IM, a combination of four different swimming styles – butterfly, backstroke, breaststroke, and freestyle – swum in this order, each for a distance of 50m or a quarter of the total distance of the race); and 400m IM.

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**Table 1. z-scores from the 2008 and 2012 Summer Olympics, Women's Swimming Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's z-score	Lowest z-score	Winner's adjusted z-score <sup>b</sup>
2008					
50m free	<i>B. Steffan</i>	Germany	1.054	-1.462	0.970
100m free	<i>B. Steffan</i>	Germany	1.377	-0.988	1.248
200m free	<b>F. Pellegrini</b>	Italy	1.140	-1.103	1.016
400m free	R. Adlington	Great Britain	0.629	-2.390	1.024
800m free	<b>R. Adlington</b>	Great Britain	1.812	-1.393	1.807
100m fly	L. Trickett	Australia	1.593	-1.376	1.555
200m fly	<b>Z. Liu</b>	China	1.677	-1.150	1.581
100m back	N. Coughlin	United States	1.332	-1.500	1.301
200m back	<b>K. Coventry</b>	Zimbabwe	1.644	-1.523	1.675
100m breast	<i>L. Jones</i>	Australia	2.137	-1.128	2.056
200m breast	<b>R. Soni</b>	United States	1.888	-1.179	1.810
200m IM	<b>S. Rice</b>	Australia	1.395	-1.453	1.359
400m IM	<b>S. Rice</b>	Australia	1.177	-1.439	1.105
2012					
50m free	<i>R. Kromowidjojo</i>	Netherlands	1.898	-1.168	1.818
100m free	<i>R. Kromowidjojo</i>	Netherlands	1.816	-1.582	1.914
200m free	<i>A. Schmitt</i>	United States	1.953	-1.046	1.842
400m free	<i>C. Muffat</i>	France	1.386	-1.084	1.268
800m free	K. Ledecky	United States	1.641	-1.287	1.579
100m fly	<b>D. Vollmer</b>	United States	2.095	-1.227	2.047
200m fly	<i>L. Jiao</i>	China	1.704	-1.311	1.655
100m back	M. Franklin	United States	1.254	-2.137	1.741
200m back	<b>M. Franklin</b>	United States	1.797	-1.511	1.848
100m breast	R. Meilutyte	Lithuania	1.541	-1.280	1.469
200m breast	<b>R. Soni</b>	United States	1.358	-1.764	1.460
200m IM	<i>S. Ye</i>	China	1.192	-1.949	1.372
400m IM	<b>S. Ye</b>	China	1.972	-0.905	1.833

<sup>a</sup>Winner's name is in italics (boldface) if he/she set an Olympic (world) record.

<sup>b</sup>Winner's z-score recalculated without the last-place finisher.

**Table 2. z-scores from the 2008 and 2012 Summer Olympics, Men's Swimming Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's z-score	Lowest z-score	Winner's adjusted z-score <sup>b</sup>
2008					
50m free	<i>C. Cielo Filho</i>	Brazil	1.892	-1.079	1.788
100m free	A. Bernard	France	1.417	-1.398	1.366
200m free	<b>M. Phelps</b>	United States	1.923	-1.120	1.830
400m free	T. Park	South Korea	0.939	-2.312	1.578
1500m free	O. Mellouli	Tunisia	0.916	-1.948	0.957
100m fly	<i>M. Phelps</i>	United States	1.399	-1.356	1.334
200m fly	<b>M. Phelps</b>	United States	1.622	-1.140	1.522
100m back	<b>A. Peirsol</b>	United States	1.804	-1.749	2.033
200m back	<b>R. Lochte</b>	United States	1.474	-1.345	1.414
100m breast	<b>K. Kitajima</b>	Japan	1.551	-1.284	1.481
200m breast	<i>K. Kitajima</i>	Japan	1.540	-1.746	1.686
200m IM	<b>M. Phelps</b>	United States	1.773	-1.396	1.764
400m IM	<b>M. Phelps</b>	United States	1.665	-1.207	1.583
2012					
50m free	F. Manaudou	France	1.706	-1.482	1.727
100m free	N. Adrian	United States	1.199	-1.942	1.377
200m free	Y. Agnel	France	1.706	-1.494	1.734
400m free	<i>Y. Sun</i>	China	1.723	-1.192	1.640
1500m free	<b>Y. Sun</b>	China	1.709	-1.339	1.670
100m fly	M. Phelps	United States	1.661	-1.292	1.603
200m fly	C. le Clos	South Africa	1.264	-0.928	1.130
100m back	<i>M. Grevers</i>	United States	1.993	-1.216	1.933
200m back	<i>T. Clary</i>	United States	1.225	-1.327	1.135
100m breast	<b>C. van der Burgh</b>	South Africa	1.615	-1.727	1.769
200m breast	<b>D. Gyurta</b>	Hungary	1.492	-1.061	1.374
200m IM	M. Phelps	United States	1.497	-1.133	1.391
400m IM	R. Lochte	United States	1.727	-1.260	1.665

<sup>a</sup>See Table 1.<sup>b</sup>See Table 1.

Tables 1 and 2 show the highest and lowest  $z$ -scores for the winners in the thirteen different individual women's and men's swimming events, respectively. Leisel Jones of Australia posted the highest  $z$ -score (2.137) (as well as the highest adjusted  $z$ -score, 2.056) among women swimmers in the 2008 Summer Olympics in Beijing, earning a gold (and setting an Olympic record) in the 100m breast. In the 2012 Summer Olympics in London, American Dana Vollmer won gold and set a world record in the 100m fly. Her  $z$ -score (2.095) and adjusted  $z$ -score (2.047) are tops among women swimmers in 2012.

Among the men, American swimmer Michael Phelps's most dominant individual performance in 2008 was his third race, in the 200m free (unadjusted  $z = 1.923$ , adjusted  $z = 1.830$ ). Phelps competed in and won five individual swimming events in 2008, setting four world records and one Olympic record. The highest winner's adjusted  $z$ -score in men's 2008 swimming events, however, belonged to American Aaron Peirsol in the 100m back. Although Phelps won six additional medals in 2012 (including two gold medals in individual events, the 200m fly and the 200m IM), the male swimmer with the highest  $z$ -score and adjusted  $z$ -score was American Matt Grevers in the finals of the 100m back, bettering Aaron Peirsol's Olympic (and, at the time, world) record set in 2008.

A comparison of the top and bottom halves of Table 1 shows that the average winners' adjusted  $z$ -scores across thirteen different events was marginally higher for women in 2012 than for women in 2008 (1.680 in 2012 *v.* 1.424 in 2008,  $p = .068$  for a two-tailed paired  $t$ -test). For the same thirteen events in men's swimming, there was no discernible difference between the two averages in the two summer Olympics (1.550 in 2012 *v.* 1.564 in 2008,  $p = .870$ ). Excluding the 800m free (women's events) and the 1500m free (men's events), one could compare the average adjusted  $z$ -value for female and male swimmers in the remaining twelve events at the 2008 Summer Olympics (1.392 for women *v.* 1.615 for men,  $p = .130$  for a two-tailed paired  $t$ -test) and at the 2012 Summer Olympics (1.689 for women *v.* 1.540 for men,  $p = .165$ ). In both years, the winners in the men's races were neither more nor less dominant than the winners in the women's races.

#### Track

Six individual track events – 100m dash, 200m, 400m, 800m, 100m (110m) hurdles for women (men), and 400m hurdles – were examined at the Olympics in 2008 and 2012. The track results are reported for women in Table 3 and for men in Table 4.

**Table 3.  $z$ -scores from the 2008 and 2012 Summer Olympics, Women's Track Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's $z$ -score	Lowest $z$ -score	Winner's adjusted $z$ -score <sup>b</sup>
2008					
100m	S. Fraser	Jamaica	1.927	-1.113	1.832
200m	V. Campbell-Brown	Jamaica	1.383	-1.391	1.326
400m	C. Ohuruogu	Great Britain	1.024	-1.956	1.126
800m	P. Jelimo	Kenya	1.233	-2.105	1.641
100m hurdles	D. Harper	United States	1.207	-2.241	1.936
400m hurdles	M. Walker	Jamaica	1.280	-2.119	1.752
2012					
100m	S. Fraser-Pryce	Jamaica	1.309	-1.335	1.230
200m	A. Felix	United States	1.514	-1.553	1.536
400m	S. Richards-Ross	United States	1.120	-1.867	1.204
800m	M. Savinova	Russia	1.472	-1.475	1.454
100m hurdles	S. Pearson	Australia	1.083	-2.083	1.347
400m hurdles	N. Antyukh	Russia	1.212	-1.202	1.101

<sup>a</sup>See Table 1.

<sup>b</sup>See Table 1.

**Table 4. z-scores from the 2008 and 2012 Summer Olympics, Men's Track Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's z-score	Lowest z-score	Winner's adjusted z-score <sup>b</sup>
2008					
100m	<b>U. Bolt</b>	Jamaica	2.209	-1.021	2.097
200m	<b>U. Bolt</b>	Jamaica	1.720	-1.143	1.610 <sup>c</sup>
400m	L. Merritt	United States	2.217	-1.026	2.107
800m	W. Kipkemboi Bungei	Kenya	0.827	-2.026	0.866
110m hurdles	D. Robles	Cuba	1.597	-1.447	1.586
400m hurdles	A. Taylor	United States	1.483	-2.053	1.973
2012					
100m	<i>U. Bolt</i>	Jamaica	0.601	-2.449	1.625
200m	U. Bolt	Jamaica	1.388	-1.435	1.345
400m	K. James	Grenada	1.993	-1.223	1.937
800m	<b>D. Lekuta Rudisha</b>	Kenya	1.881	-1.204	1.812
110m hurdles	A. Merritt	United States	1.474	-1.160	1.361 <sup>d</sup>
400m hurdles	F. Sánchez	Dominican Rep.	1.367	-1.306	1.287

<sup>a</sup>See Table 1.<sup>b</sup>See Table 1.<sup>c</sup>Calculated with five runners due to two disqualifications.<sup>d</sup>Calculated with six runners due to one disqualification.

For the women, not one of the six races resulted in a world record either year. And, only one of the twelve times was an Olympic record (in the 100m hurdles in 2012). In the 2008 Olympic Games, Shelly-Ann Fraser of Jamaica recorded the highest z-score in the 100m dash (1.927), but Dawn Harper of the United States had the highest winner's adjusted z-score in the 100m hurdles (1.936). Four years later in London, the now married sprinter Shelly-Ann Fraser-Price repeated as the gold medalist in the 100m. But, the sprinter with the highest z-score (1.514) and adjusted z-score (1.536) was 200m specialist American Allyson Felix.

Usain Bolt's name appears four times in Table 4, twice in 2008 (new world records in the 100m and 200m sprints) and twice again in 2012 (a new Olympic record in the 100m

dash). But, in 2008, American sprinter LaShawn Merritt edged out double gold medalist Bolt with the highest z- and adjusted z-scores (2.217 and 2.107, respectively). In 2012, Grenadian runner Kirani James recorded higher z- and adjusted z-scores in winning the 400m run than did Kenyan David Rudisha who set a new world record in the 800m.

Comparisons of the women's average adjusted z-score across six events in 2008 and 2012 revealed no discernible difference (1.602 in 2008 and 1.312 in 2012,  $p = .119$  for a two-tailed paired  $t$ -test). Similarly, there was no discernible difference in the men's two averages (1.725 in 2008 and 1.580 in 2012,  $p = .563$ ). The men's winners were neither more nor less dominant than the women's winners in either 2008 ( $p = .606$ ) or 2012 ( $p = .058$ ).

## Gymnastics

Under artistic gymnastics, we examined four women's events (balance beam, floor exercise, uneven bars,

and vault) and six men's events (floor exercise, horizontal bar, parallel bars, pommel horse, rings, and vault).

**Table 5. z-scores from the 2008 and 2012 Summer Olympics, Women's Gymnastics Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's z-score	Lowest z-score	Winner's adjusted z-score <sup>b</sup>
2008					
Beam	S. Johnson	United States	1.094	-1.730	1.096
Floor	S. Izbasa	Romania	1.104	-1.823	1.155
Uneven bars	K. He	China	0.735	-2.037	0.724
Vault	J. Un	North Korea	0.517	-2.436	0.885
2012					
Beam	L. Deng	China	1.137	-1.635	1.114
Floor	A. Raisman	United States	1.314	-2.105	1.784
Uneven bars	A. Mustafina	Russia	1.211	-1.433	1.143
Vault	S. Izbasa	Romania	1.113	-1.378	1.016 <sup>c</sup>

<sup>a</sup>See Table 1.

<sup>b</sup>See Table 1.

<sup>c</sup>Calculated with six gymnasts, due to one incomplete vault (which was given a "0") and one gymnast with the lowest non-zero score.

**Table 6. z-scores from the 2008 and 2012 Summer Olympics, Men's Gymnastics Events**

Name of event	Winner's name <sup>a</sup>	Country	Winner's z-score	Lowest z-score	Winner's adjusted z-score <sup>b</sup>
2008					
Floor	K. Zou	China	1.092	-1.994	1.263
Horizontal bar	K. Zou	China	1.249	-1.406	1.179
Parallel bars	X. Li	China	1.350	-1.770	1.454
Pommel horse	Q. Xiao	China	1.210	-1.717	1.240
Rings	Y. Chen	China	1.263	-1.886	1.420
Vault	L. Blanik	Poland	1.141	-1.516	1.083
2012					
Floor	K. Zou	China	1.360	-1.384	1.298
Horizontal bar	E. Zonderland	Netherlands	1.125	-1.429	1.045
Parallel bars	Z. Feng	China	1.682	-1.334	1.639
Pommel horse	K. Berki	Hungary	1.256	-1.492	1.210
Rings	A. Zanetti	Brazil	0.955	-1.991	1.046
Vault	H. Yang	South Korea	1.295	-1.467	1.248

<sup>a</sup>See Table 1.<sup>b</sup>See Table 1.

Table 5 summarizes the results for female gymnasts. Romanian Sandra Izbaşa won gold in 2008 on floor exercise with the highest z-score of 1.104 (and an adjusted z-score of 1.155). In 2012, American Alexandra ("Aly") Raisman won individual gold on floor, with the highest z-score (1.314) as well as the highest adjusted z-score (1.784).

Table 6 summarizes the results for male gymnasts. Noteworthy is the domination of Chinese gymnasts in Beijing in 2008. Xiaopeng Li's z-score (1.350) and adjusted z-score (1.454) on parallel bars were highest in 2008. Countryman's Zhe Feng's z-scores [unadjusted (1.682) and adjusted (1.639)] also on parallel bars were highest in 2012.

### Concluding Remarks

Standardized scores known as z-scores are used to determine the most dominant Olympian at the 2008 Beijing

Games and 2012 London Games in individual events in women's and men's swimming, track, and gymnastics. A z-score measurement would be an "extreme outlier" if it fell more than 3 standard deviations above or below the mean. In the finals of all individual events contested in the three aforementioned sports, no athlete in either 2008 or 2012 was an "extreme outlier."

The most dominant athlete (with the highest z-score, calculated with or without the last place finisher) at the 2008 Beijing Games in the three sports was neither swimmer Michael Phelps nor sprinter Usain Bolt, but rather LaShawn Merritt in the 400 meter run. The most dominant athlete four years later was swimmer Dana Vollmer, who set a world record in the 100 meter butterfly. In 2012, she was the *only* athlete whose performance in the finals of an individual swimming, track, or gymnastic event fell more than 2 standard deviations above the mean.

**2008 Gymnastics**

	beam	women_floor	uneven_bars	women_vault	men_floor	horiz_bar
1	16.225	15.65	16.725	15.65	16.05	16.2
2	16.025	15.5	16.725	15.575	15.775	16.175
3	15.95	15.425	16.65	15.562	15.725	15.875
4	15.9	15.35	16.625	15.537	15.65	15.675
5	15.625	15.025	16.375	15.05	15.575	15.45
6	15.3	14.975	16.325	14.55	15.2	15.225
7	14.825	14.55	15.575	14.487	14.85	15
8	14.45	14.125	14.875	7.812	14.125	14.825

	parallel_bars	pommel_horse	rings	men_vault
1	16.45	15.875	16.6	16.537
2	16.25	15.725	16.425	16.537
3	16.2	15.725	16.325	16.475
4	15.975	15.45	16.225	16.225
5	15.725	15.375	16.225	16.062
6	15.7	15.175	16.2	16.05
7	15.65	14.975	15.825	15.925
8	15.15	14.65	15.525	15.737

**2008 Swimming**

	women50mfree	women100mfree	women200mfree	women400mfree	women800mfree
1	24.06	53.12	114.82	243.22	494.1
2	24.07	53.16	114.97	243.29	500.23
3	24.17	53.39	115.05	243.52	503.03
4	24.25	53.97	115.78	243.6	503.11
5	24.26	54.06	116.87	244.56	506.34
6	24.63	54.21	117.65	244.66	506.39
7	24.65	54.21	117.83	245.05	509.79
8	24.77	54.29	117.83	251.26	512.35

	women100mfly	women200mfly	women100mback	women200mback	women100mbreast
1	56.73	124.18	58.96	125.24	65.17
2	57.1	124.72	59.19	126.23	66.73
3	57.25	126.26	59.34	127.13	67.34
4	57.84	127.02	59.38	127.88	67.43
5	57.99	127.32	59.4	128.23	67.62
6	58.06	127.36	59.72	128.51	67.63
7	58.1	127.57	60.1	128.84	68.08

8	58.54	128.23	60.18	130.12	68.43
	women200mbreast	women200mim	women400mim	men50mfree	men100mfree
1	140.22	128.45	269.45	21.3	47.21
2	142.05	128.59	269.89	21.45	47.32
3	143.02	130.34	271.71	21.49	47.67
4	143.24	130.68	274.24	21.62	47.67
5	143.76	131.43	274.34	21.64	47.75
6	143.77	131.56	279.44	21.65	48.04
7	145.14	132.43	280.04	21.67	48.2
8	145.23	133.36	282.13	21.72	48.33

	men200mfree	men400mfree	men1500mfree	men100mfly	men200mfly
1	102.96	221.86	880.84	50.58	112.03
2	104.85	222.44	881.53	50.59	112.7
3	105.14	222.78	882.69	51.12	112.97
4	105.97	223.11	883.21	51.13	114.35
6	106	223.45	888.16	51.47	114.35
7	106.95	223.84	892.11	51.5	114.6
8	107.14	223.97	895.2	51.59	114.71
	107.47	228.29	905.12	51.86	115.14

	men100mback	men200mback	men100mbreast	men200mbreast	men200mim	men400mim
1	52.54	113.94	58.91	127.64	114.23	243.84
2	53.11	114.33	59.2	128.88	116.52	246.16
3	53.18	114.93	59.37	128.94	116.53	248.09
4	53.18	115.49	59.57	129.03	118.14	252.16
5	53.31	115.72	59.74	129.22	118.22	252.47
6	53.39	116.39	59.87	129.76	119.24	252.84
7	53.51	116.52	60.2	130.57	119.43	253.38
8	53.99	117	60.24	131.48	120.76	255.4

**2008 Track**

	women100m	women200m	women400m	women800m	women100mhurdles	women400mhurdles
1	10.78	21.74	49.62	114.87	12.54	52.64
2	10.98	21.93	49.69	116.07	12.64	53.7
3	10.98	22	49.93	116.73	12.64	53.84
4	11.03	22.01	50.01	116.94	12.65	53.96
5	11.07	22.34	50.03	117.68	12.65	54.29
6	11.14	22.36	50.11	118.24	12.66	54.96
7	11.19	22.61	50.68	118.73	12.72	54.97
8	11.2	22.68	51.18	122.63	12.94	57.55

	men100m	men200m	men400m	men800m	men110mhurdles	men400mhurdles
1	9.69	19.3	43.75	104.65	12.93	47.25
2	9.89	19.96	44.74	104.7	13.17	47.98
3	9.91	19.98	44.8	104.82	13.18	48.06
4	9.93	20.22	44.84	104.94	13.24	48.3
5	9.95	20.4	45.11	104.95	13.36	48.42
6	9.97	20.59	45.12	105.88	13.46	48.52
7	10.01		45.22	105.96	13.6	48.6
8	10.03		45.39	107.19	13.69	49.96

### 2012 Gymnastics

	menvault	menfloor	menhorizbar	menparabar	menpommel	menrings
1	16.533	15.933	16.533	15.966	16.066	15.9
2	16.399	15.8	16.4	15.8	16.066	15.8
3	16.316	15.8	16.366	15.566	15.6	15.733
4	16.183	15.366	16.266	15.5	15.4	15.666
5	16.05	15.333	15.833	15.333	15.141	15.633
6	15.866	15.333	15.466	15.3	14.766	15.6
7	15.633	15.1	15.333	15.3	14.733	15.108
8	15.533	14.966	15.133	15.1	14.3	14.733

	womenbeam	womenfloor	womenunevenbar	womenvault
1	15.6	15.6	16.133	15.191
2	15.5	15.2	15.933	15.083
3	15.066	14.9	15.916	15.05
4	15.066	14.9	15.766	15.016
5	14.583	14.833	15.666	14.783
6	14.2	14.566	15.266	14.516
7	13.633	14.5	14.966	14.483
8	13.166	13.333	14.9	

### 2012 Swimming

	men400mfree	men100mbreast	men400mim	women100mfly	women400mim	women800mfree
1	220.14	58.46	245.18	55.98	268.43	494.63
2	222.06	58.93	248.86	56.87	271.27	498.76
3	224.69	59.49	248.94	56.94	272.91	500.32
4	226.02	59.53	249.28	57.17	273.49	502.72
5	226.39	59.79	252.42	57.27	274.17	503.86
6	227.03	59.87	253.3	57.35	275.49	503.89
7	228.62	59.97	253.49	57.48	275.49	509.26
8	229.25	60.84	254.89	57.76	275.62	509.28

	women400mfree	men200mfree	women100mback	men100mback	women100mbreast	women200mim
1	241.45	103.14	58.33	52.16	65.47	127.57
2	241.77	104.93	58.68	52.92	65.55	128.15
3	243.01	104.93	58.83	52.97	66.46	128.95
4	243.98	105.04	59	53.08	66.93	129.55
5	244.5	105.53	59.2	53.35	66.95	129.83
6	245.95	106.53	59.23	53.48	66.96	131.13
7	246.24	106.93	59.29	53.55	66.98	131.29
8	246.25	107.75	60.5	53.77	67.55	134.19
	men200mfly	women200mfree	men200mbreast	women200mfly	men100mfree	women200mbreast
1	112.96	113.61	127.28	124.06	47.52	139.59
2	113.01	115.58	127.43	125.25	47.53	140.72
3	113.21	115.81	128.29	125.48	47.8	140.92
4	114.35	115.82	128.35	125.78	47.84	141.65
5	115.06	116.73	129.02	126.78	47.88	143.16
6	115.07	117.25	129.25	126.8	47.92	143.27
7	115.08	117.6	129.28	127.33	48.04	143.72
8	115.18	117.68	129.44	127.77	48.44	146

	men200mim	women100mfree	men200mback	men50mfree	men100mfly
1	114.27	53	113.41	21.34	51.21
2	114.9	53.38	113.78	21.54	51.44
3	116.22	53.44	113.94	21.59	51.44
4	116.74	53.47	115.59	21.61	51.81
5	117.35	53.64	115.59	21.78	51.81
6	118.53	53.66	117.03	21.8	51.82
7	119.05	53.75	117.62	21.82	51.88
8	119.1	54.02	118.02	21.98	52.05

	women200mback	women50mfree	men1500mfree
1	124.06	24.05	871.02
2	125.92	24.28	879.63
3	126.55	24.39	880.31
4	127.26	24.46	890.61
5	127.43	24.47	891.92
6	128.18	24.61	892.99
7	128.43	24.62	894.32
8	129.86	24.69	900.76

**2012 Track**

	men110mhurdles	men800m	women400m	women800m	men400m	men400mhurdles
1	12.92	100.91	49.55	116.19	43.94	47.63
2	13.04	101.73	49.7	117.23	44.46	47.91
3	13.12	102.53	49.72	117.53	44.52	48.1
4	13.39	102.82	49.75	117.59	44.79	48.24
5	13.4	102.95	50.11	117.93	44.81	48.25
6	13.43	103.2	50.17	119.21	44.83	48.86
7	13.53	103.32	50.33	119.63	44.98	49.12
8		103.77	50.79	120.19	45.14	49.15

	men200m	men100m	women100m	women100mhurdles	women200m	women400mhurdles
1	19.32	9.63	10.75	12.35	21.88	52.7
2	19.44	9.75	10.78	12.37	22.09	52.77
3	19.84	9.79	10.81	12.48	22.14	53.38
4	19.9	9.8	10.85	12.58	22.38	53.66
5	20	9.88	10.89	12.58	22.39	53.92
6	20.19	9.94	10.94	12.65	22.57	55.07
7	20.57	9.98	11	12.69	22.63	55.27
8	20.69	11.99	11.01	13.07	22.87	55.31

**References**

1. M. Futterman, The best Olympic performance so far, *Wall Street Journal*, February 24, 2010  
at [online.wsj.com/article/SB10001424052748704188104575083680705933708.html](http://online.wsj.com/article/SB10001424052748704188104575083680705933708.html).
2. Olympic results in swimming, track, and gymnastics: [www.olympic.org/sports](http://www.olympic.org/sports)

**Footnotes**

1. Michael Phelps (United States) won eight gold medals in 2008, four more golds in 2012 (in addition to two silver medals), not to mention six gold and two bronze medals at the 2004 Athens Olympics, for a total of 22 medals.
2. Usain Bolt (Jamaica) actually won two events, a so-called “double double” – 100 meters and 200 meters – in back-to-back Olympics (2008 and 2012).
3. Kai Zou (China) won individual gold medals in floor exercise at the 2008 Olympic Games in Beijing and at the 2012 Olympic Games in London, another individual gold on the horizontal bar in 2008 and a bronze on the same apparatus in 2012.
4. Consider the women’s 100m backstroke in 2012. Chinese swimmer Fu Yuanhui finished eighth (or last), 2.17 seconds slower than winner’s Missy Franklin’s time and 1.21 seconds slower than the seventh place swimmer. That is, Fu Yuanhui’s time dramatically increased the standard deviation, resulting in a relatively low z-score for Franklin. When Fu Yuanhui’s time is excluded, Missy Franklin’s (adjusted) z-score is about 40 percent higher.