



TRENDS AND PREDICTIONS OF OLYMPIC WINNING PERFORMANCES : 1952 -1988

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The purpose of this paper is to estimate the rate of improvement of certain Olympic events and to identify trends in those rates of improvement. Many of the over 220 current Olympic events do not lend themselves to such a study. Further, wartime gaps in Olympic competition and the influence of high altitude upon the Mexico City Olympics must be considered.

One cannot infer changes in quality from the total score or winning margin in team sports such as basketball and handball and individual sports such as wrestling and boxing. Although a single metric is

available for gymnastics and diving, the scoring procedure has changed and is inherently subjective.

In timed events such as yachting and the marathon, the terrain, distance, and weather conditions speak against meaningful comparisons.

The year 1952 is chosen as the starting point for this study since the effects of World War II had largely diminished, the USSR had re-entered competition, and an unbroken string of Olympic Games spans the period from then until now. There are 28 events in athletics (called track and field in

the USA) and 11 events in swimming which have been included in all Olympics from 1952 until 1984. These events have in common that the competitive conditions are consistent enough to permit a meaningful comparison of the winning performances.

Analyses of these 39 events were published by this author in 1977 and 1982 (see the References at the end of this paper). To this list can be added 7 weightlifting events that span the period but for which special consideration is needed. The weight ranges by which competitors are classified as middleweight, light-heavyweight, middle-heavyweight and super-heavyweight beginning in 1972 are equivalent to the classes welterweight, middleweight, light-heavyweight, and heavyweight respectively before 1972. Before 1976 the total weight was combined for 3 lifts. Starting in 1976 only 2 lifts are used. This change makes it necessary to extract the highest totals for the current two lifts from prior Olympic data.

In summary there are 46 events contested over the study period. For those events trends in winning performances may be evaluated. A group of 22 newer events will be considered later in this paper. The latter events were added after 1952.

In order to estimate the rate of improvement of each event it is assumed that the winning performance in one Olympics is equal to a factor M times the winning performance in the previous Olympics plus a random fluctuation. The method of least-squares may be used to select a value of M which fits all the past data reasonably well. It is not within the scope of this paper to consider a rigorous proof of this procedure. For those who may be interested, the least-squares value of M is given by :

$$M = \frac{\sum_{n=2}^N X_{n-1}X_n}{\sum_{n=2}^N X_{n-1}^2}$$

where X_n indicates the winning performance in Olympics number n (a convenient way to number the Olympics starting with 1952) and N is the last Olympics used (the 1984 Olympics would be the ninth starting with 1952).

The percent improvement per Olympiad (%I/O) may be computed for events where M should be greater than one (weightlifting and discus events for example) by taking 100 (M-1). If M = 1.054 for a weightlifting event the %I/O would be 5.4%. For timed events in which M should be less

than 1, the %I/O is 100 (1 -M). If M = .98 for the 100 metre swim, the %I/O would be 2%.

High altitude is said to improve the performance in short-duration events and impede the performance in longer-duration events. Note for example Bob Beamon's exceptional long jump in 1968 as compared to the relatively slow distance-running times wherein runners from high-altitude African nations dominated. In this study the 1968 winning performances were replaced by the geometric mean of the 1964 and 1972 performances (for the mathematically-oriented reader that means that each winning performance in Olympics number 5 (X_5) is replaced by $\sqrt{X_4 X_6}$). The 1968 Olympic winning performances are therefore replaced by what would have been expected to occur in 1968 if that Olympics had been held at low altitude.

PERCENT IMPROVEMENT BY TYPE OF EVENT

Table 1 shows the %I/O averaged by type of event for data up to and including the indicated Olympiad.

Men's events can be ranked in order of increased rate of improvement : running, jumping, swimming and throwing. Weightlifting and throwing events are about equal. It appears that the application of leverage plays a central role in determining the rate of improvement. The rate of improvement in women's events follows the same order as the men's events excluding weightlifting in which women do not compete. The %I/O for women is consistently higher than that of men for each type of event.

TABLE 1
Average Percent Improvement per Olympiad from 1952 through the Indicated Date for Selected Sports Disciplines.

Sport	1964	1976	1980	1984
Men's running	0,85	0,73	0,54	0,66
Men's jumping	1,85	1,42	1,59	1,32
Men's Throwing	4,13	3,54	3,17	2,38
Women's running	1,03	0,97	1,02	0,96
Women's jumping	3,53	1,79	2,00	1,80
Women's throwing	5,22	4,91	4,69	3,14
Men's swimming	2,37	2,55	2,20	2,06
Women's swimming	2,79	2,84	2,67	2,29
Weightlifting	4,05	3,42	3,62	2,29
% events improved	84,8	78,3	67,4	45,7

The %I/O's are generally diminishing when viewed across the span of Olympiads. That is, there is consistent improvement but the rate of that improvement is slowing down. That conclusion may be supported by examining the percent of the

46 events in which the winning performance of one Olympics is better or equal to that in the previous Olympics. One has 1956 (87%), 1960 (89%), 1964 (85%), 1976 (78%), 1980 (67%), 1984 (46%). Clearly the rate of improvement had been diminishing before the unfortunate absence of several Western nations in 1980 and Eastern European nations in 1984. Abnormally large fluctuations in the averages in Table 1 are indicators of classes or a group of events in which the absent nations are normally dominant.

From 1976 to 1980 the average %I/O declined considerably in men's running and swimming events, and indication that these events are dominated by Western athletes. From 1980 to 1984 the average %I/O dropped dramatically in men's and women's throwing events, women's swimming events, and weightlifting, areas apparently dominated by Eastern European athletes. Further evidence for these conclusions follows from predictions of each of the 39 events previously reported and the 7 weightlifting events added in this study.

PREDICTIONS FOR 1984

Table 2 contains, for each of 46 events, the %I/O through 1984, the actual 1984 winning performance, the prediction for 1984 based on data through 1980, and the percent error between predicted and actual outcomes. A negative percent error indicates an actual performance that was worse than predicted, that is, time duration was longer, distance or height was shorter, or lifted weight was less. In 67% of the events the actual performance was worse than predicted. In 54% of the events, the 1984 winning performance was worse than in 1980, including all 7 weightlifting events and 4 of the 5 women's swimming events.

The relative strength of Eastern and Western athletes may also be compared using data from the post-Olympic Friendship Games. Those games were held for Eastern European athletes and some Western invitees. In those games the Olympic winning performance was bettered in all 4 men's throwing events and in all 3 women's throwing events. Conversely, none of the winning performances in the 12 men's running events were bettered. Another source of comparison was the men's USA swimming championships held after the 1980 Olympics, in which American men bettered the Olympic winning performances in 6 of 11 events.

The above data supports the conclusion that the Western athletes tend to dominate men's run-

ning and swimming events while Eastern European athletes tend to dominate men's and women's throwing events, women's swimming events, and weightlifting.

An investigation of the accuracy of predictions for previous Olympic Games supports the conclusion that the average Olympic winning performance of 1980 (when many Western athletes were absent) was diminished by 1% for the events studied. When Eastern athletes were absent in 1984, a reduction of nearly 3% was noted. The greater detriment due to the absence of Eastern European athletes is due to the fact that the events they dominate are those which have had relatively high percent improvements as compared to those dominated by Western athletes.

In spite of the absence of certain athletes in 1980 and 1984 most of the predictions in both Olympics were quite accurate.

The actual winning performances in 9 of the events in Table 2 are within 1% of the predicted outcomes. Sara Simeoni of Italy may be the most predictable athlete of the last two Olympics. In the 1980 women's high jump she won with the exact predicted height of 1.97 m. In 1984 she attained a height of 2.00 m as compared to the prediction of 2.01 m, only to have Ulrike Meyfarth of West Germany reach 2.02 m to win the gold medal. Valerie Brisco-Hooks of the USA in the women's 200 m run and Victor Davis of Canada in the men's 200 m breaststroke won in essentially the time predicted.

American Carl Lewis' victory in the 100 m run exceeded the prediction by the greatest percent (2.4%) of the 46 events. Sebastian Coe of Great Britain exceeded the prediction by 2.3% in the 1500 m run.

Furthest below expectation (-18.2%) was Petre Becheru of Romania, winner of light-heavy-weight weightlifting. He would not have won in 1980 or 1976. Claudia Losch of West Germany was 15.4% below expectation when she won the women's shot put. Her distance would not have won in 1980, 1976, or 1972.

PREDICTIONS FOR 1988

Table 2 contains predictions for 1988 for the 46 events that have been contested from 1952 through 1984. These predictions for 1988 are computed by applying the percent improvement per Olympiad to the 1984 winning performance, assuming that each rate of improvement will continue for the next 4 years. Table 3 contains predictions for 1988 for 22

TABLE 2
Accuracy of Predictions for 1984 and Predictions for 1988 : 46 Events. Distances and heights are in meters. Weights are in kilograms.

Events	% Imp/Olymp.	1984 Actual	1984 Predict.	% error	1988
Mens 100 m run	0.52	9''99	10''23	2.40	9''94
Mens 200 m run	0.56	19''80	20''12	1.60	19''69
Mens 400 m run	0.46	44''27	44''41	0.30	44''06
Mens 800 m run	0.74	1'43''00	1'44''85	1.80	1'42''24
Mens 1500 m run	0.73	3'32''53	3'37''41	2.30	3'30''98
Mens 5000 m run	0.94	13'05''59	13'14''54	1.10	12'58''20
Mens 10 000 m run	0.67	27'47''54	27'29''36	-1.10	27'36''35
Mens 4x100 m relay	0.73	37''83	38''00	0.40	37''55
Mens 4x400 m relay	0.42	2'57''91	3'00''69	1.60	2'57''17
Mens 110 m hurdles	0.47	13''20	13''34	1.10	13''14
Mens 400 m hurdles	0.79	47''75	48''39	1.30	47''37
Mens 3000 m stiplchse	0.84	8'11''80	8'04''78	-1.40	8'07''68
Mens high jump	1.74	2.35	2.41	-2.60	2.39
Mens triple jump	0.75	17.26	17.51	-1.40	17.39
Mens long jump	1.46	8.54	8.71	-2.00	8.66
Mens pole vault	2.84	5.75	5.98	-4.00	5.91
Mens shot put	2.26	21.26	21.93	-3.20	21.74
Mens discus	2.26	66.60	68.42	-2.70	68.10
Mens hammer throw	2.92	78.08	85.41	-9.40	80.36
Mens javelin	1.60	86.76	93.62	-7.90	88.15
Womens 100 m run	0.61	10''97	11''00	0.30	10''90
Womens 200 m run	1.04	21''81	21''80	—	21''58
Womens 4x100 m relay	1.24	41''65	41''01	-1.50	41''13
Womens high jump	2.28	2.02	2.01	0.50	2.07
Womens long jump	1.31	6.96	7.18	-3.20	7.05
Womens shot put	2.98	20.48	23.63	-15.40	21.09
Womens discus	2.60	65.36	73.06	-11.80	67.06
Womens javelin	3.83	69.56	71.32	-2.50	72.22
Mens 100 m swim	1.82	49''8	49''44	-0.70	48''89
Mens 400 m swim	2.01	3'51''23	3'46''13	-2.20	3'46''59
Mens 1500 m swim	2.62	15'05''20	14'31''32	-3.70	14'41''48
Mens 100 m backstroke	2.08	55''79	55''30	-0.90	54''63
Mens 200 m breaststroke	1.81	2'13''34	2'13''40	—	2'10''93
Mens 4x200 m relay	2.02	7'15''69	7'14''42	-0.30	7'06''91
Womens 100 m swim	2.40	55''92	53''19	-4.90	54''58
Womens 400 m swim	3.02	4'07''10	4'00''58	-2.60	3'59''63
Womens 100 m badstroke	2.25	1'02''55	59''14	-5.50	1'01''14
Womens 200 m breaststroke	1.63	2'30''38	2'26''73	-2.40	2'27''93
Womens 4x100 m relay	2.16	3'43''43	3'37''26	-2.80	3'38''61
Bantamweight	2.05	267.50	283.00	-5.80	273.00
Featherweight	1.87	282.50	297.50	-5.30	288.00
Lightweight	2.36	320.00	356.50	-11.40	327.50
Middleweight	2.04	340.00	372.50	-9.60	347.00
Light heavyweight	2.00	355.00	419.50	-18.20	362.00
Middle heavyweight	2.77	392.50	387.00	1.40	403.50
Super heavyweight	2.94	412.50	461.00	-11.80	424.50
Mean				-3.10	
Standard deviation				4.79	

TABLE 2a
Predictions in Feet and Inches for the Events in Table 2

Events	1988
Mens high jump	7'10''
Mens triple jump	57'00 1/2''
Mens long jump	28'04 1/2''
Mens pole vault	19'04 1/2''
Mens shot put	71'03''
Mens discus	223'05''
Mens hammer throw	263'07''
Mens javelin	289'02''
Womens high jump	6'09 1/2''
Womens long jump	23'01 1/2''
Womens shot put	69'02 1/4''
Womens discus	220'0''
Womens javelin	236'11''

newer events. Of these, 2 were instituted in 1956, 3 in 1960, 4 in 1964, 8 in 1968, and 5 in 1972. To simplify computations, the period from 1972 through 1980 was used in generating the %1/O.

The expected error of these 68 predictions for 1988 may be estimated based on attempts at making predictions for the past Olympics. Ninety five percent of the percent errors for 1988 should lie between the mean of previous percent error plus or minus 2 standard deviations. The standard deviation of a set of data is a statistical measure of the data's spread. Based on such past data, the error for the 33 athletics predictions should lie in the range -1.2% ±5.8% ; the error for the 26 swimming predictions in the range -1.2% ±3.9% ; and the error for the 9 weightlifting predictions in the range -2.5% ±9%. The actual ranges will depend strongly on the presence or absence of Western and Eastern athletes, an occurrence which defies prediction at this time.

TABLE 3
Predictions for 1988: 22 Events Added after 1952. Weights are in Kilograms.

	% Imp/Olymp.	1964
Womens 400 m run	1.54	48''83
Womens 800 m run	0.32	1'57''60
Womens 1500 m run	-0.22	4'03''25
Womens 100 m hurdles	-0.65	12''84
Womens 4x400 m relay	0.79	3'18''29
Mens 200 m swim	1.61	1'47''44
Mens 200 m backstroke	0.74	2'00''23
Mens 100 m breaststroke	1.73	1'01''65
Mens 100 m butterfly	0.74	53''08
Mens 200 m butterfly	1.02	1'57''04
Mens 200 m 4 butterfly	1.84	4'17''41
Mens 4x100 m mdl. relay	1.33	3'39''30
Womens 200 m swim	1.23	1'59''23
Womens 800 m swim	1.86	8'24''95
Womens 100 m backstroke	1.73	2'12''38
Womens 100 m breaststroke	1.74	1'09''88
Womens 100 m butterfly	2.27	59''26
Womens 200 m butterfly	2.19	2'06''90
Womens 400 m ind. mdl.	2.88	4'39''24
Womens 4x100 m mlr. relay	1.70	4'08''34
Flyweight	1.24	235
Second heavyweight	1.34	390

MEN VERSUS WOMEN IN SWIMMING

Table 4 contains the percent differences between the winning male and female swimmers in events over common distances. This data indicates that the percent difference diminishes with distance in each stroke. That is, the difference in time between the winning male and female swimmer rises with distance but not in proportion to the distance of the event. In the 1984 Olympics, the winning male

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swimmer was faster by 6.12 seconds at 100 m, 11.79 seconds at 200 m, and by 15.87 seconds at 400 m. The data supports the inclusion of the womens marathon in the 1984 Olympics and the data calls for a women's 1500 m swim in future Olympics.

Table 4 shows that the average percent difference rose from 1980 to 1984 reversing a generally downward trend that had held for several Olympiads.

The larger percent differences for 1984 may be due to the absence of Eastern European women swimmers who tend to dominate those events. Should that group compete in 1988, it is expected that the percent differences should drop accordingly.

TABLE 4
Percent Differences Between Winning Male and Female Swimmers

Events	1972	1976	1980	1984
100 m freestyle swim	12.6	10.2	8.0	10.9
200 m freestyle	8.7	7.5	7.2	9.9
400 m freestyle	7.2	7.2	7.0	6.4
100 m backstroke	14.0	10.3	7.1	10.8
200 m backstroke	11.8	10.1	7.5	9.2
100 m breaststroke	11.8	11.3	9.8	11.8
200 m breaststroke	13.5	11.9	9.2	11.3
100 m butterfly	14.3	9.6	9.1	10.4
200 m butterfly	11.0	9.3	8.2	7.8
200 m indiv. medley	11.1			8.5
400 m indiv. medley	10.2	6.8	4.8	7.8
4x100 m medley relay	12.5	10.4	7.8	11.7
4x100 m free relay	12.2			10.9
Average of 13 events	11.5	9.5	7.8	9.8





COMMENTARY

Some subjective comments may be added to the above objective conclusions. Since the 1984 Olympics venues were nearby, this author had the opportunity to view firsthand those events that he had seen only on television. The most memorable aspect of the 1984 Olympics was the goodwill shown to all competitors by the American public. The struggling marathon also-ran was accorded much the same applause as the front runner. Nearly the same support was given to the weightlifter attempting his national record as was given to the medal contender lifting a far heavier weight. The absence of the average athlete who might have experienced such moments of glory is perhaps

more of a tragedy than the absence of the superlative performers who will compete again. I join true sportsmen everywhere who hope that for one gleaming period every four years the world can focus attention on the spectacle at athletic competition among all nations rather than the spectre of international strife among a few.

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