



The weekly recap of what is going on in the world of biomechanics.

## **Correction of the current swimming world records from the time of the high-tech swimsuits**

In the time around the Olympic Summer Games 2008 in Beijing, more than 130 world records in swimming were broken. In retrospect, this was attributed to the invention and use of so-called high-tech swimsuits. These novel full-body suits used non-textile materials such as polyurethane for the first time and were able to reduce water resistance and improve the body position in the water due to more buoyancy. Although the swimsuits were banned again in 2010 due to accusations of technology doping, many of the records set at that time have remained valid and still exist today. The goal of the presented study was to determine the actual impact of the swimming suits with the help of data analysis and statistics and to estimate how these records would look like today without these short performance boosts. We want to show you today that biomechanical research can sometimes be advanced by only theoretical considerations and mathematical models.

To evaluate the influence of the swimsuits, the authors have created a data set of swim times of the most common freestyle events (50m, 100m, 200m, 4x100m) from the semi-finals and finals of the Olympic Games and World Championships in the relevant time period. The Olympic Games of 2008 and the World Championship of 2009 represented the performance with high-tech suits and the World Championships of 2011 and the Olympic Games of 2012 from London represented the performance without. The aim of the authors was to highlight the following three aspects:

1. how big is the hightech swimsuit bias?
2. what natural improvements in performance (through better swimming technique or training methods) have occurred over the period 2008-2012?
3. how good was the intrinsic performance of the swimmers in 2008?

Sure, it would be easy to simply discard the records of 2008 and 2009 and refer to



technology doping, but that would not take into account whether a world record would have been set even without a high-tech suit and where it would be today.

To answer these questions, the authors first used longer time series (from 1985 to 2015) to examine the development of the annual record times in the various disciplines and reconstruct the “missing” times of 2008 and 2009.

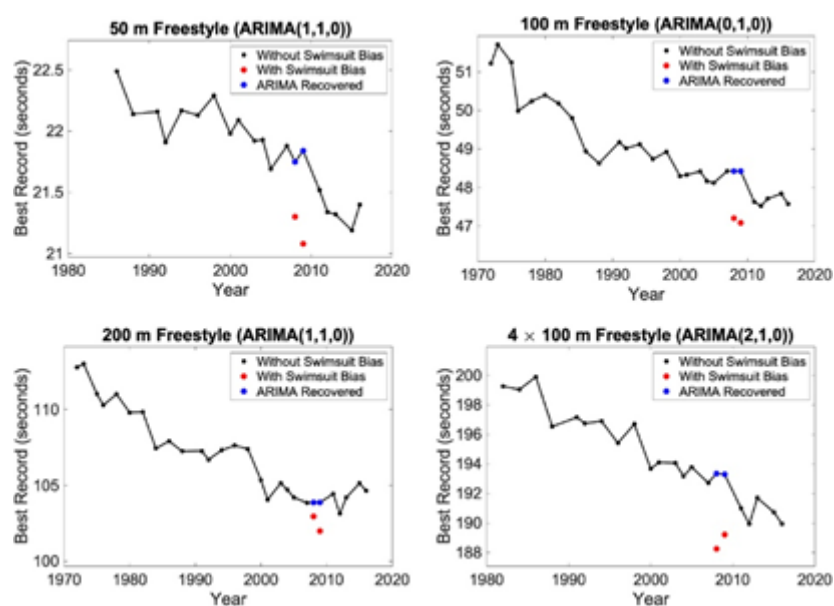


Figure 1: Development of the yearly best times for the different swimming events. The figure shows the significant jump in world record times in 2008 and 2009. Figure from Gao, Li and Wang (2020).

In order to describe the natural improvement of the athletes mathematically, the times achieved in the respective competitions were described with normal distributions (what a normal distribution is and why it is often used in biomechanical research can be read in a separate article on statistical fundamentals). Using the mean and standard deviation of these distributions, a new random sample of 5000 values was generated (this method is called bootstrapping), from which the distribution of improvements between 2008 and the following events was calculated. Distributions and non-discrete values were intentionally used here because the authors wanted to take into account that their model has a certain uncertainty and that different swimmers develop differently over the same period. Using this method it was calculated for 50m races that developments according to the historical data would have



shown improvements of 0.037, 0.110 and 0.147s in 2009, 2011 and 2012 compared to 2008.

To determine the influence of the suits, the reconstructed world records and calculated natural improvements were subtracted from the achieved world records. Taking all factors into account, the authors have now calculated how high the current world records should be.

Event	Current record	Corrected record	Best time since 2010
50m	20.91	21.31	21.04
100m	46.91	47.47	46.96
200m	1:42.00	1:42.95	1:43.14
4x100m	3:08.24	3:10.65	3:09.06

Table 1: Current world records, corrected world records and best times since 2010 as presented by Gao, Li and Wang (2020)

For the shorter distances (50m, 100m and 4x100m), the best times since 2010 are still below the predicted records, which indicates a strong natural development of the athletes' performance since 2008. The greater difference in the 200m times shows that over the longer distance the influence of the swimsuits had a greater effect and other factors, such as the start jump, are less important.

Unfortunately, this study cannot answer the question of how to deal with the records set in 2008 and 2009. Nevertheless, the authors were able to show that current developments partly exceed the expected developments and that it will not be long before the records of that time are broken by a new generation of athletes.

Gao Z., Li Y., Wang Z. (2020) Restoring the real world records in Men's swimming without high-tech swimsuits. *Journal of Quantitative Analysis in Sports*, 000010151520190087, eISSN



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