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©Journal of Sports Science and Medicine (2010) 9, 214-223
http://www.jssm.org

Research article

Women and men in sport performance: The gender gap has not evolved since 1983

Valérie Thibault [1]✉, Marion Guillaume [1], Geoffroy Berthelot [1], Nour El Helou [1], Karine Schaal [1], Laurent Quinquis [1], Hala Nassif [1], Muriel Tafflet [1,3], Sylvie Escolano [1,3], Olivier Hermine [2,4] and Jean-François. Toussaint [1,2,5]

[1] IRMES, INSEP, Paris, France, [2] Université Paris-Descartes, Paris, France, [3] INSERM U970, Centre de Recherche Georges Pompidou, Paris, France,[4] Service Hématologie, Hôpital Necker and CNRS UMR, Paris, France,[5] CIMS, Hôtel-Dieu, Assistance Publique - Hôpitaux de Paris, Paris, France

Abstract

Sex is a major factor influencing best performances and world records. Here the evolution of the difference between men and women's best performances is characterized through the analysis of 82 quantifiable events since the beginning of the Olympic era. For each event in swimming, athletics, track cycling, weightlifting and speed skating the gender gap is fitted to compare male and female records. It is also studied through the best performance of the top 10 performers in each gender for swimming and athletics. A stabilization of the gender gap in world records is observed after 1983, at a mean difference of 10.0% ± 2.94 between men and women for all events. The gender gap ranges from 5.5% (800-m freestyle, swimming) to 18.8% (long jump). The mean gap is 10.7% for running performances, 17.5% for jumps, 8.9% for swimming races, 7.0% for speed skating and 8.7% in cycling. The top ten performers' analysis reveals a similar gender gap trend with a stabilization in 1982 at 11.7%, despite the large growth in participation of women from eastern and western countries, that coincided with later-published evidence of state-institutionalized or individual doping. These results suggest that women will not run, jump, swim or ride as fast as men.

Key words: World records, best performances, gender difference, elite sport.

Introduction

Sex has been identified as a major determinant of athletic performance through the impact of height, weight, body fat, muscle mass, aerobic capacity or anaerobic threshold as a result of genetic and hormonal differences (Cureton et al., 1986; Maldonado-Martin et al., 2004; Perez-Gomez et al., 2008; Sparling and Cureton, 1983). Some authors have suggested that gender differences in race records may disappear (Beneke et al., 2005; Tatem et al., 2004; Whipp and Ward, 1992); other have studied physiological limits in sport with non linear models, but with limited data (Nevill and White, 2005; Nevill et al., 2007). However, men and women differences should first be studied through the complete panel of quantifiable Olympic disciplines. Over the modern Olympic era (1896-2007) the evolution of time, distance or height values of world records was shown to follow a piecewise exponential model (Berthelot et al., 2008). Further, women presently display lower record values compared to men. An asymptote for all events has been suggested, with a limit in women's performances that remains inferior to men's. Thus, gender gaps will probably be settled when men and women reach their physiological limits. Here we compare the improvement of male and female world records and ten best performances (*ie.* the best performance of the top ten performers of each gender every year) over the modern Olympic era in order to measure the evolution of gender gaps.

Methods

The data set included 82 events from five quantifiable Olympic disciplines (International Olympic Committee, 2008; Official Fina website, 2008; USA Swimming website, 2008): athletics, swimming, speed skating, track cycling and weightlifting. The number of each Olympic event by discipline is given in Table 1. Only events strictly comparable between men and women were studied. For track events, selected races have the same distances for both (women's 100m hurdles and men's 110m hurdles have been excluded) and of field events, only jumps were included. Throws were excluded as projectile weights are different for men and women. All weight categories in weightlifting do not exactly match (8 divisions for men from 56kg to 105+kg and 7 for women from 48kg to 75+kg). Therefore weightlifting world records analysis was performed through 3 classes only: the heaviest (Heavyweight), the lightest (Flyweight), and an in-between matching category (Lightweight, 63-69kg for women and 64-70kg for men).

For all 82 Olympic events, world records progressions were compiled. Each gender gap series started with the first common chronological record for both men and women. An unbeaten record was extended until it is improved (there is not one newly established record every year); 2768 gaps were measured for world records (Figure 1).

Ten best performers database

For 60 swimming and athletics events, the best performance of the first ten performers were collected every year from three data sources (International Olympic Committee, 2008; Official Fina website, 2008; USA Swimming website, 2008) over the 1891 - 2008 period for 26 athletics events and the 1963 - 2008 period for 34 swimming events; 23864 performances were analysed (*ie.* 11932 ten

Received: 07 December 2009 / Accepted: 02 March 2010 / Published (online): 01 June 2010

Table 1. Comparable events between male and women. Only events strictly comparable are included in the study (100m Hurdles Women, 110m Hurdles Men and throws excluded).

Track and Field	Swimming	Cycling*	Speed Skating*	Weightlifting*
High Jump	50m FS	Sprint	500 m	Fly weight (-56kg / -48kg)
Long Jump	100m FS		1000 m	Light weight (-69kg / -69kg)
Pole Volt	200m FS		1500 m	Heavy weight (+105 / +75kg)
Triple Jump	400m FS		5000 m	
	800m FS			
100 m	1500m FS			
200 m	100m Back			
400 m	200m Back			
800 m	100m Breast			
1 500 m	200m Breast			
5 000 m	100m Fly			
10 000 m	200m Fly			
4x100 m *	4x100m FS			
4x400 m *	4x100m MR			
400m hurdles	4x200m FS			
20km Walk *	200m IM			
Marathon	400m IM			

* No data for TBP

best performances gaps) from a compiled International Olympic Committee database collecting 45968 best performances (International Olympic Committee, 2008) with associated gender and citizenship.

Estimate of gender gaps

The gender gaps between world records (WR) and between ten best performances were calculated, as well as their scattering evolution and number of records beaten yearly.

For each year, the gap between the two records is calculated as follows:

for chronometric events ($WR_m < WR_w$)

$$\Delta_i = WR_{wi} - WR_{mi}$$

for non-chronometric events ($WR_m > WR_w$)

$$\Delta_i = WR_{mi} - WR_{wi}$$

Where WR_{wi} is the world record of women at year i, WR_{mi} is the world record of men at year i.

The gaps of the top ten performers were measured each year. Ten gaps were calculated; the first female performance compared to the first male performance, the second female to the second male and so forth. The yearly ten best performances gender gap TBP_i is the mean of the 10 individual gaps:

$$TBP_i = \frac{1}{10} * \sum_{i=1}^{10} \Delta_{ij}$$

Where Δ_{ij} is the gender gap for the j-th performance at year i.

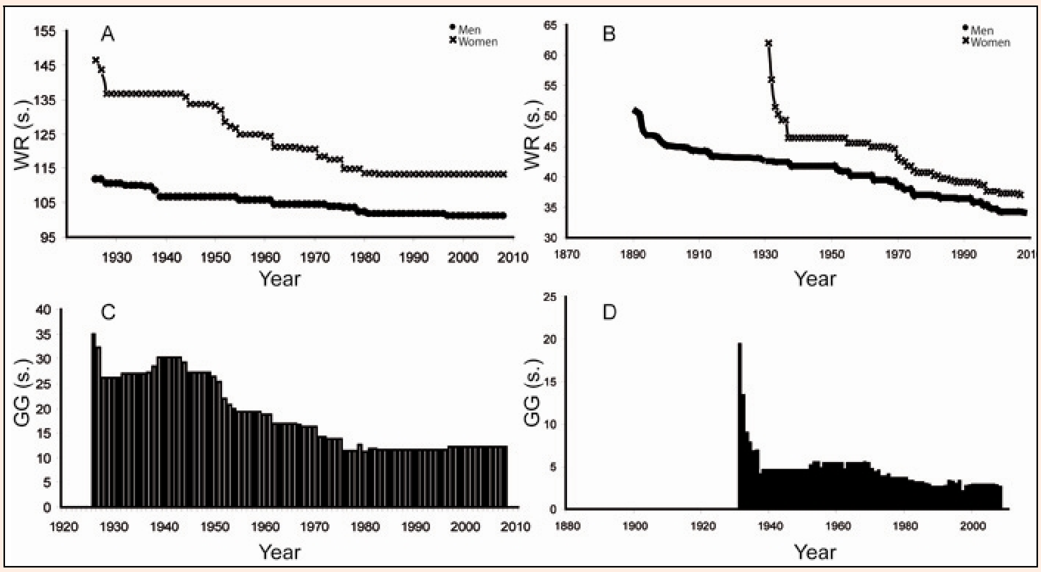

Figure 1. World Record and Gender Gap evolution over the Olympic era in A. 800m, Athletics world records B. 500 m, Speed skating, world records C. 800m, Athletics D. 500 m, Speed skating.

Change of incline

A breaking slope method was used for the gender gap (GG) curves of 66 Olympic events in swimming, athletics, speed skating and track cycling. It aimed to find the best combination of two linear regressions, which showed the largest difference between their slope – a significant decrease in gender gaps variations. For each event, a first model was performed with a minimum of eight points (eights years of records or performances) to fit the first linear regression. The second regression was fitted with the points that were left (from the ninth point to the last one). An eight year segment representing two Olympiads was chosen as the minimum time span over which a period could be considered as stable. Then, a second model was created with the first slope now including one more point, and the second slope including the points left.

All possible two part linear models were thus performed until all points were included in the first slope. For each model, coefficients of each slope, differences of slopes and global R^2 of each regression are collected. Finally, the model with the greatest R^2 and the most significant slope difference was kept. The breakpoint date was then determined by the cross point of the two linear regressions of the chosen model.

Gender gaps evolution according to time was modelled by

$$GG = \alpha + \beta t + (\alpha' + \beta' t)1_{[t \geq \tau]}$$

Where $1[t \geq \tau]$ is an indicator function taking value 0 if $t < \tau$ and 1 if $t \geq \tau$.

Stated otherwise, the trends before and after the breakpoint date τ are linear, but the slope of the two lines may differ on either side of the breakpoint. Regression parameters α, β, α' and β' were estimated by maximum likelihood; the R^2 coefficient measured the global fit of the model to the data.

Analyses were conducted using SAS software 9.2 version (SAS Institute, Cary, NC, USA)

Estimation of stabilized gender gaps

After the breakpoint dates, the stabilized gender gaps $\overline{\Delta m}$ were calculated and expressed as follows:

$$\overline{\Delta m} = \frac{\sum_{i=\bar{j}}^{n} \Delta i}{\sum_{i=\bar{j}}^{n} \frac{WR_{mi} + WR_{wi}}{2}}$$

with $\bar{j}$ being the date of stabilization.

Variation coefficients

The standard deviation of the ten best was measured for each event in order to calculate the yearly coefficient of variation $c_v(t)$:

$$c_v(t) = \frac{\sigma_{p(t)}}{\overline{p(t)}}$$

with $\overline{p(t)}$ representing the mean value of the 10 performances vector at year t and $\sigma_{p(t)}$: standard deviation of the performances vector.

Wilcoxon test

The coefficients of variation of the gender gaps for the two periods (before and after breakpoint date) were compared by a Wilcoxon signed-rank test. This nonparametric test was used since the data (performances values) could not be assumed to be normally distributed.

Historical analysis

The annual cumulative proportions were used to describe the secular evolution of world records (Guillaume et al., 2009).

Factor $a_{c,t}$ is the annual ratio of the number of world records for the country c over the total number of world records:

$$a_{c,t} = WR_{c,t}/WR$$

P is the annual cumulative proportion over the Olympic era:

$$P_{c,t_0,t} = \sum_{t_0}^{t} a_{c,t}$$

for the first year t_0, year t and the country c. Factor P defines the annual cumulative world records progression rate for each country.

For the evolution analysis of factor P, the mean slope of annual cumulative proportions (S) was calculated by linear regressions over 4 periods: 1921-1940, 1951-1970, 1971-1990, 1991-2008. S was defined as:

$$S(P) = \Delta P_{c,t_0,t} / \Delta t$$

Statistical analysis was performed with the R software (R Development Core Team, 2008). One way linear regressions were used to calculate the slopes of factors G and P. Statistical significance was considered at $p < 0.01$.

World records' evolution profile

In two disciplines (athletics and swimming), a graphic representation of the number of world records obtained each year through a 4-year smoothing mean illustrated the gender profile of their evolution since the beginning of the Olympic era.

Results

Descriptive analysis: Gender gaps

The breaking slopes method shows a breakpoint date separating the events into two periods. The first one fits the fast reduction of the gender gaps, while the second one corresponds to a period of stability (after 1978, Figure 1C). Results of the Wilcoxon test show that the two periods are significantly different, with the coefficients of variation of the second period being inferior to the first one. Slope breaks results are listed in Table 2.

Table 2. **Breakpoint dates; GG at stability; and Variation coefficient before breakpoint date (CV BD) and after (CV AD) for all events. * If a breakpoint date is not detectable (recently officialised women event), the given value is the last 2008 GG.**

	Breakpoint date	Stable GG (%)	CV BD	CV AD	Breakpoint date	Stable GG (%)	CV BD	CV AD
Track and Field	**RECORD**				**TBP**			
High jump	1961	17.17	0.12	0.04	1967	17.89	0.08	0.08
Long jump	1988	18.76	0.13	0.01	1985	19.08	0.15	0.08
Pole Vault	-	*26.89	-	-	2002	22.48	0.16	0.06
Triple Jump	1998	16.63	0.07	0.00	1998	16.46	0.12	0.05
100M	1993	6.50	0.32	0.07	1984	9.00	0.25	0.08
200M	1991	9.19	0.15	0.10	1986	10.18	0.17	0.08
400M	1984	9.98	0.16	0.11	1979	11.26	0.16	0.09
800M	1982	10.38	0.30	0.03	1978	11.28	0.34	0.08
1 500M	1975	10.55	0.17	0.06	1977	12.25	0.12	0.08
5 000M	1989	12.85	0.12	0.04	-	*10.29	-	-
10 000M	1989	10.80	0.19	0.06	-	*11.98	-	-
4*100M	1985	13.96	0.28	0.05				
4*400m	1977	11.23	0.15	0.06				
400m Hurdles	1982	11.86	0.09	0.07	1982	11.59	0.16	0.07
20km Walk	1995	10.02	0.33	0.07				
Marathon	1976	10.60	0.29	0.30	1973	12.70	0.32	0.15
Swimming	RECORDS				TBP			
50m FS	2001	10.66	0.07	0.03	1995	13.15	0.11	0.11
100m FS	1961	10.27	0.44	0.07	1975	10.99	0.06	0.06
200m FS	1979	8.47	0.42	0.11	1977	9.48	0.17	0.09
400m FS	1980	7.36	0.46	0.14	1979	8.74	0.21	0.09
800m FS	1978	5.52	0.41	0.13	1983	6.53	0.10	0.12
1500m FS	1968	6.36	0.34	0.10	1983	8.35	0.33	0.10
100m Back	1981	9.53	0.25	0.07	1979	10.72	0.12	0.06
200m Back	1995	7.92	0.25	0.08	1979	9.60	0.17	0.07
100m Breast	1961	10.03	0.25	0.13	1986	10.88	0.08	0.08
200m Breast	1961	9.49	0.30	0.14	1986	10.00	0.10	0.08
100m Fly	1984	9.34	3.66	0.27	1979	11.02	0.17	0.07
200m Fly	1981	8.20	0.28	0.12	1975	9.73	0.15	0.09
4*100m FS	1981	10.32	0.17	0.04	1975	9.99	0.10	0.08
4*100m MR	1981	10.57	0.17	0.04	1978	9.04	0.19	0.08
4*200m FS	2002	10.60	0.05	0.05	1988	12.79	0.59	0.07
200m IM	1982	9.45	0.16	0.12	1989	10.14	0.10	0.08
400m IM	1982	7.91	0.22	0.12	1979	11.62	0.17	0.06
Speed Skating	RECORDS							
500m	1988	6.94	6.13	0.63				
1000m	1992	7.04	10.11	0.69				
1500m	1988	6.73	10.42	0.89				
5000m	1991	7.10	8.09	0.74				
Cycling	RECORDS							
Sprint	1993	8.68	1.44	0.86				
Average	**1983.11**	**9.97**	**1.27**	**0.18**	**1982.00**	**11.68**	**0.18**	**0.08**
SD	**10.72**	**2.94**	**2.75**	**0.24**	**7.61**	**3.46**	**0.11**	**0.02**

Athletics analysis

Analysis of world records in athletics shows that global stability was reached in 1983.7 (± 9.57). Gender gaps have been stable in jumping and running events since 1982.3 and 1984.8 respectively. Gender gaps decreased in the running events from 30.0% (± 6.48) in 1922 to 10.7% (± 1.85) since their stabilisation, and from 30.1% (± 8.52) to 17.5% (± 1.11) for jumping events. For the ten best performances, the global stability date is 1983.9 (± 4.45). The ten best performances' gender gaps evolved from 25.3% (± 4.46) for races at the beginning of the Olympic era to 11.2% (± 1.25) since stabilization and from 30.0% (± 3.86) to 19.0% (± 2.57) after 1984 for jumps.

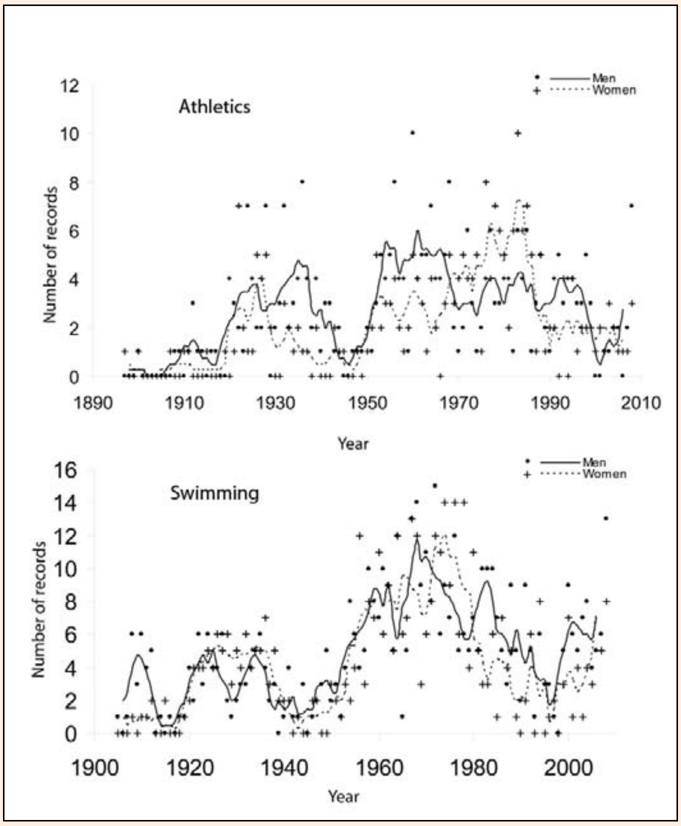

Figure 2. **Number of world records per year and gender. Solid line is 4 year-smoothing mean for men's world records and dotted line for women's world records.**

Swimming analysis

Gender gaps have been stable since 1979.9 in swimming events. In swimming, world records gender gaps evolved from 22.9 % (± 5.44) at the beginning of the century (1916) to 8.9 % (± 1.54) since their stabilization. For the ten best performances, results show stability in 1981.5 at 10.16 % (± 1.60) while it was 13.4% (± 1.86) in 1963.

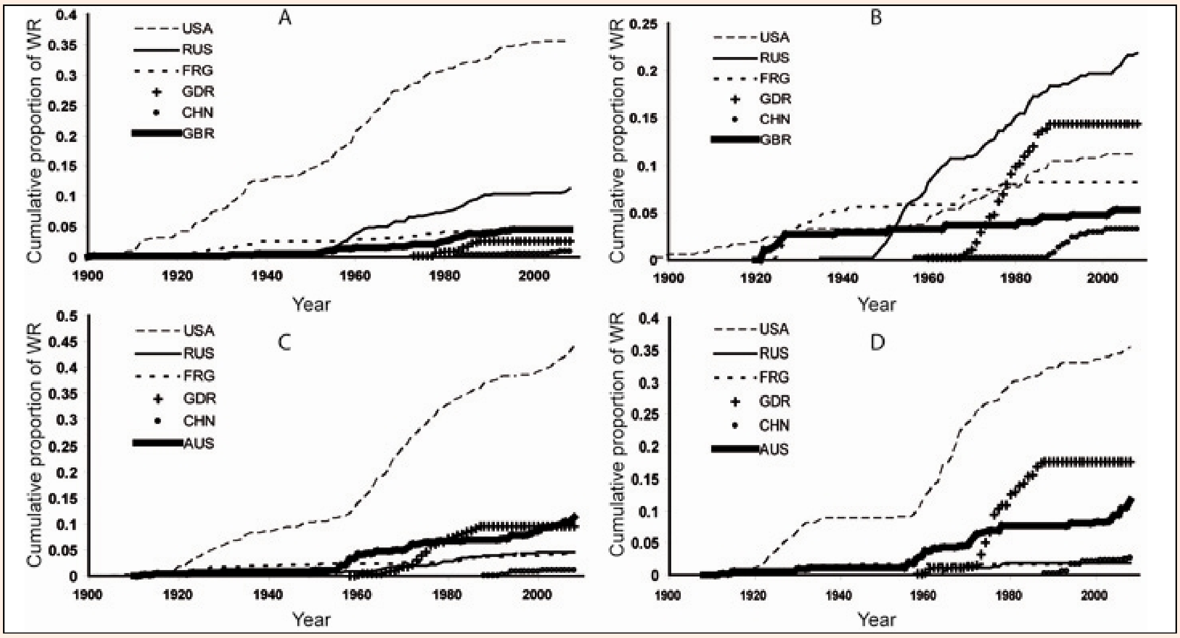

Figure 3. **Annual Cumulative Proportions of world records, by major contributing country, illustrating the geographical dispersion of world records for each gender in A. Athletics Men B. Athletics Women C. Swimming Men D. Swimming Women (0,1 = 10%).** USA: United States of America. RUS: USSR and Russia, FRG: Germany, Federal Republic of Germany and reunited Germany. GDR: German Democratic Republic. CHN: China. GBR: Great-Britain. AUS: Australia.

Table 3. Slope of linear regressions of annual cumulative proportions of WR for the major 6 countries.

T & F Men	1920-1939	1950-1969	1970-1989	1990-2008
USA	0.005	0.0071	0.0027	0.0013
RUS		0.0033	0.0022	0.0003
ALL	0.0011	0.0003	0.0005	0
GDR			0.0015*	-
CHN			0.0002	0.0003
GBR	0.0002	0.0005*	0.0013	0.0002
T & Women				
USA	0.0007	0.0005	0.0022	0.0006
RUS	0.0002	0.0047	0.0041	0.0018
ALL	0.0031	0.0005	0.0005	0
GDR		0.0004	0.0071	-
CHN		0.0002	0.0002	0.0009
GBR	0.0012	0.0004	0.0005*	0.0005*
Swimming Men				
USA	0.0037	0.0075	0.0063	0.0031
RUS		0.0009	0.0012	0.0005
ALL	0.0007	0.0001	0.0007	0.0003*
GDR		0.0007	0.0042	-
CHN			0	0.0005
AUS	0.0002	0.0024	0.0007*	0.0022
Swimming Women				
USA	0.0043*	0.008	0.0041	0.0015
RUS		0.0006	0.0006	0
ALL	0.0007	0	0	0.0006*
GDR		0.0008	0.0091	-
CHN			0.0001	0.0012
AUS	0.0003*	0.0022	0.0010*	0.0017*

P < 0.001 for all the results except those indicated * T & F = Track & Field

Cycling, speed skating and weightlifting

Only one event was comparable in cycling. The gender gap in the sprint has been stable since 1993 at 8.7%. In speed skating the gender gap no longer fluctuates since 1989.7 (± 2.1) at 6.95% (± 0.16).

The gender gap in weight lifting world records is at 36.8% (± 6.2) since women officially started competing in 1998. With 10 years of hindsight only, no breakpoint date has been detected yet.

Historical analysis

World records evolution (Figure 2) was altered by both world wars, with a decreasing number of records during these two periods. A similar trend is also observed at the beginning of the 1980s for swimming and of the 1990s for athletics. A major peak in swimming for both male and female appears around 1970, while such peaks occur at different dates in athletics: 1960 for men and 1983 for women.

Since the beginning of the Olympic era, the United States of America has dominated men's athletics and men and women's swimming (Figure 3). The German Democratic Republic (GDR) was the first European country to dominate women's athletics and swimming, starting after the Second World War.

The linear regression slopes for swimming and athletics are listed in Table 3. For the USA, the largest slope corresponds to the period from 1950 to 1970, except for women's athletics (1970-1989). In athletics, the men's slope is greater (0.007) than the women's (0.002). The GDR's greatest slope corresponds to the period from 1970 to 1989 and is more important for the women (0.009 for swimming and 0.007 for athletics) than for the men (0.004 and 0.0015, respectively). The greatest slopes observed in the Chinese performances occur after 1990.

World record evolution profile and participation

The number of participants in the Olympics and number of records did not follow the same evolution (Figure 2, Figure 4). Indeed, the number of women participating has increased over the last two decades, while the frequency at which world records occur has been decreasing.

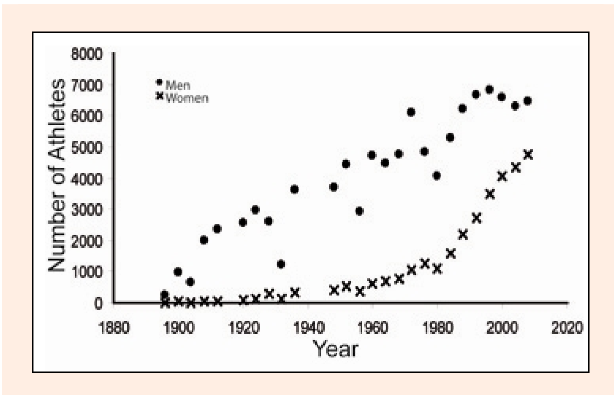

Figure 4. Participant number at the Olympic Games by gender.

Discussion

Our results show that the gender gap in Olympic sport performance has been stable since 1983. These suggest that women's performances at the high level will never match those of men. This stabilization is the expression of a significant narrowing of gaps for all events (Cheuvront et al., 2005). Indeed, even when performances still improve, these progressions are proportional for each gender. The reduction and stabilization of the gender gaps in performance is a general pattern observed in all athletes and all disciplines (Figure 4). Stability appears through all of the parameters studied: coefficients of variation, slope coefficients, coincident breakpoint dates between world records and ten best performances. This stability is not affected by external, non physiological factors such as technology and doping advancements that could challenge it.

The yearly analysis of the number of world records shows a major, 22-year time lag in athletics between the men's and women's peaks, corresponding to the period where the fastest reduction in the gender gap occurred. After 1950, women began to benefit from improvements in training techniques that were developed from the men's training experience during the first half of the XXth century. Like men, they also benefited from a better medical and nutritional environment. The fast improvement rate of female performances' observed since then could also be explained by the increasing number of events proposed to women and by the investment of East European nations in women's sports (Geipel, 2001; Seppelt and Schück, 1999). In fact, the last period of acceleration in these improvements prior to the breakpoint date of the early 1980s coincides with published evidence of institutionalized doping. According to former GDR athletes, many of them were being administrated drugs to enhance muscle strength, aggressiveness and performance since 1966 (Franke and Beredonk, 1997; Geipel, 2001). However the trend linking performance-enhancing drugs and women in particular is still unknown. While it should be considered that the technological advancements leading to increased efficiency of some androgenic drugs on the physiology of female athletes could have played a role in some countries' investment in women's sport programs, the inverse could also be true. It may have been the idea of a potential progression margin in female sport as analyzed just after the Second World War, associated with the discovery of ergogenic and androgenic steroids that could have induced the interest and investment in the development of doping techniques to be applied to female athletes. Women doping during the 1970s could have sped up female progression and accelerated the gender gap reduction.

During the Cold War, many countries were fighting for the largest political influence. One manner in which to obtain international prestige was realized through athletic performance (Guillaume et al, 2009). While women's sports were not as developed as men's, east European countries, such as GDR, invested in female performance programs (Staatsplan 14.25) (Franke and Beredonk, 1997; Seppelt and Schück, 1999). With the use of androgenic steroids, beating records and winning medals were probably seen as an easier challenge for women than men. Such a strategy of optimized returns may have translated into an early and intense investment of communist countries in women's sport (Geipel, 2001; Seppelt and Schück, 1999), later followed by other countries or individuals (Guillaume et al., 2009). In fact, the geographical repartition analysis of world records evolution (Figure 5) shows a wider distribution of nations for women's athletics than for men's, with a women's domination by Russia after the Second World War, while men's competitions show a larger dominance by USA athletes.

Unlike athletics, a time lag is not observed in swimming, where women's competitions chronologically started much earlier. While men's first records were obtained in 1927 on average for all swimming races, women's world records were first set in 1932. Only 5 years separate the beginning of swimming competitions for each gender while 28 years separated the first men records (1914 on average for all events) from first women records (1942) in athletics.

In women's weightlifting, we did not detect a

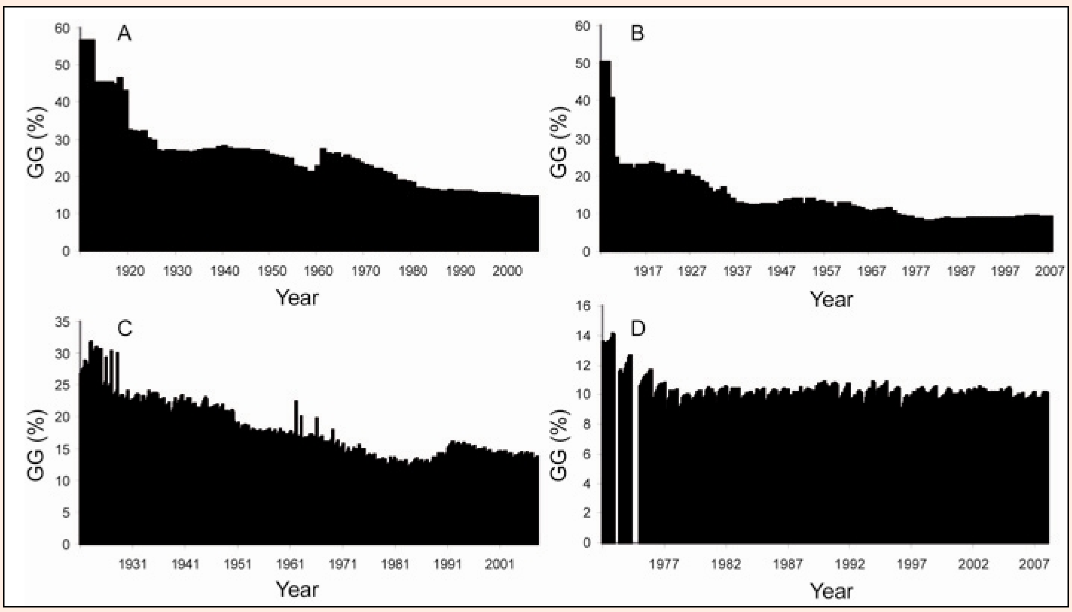

Figure 5. **Global GG evolution in percentage for A. Track and field WR. B. Swimming WR C. Track and field TBP D. Swimming TBP (missing data in 1964 and 1974). The peak after 1960 is due to the introduction of female marathon WR.**

breaking point due to the recent introduction of women into this sport. Performances and gender gap have nevertheless both reached a plateau. Besides, 50.4% of world records in women weightlifting are set by Chinese athletes (Guillaume et al., 2009).

A recent and slight increase in gender gaps can be observed for 12 out of 38 events. This is not specific to any particular discipline, and corresponds to the enhancement of men's performances with a simultaneous regression or stabilization of women results. Also a small discrepancy is shown between the predicted year where women and men will reach world records asymptotic limits (2028 *vs* 2042 respectively) (Berthelot et al., 2008). Taking into consideration that men may continue to progress in a few events, gender gaps may slightly increase before reaching full stability (Seiler et al., 2007; Holden, 2004).

Random and unannounced drug testing was introduced in athletics in 1989. The declining use of banned performance-enhancing drugs may have also contributed to the most recent and slight increase of gender gaps. Men still improve, though at a lower rhythm, while women stopped their progression. Men are more likely to adopt behaviours at increased risk, whereas a higher percentage of women engage in preventive actions linked to health and longevity (Courtenay, 2000; Mercer et al., 2007). Another explanation could be the higher interest of media in male sport, and the greater rewards offered.

This major investment of East European countries in women's sport can be assessed by the annual cumulative proportions slope coefficient. Soviet Union has a slope twice as high as the USA's for women's world records during the 1970s and the 1980s. East Germany's progression slopes are always greater for women than for men and similar to the Russian women's progression for athletics. The percentage of women's world records obtained by GDR athletes is about 33.1% between 1970 and 1989 and 30.7% for the Soviet Union, compared to 11.2% for the United States of America and 3.2% for West Germany. This massive representation of two countries (Riordan, 1996; Seppelt and Schück, 1999), in which the incidence of doping was proven or highly suspected, could have accelerated the reduction of the gender gaps (Franke and Beredonk, 1997; Geipel, 2001). However, it should be clear that these are not the only nations in which female athletes have resorted to illegal performance enhancing procedures.

The connection between women's participation in international events and performance may not be quite relevant. On average, the mean date of the first men's world records was 1925 (± 21), while mean date for women first world record was 1955 (± 36). Despite a 30 year time lag average between men and women mean debuts, women rapidly progressed before the gender gaps stabilized. The number of participants in the Olympic Games is a measurable indicator of the involvement of elite athletes globally. Quotas and incentives of organizing authorities encourage the participation of women. While only 37 women attended the 1908 Olympic Games, in 2008 they represented 42.4% of all registered athletes (4746 women and 6450 men) at the Olympic Games in Beijing (International Olympic Committee, 2008). The number of competing women is still increasing while the number of men has reached a maximum at the 1988 Olympic Games in Seoul (Figure 4). After taking into account the evolution of world records previously studied in this analysis, there is no measurable effect of the increasing number of women participating in the Olympic Games on world records, ten best performances and gender gaps evolution. The major increase in women's participation takes place in the 1980s, while the world record peak already occurred (Berthelot et al., 2008), and the gender gaps stability period has begun.

A breakpoint date could not be detected in 3 events: pole vault (a female event not contested from 1930s to the 1960s), 5000m and 10000m due to their recent introduction into the Olympic program. Women's weight lifting world records only began in 1998, when most of men's world records had already reached their maximal values. This explains why gender gaps are still narrowing in this discipline (though at a slower pace in the last few years). The wide discrepancy between the magnitude of gender gaps in weightlifting and jumping events and the four other disciplines studied here could be explained by the different physiological mechanisms involved to mobilize energy. The predominantly explosive type of effort required in weightlifting and jumping (Maldonado-Martin, 2004; Wilmore and Costill, 2004) could explain the greater disadvantage that women have to face against men, compared to other disciplines.

Conclusion

It appears that gender gaps in sport performance have been stable for a long time: women may never catch up with men. This stabilization of 26 years is the expression of a significant drop in the variation of these gaps' magnitude. After a significant narrowing of gender gaps, women and men now evolve in parallel, in the same direction. The late implication of women in competition, their increasing participation, as well as the individual doping behaviours and state programs for performance enhancement may all have had a historical role but no longer reduce the gap. Without any technological improvement specifically dedicated to one gender or the other, performances will probably evolve in a similar manner for both men and women. The gap may be set.

Acknowledgments

We thank all INSEP teams for their full support, Caroline Carpentier, Ghislaine Quintillan, Elisabeth Rosnet and Nadine Dubois for fruitful discussions, and the Centre National de Développement du Sport for financial contribution.

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Key points

- Sex is a major factor influencing best performances and world records.
- A stabilization of the gender gap in world records is observed after 1983, at a mean difference of 10.0% ± 2.94 between men and women for all events.
- The gender gap ranges from 5.5% (800-m freestyle, swimming) to 36.8% (weight lifting).
- The top ten performers' analysis reveals a similar gender gap trend with a stabilization in 1982 at 11.7%.
- Results suggest that women will not run, jump, swim or ride as fast as men.

AUTHORS BIOGRAPHY

Valérie THIBAULT
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: Valerie.thibault@insep.fr

Marion GUILLAUME
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: Marion.Guillaume@insep.fr

Geoffroy BERTHELOT
Employment
?
Research interest
Sport pathophysiology and epidemiology
E-mail: Geoffroy.Berthelot@insep.fr

Nour El HELOU
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: Nour.Elhelou@insep.fr

Karine SCHAAL
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
E-mail: Karine.Schaal@insep.fr

Laurent QUINQUIS
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: irmes@insep.fr

Hala NASSIF
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: Hala.Nassif@insep.fr

Muriel TAFFLET
Employment
Engineer in biostatistics and informatics
Research interest
Cardiovascular epidemiology and sudden death, sport pathophysiology and epidemiology
E-mail: muriel.tafflet@inserm.fr

Sylvie ESCOLANO
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: irmes@insep.fr

Olivier HERMINE
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: irmes@insep.fr

Jean-François TOUSSAINT
Employment
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport, INSEP, 11 Avenue du Tremblay 75012 - Paris - FRANCE
Research interest
Sport pathophysiology and epidemiology
E-mail: irmes@insep.fr

✉ **Valérie Thibault**
IRMES, Institut de Recherche bioMédicale et d'Epidémiologie du Sport INSEP, 11 Avenue du Tremblay, 75012 - Paris - FRANCE