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Kinematic Tactics in the Women's 800 m Freestyle Swimming Final at the Beijing 2008 Olympic Games

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Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

Key words: *Beijing 2008, velocity, swimming, strategy, pacing*

Abstract

Background: *The purpose of this study was to obtain knowledge on tactics of long distance swimming at the highest women professional level.*

Material/Methods: *Eight swimmers, finalists of 800 m distance of freestyle of the Beijing 2008 Olympic Games were examined. The distribution of velocity of swimming for the entire distance based on 50 m segments was analyzed. Partial, halves and quarters velocity, speed indexes and linear and nonlinear regression equations were calculated.*

Results: *It was revealed that better swimmers (placed 1–3) had their distribution of swimming as an ascending line and with very small difference between segmental velocity and that of the entire distance, while the rest of swimmers had a descending velocity line and a higher dispersion of partial values.*

Conclusions: *High performance swimmers have to hold uniform velocity of movement with small dispersion along the entire distance of swimming.*

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Introduction

There are many research articles devoted to swimming. Most often the following were studied: technique of movement of free swimming, i.e. the position of body parts, stroke length, rate, velocity, and indices, technique of start and turn, improving of propulsion, diminishing of resistance forces, structure of the entire distance divided into the start segment, free swimming, turn segments, the finish segment. The scientists who devoted their research work especially to biomechanics of swimming are, e.g.: Schleighauf [1], Hollander et al. [2], Sanders [3]. There is a lack of studies on biomechanics of tactics of swimming especially within the last 10 years. The theory of effort says the lowest energy expenditure is obtained when the velocity of movement tends to be steady. The differences of velocity between segments of the distance and mean velocity of the entire distance should be minimized. Also the second part of the distance should be covered with higher velocity than the first one. This was already observed by scientists of the Centre of Locomotion Research in Gdańsk in such sports as: marathon running [4, 5], rowing [5] and alpine skiing [5]. There are, however, few studies of the swimming strategy or tactical changes in speed/pacing. The papers by Erdmann [6] and Lipińska, Erdmann [7] reported that the best long distance swimmers had their distribution of swimming as an ascending line with small differences in velocity among every 50m segment. The aim of this study was to obtain knowledge on tactics of long distance swimming at the highest professional (Olympic) level.

Material and Method

Eight swimmers (women) were examined. They participated in 800 m freestyle swimming final of the Beijing 2008 Olympic Games. Data on the entire time of swimming and also split times for every 50 m (15 segments) were obtained from the Official Website of the Beijing 2008 Olympic Games [8].

Data on average speed were calculated for the entire distance and for every 50 m segment. Data on velocity were calculated also for halves and quarters of the entire distance but here the first 50 m of the distance were not included since a swimmer covers the first meters in the air after release by jumping forward from the starting block and obtains much higher velocity than for the remaining 50 m segments. The entire distance without the first 50 m was 750 m and was named quasi-entire distance (QED). The difference between the entire distance (ED) and QED is just 6.25%.

In order to compare the velocity of halves (H) and quarters (Q) and to assess the tendency of velocity distribution through the entire distance indices were calculated. Their calculation was based on mean velocity of the QED. The quasi-half (QH) segment (the first one) had 350 m, and the second half (H) had 400 m. The quasi-quarter (QQ, the first one) had 150 m and the remaining Q segments (second, third and fourth) had 200 m. Additionally linear and nonlinear equations of regression for each swimmer were defined.

Differences were calculated between velocities of segments and QED. Then squares of differences were calculated in order to obtain only positive values. Next, sums of differences' squares were calculated. They formed velocity differences' index (VDI) for halves and tierces. The lower the VDI, the better. To compare the steadiness of velocity of swimmers with different mean velocity, VDI was divided by QED. The results formed relative velocity differences' index (RVDI) for halves and quarters [6]. To compare 50 m fragments analysis of variance (ANOVA, post-hoc comparison test) was used (Statistica 8.0).

Results and discussion

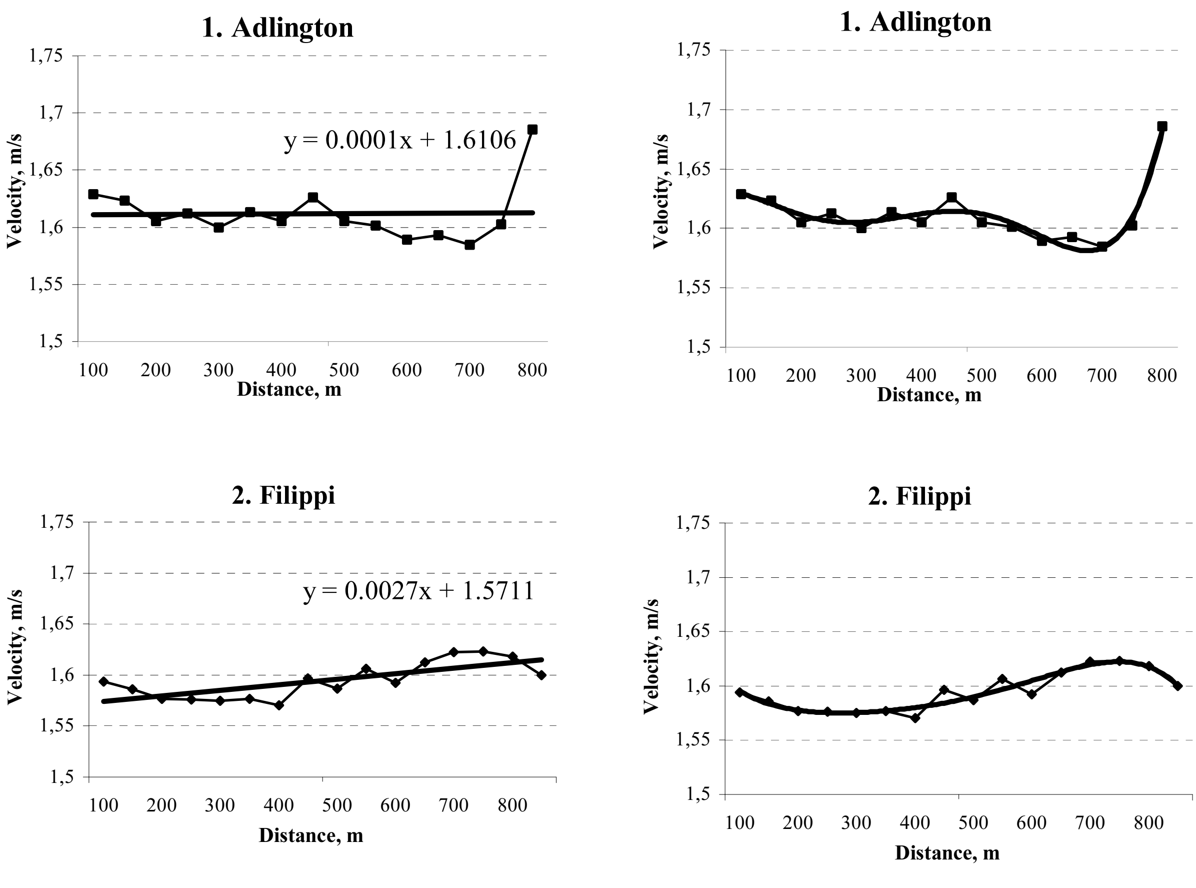
Looking at the velocities obtained by eight swimmers for the entire distance of 800 m one can observe (see Figure 1) that the highest velocity was obtained for the first 50 m, then there were different tendencies of mid-distance swimming, and again higher velocity was obtained for the last 50 m segment.

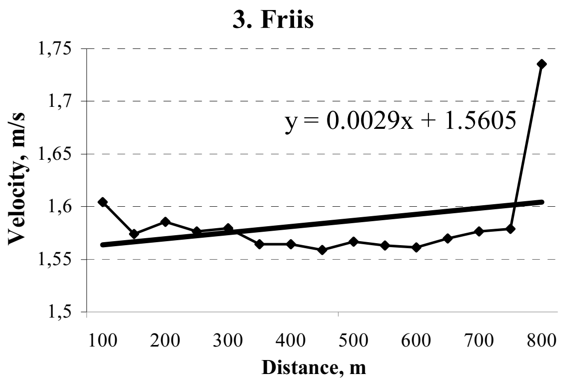
Only the best three swimmers had an ascending line of velocity, but the highest ascending line was not that of the first swimmer at the finish. It is very significant because Rebecca Adlington (gold medallist) broke the twenty-year-old record in this final. It means that a steady line of velocity with minimal ascending tendency is the best to hit record results. One can explain this optimal loss of energy owing to almost equal velocity. Swimmers from place fourth, seventh and eighth had descending lines of velocity. They swam with bigger differences among partial velocities. This is seen especially in a velocity line of swimmers no. 6–7.

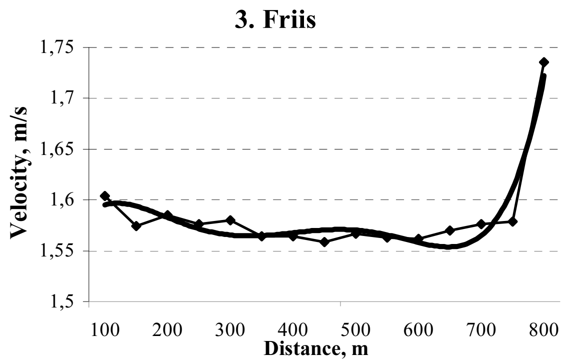
Unfortunately regressions assumes no systematic sampling and homogenous variances, but swimmers had systematically larger speeds at the beginning and the end. Maybe we would get more accurate fit by eliminating the first and last one (or two) intervals from the regressions model.

An analysis of variation shows substantial differences for velocity of 50 m segments, especially among the last but one and the last segment in comparison to the other 50 m segments (exclusive of the first one).

Fig. 1. Mean velocities for 50 m segments of the quasi-entire distance of 800 m and lines of linear and multinomial trend. Numbers 1–8 are the consecutive places obtained in the competition




3. Friis
1,75
1,7
1,65
1,6
1,55
1,5
y = 0.0029x + 1.5605
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m


3. Friis
1,75
1,7
1,65
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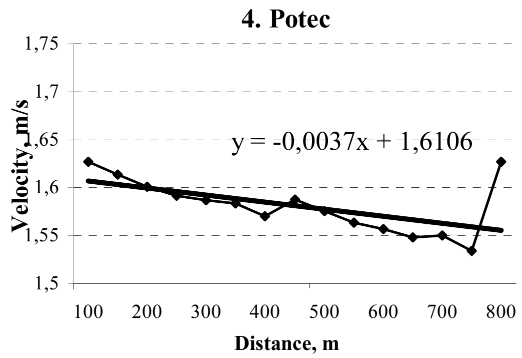
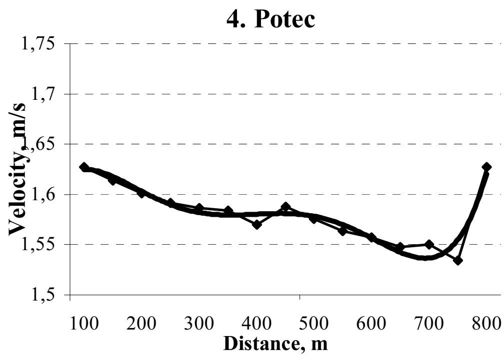
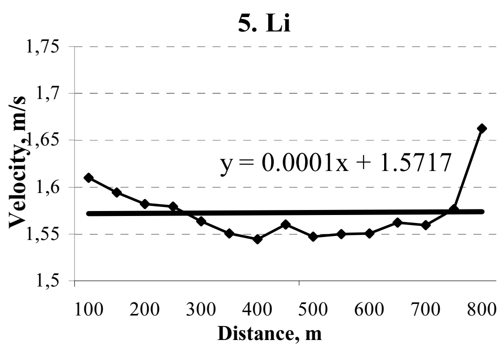
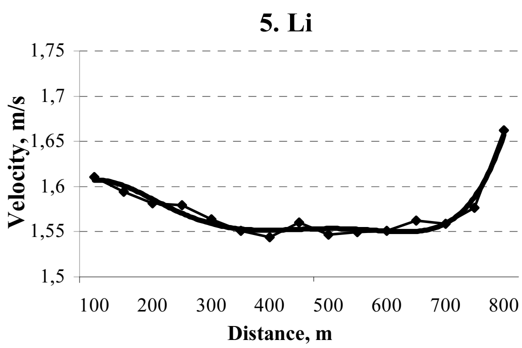
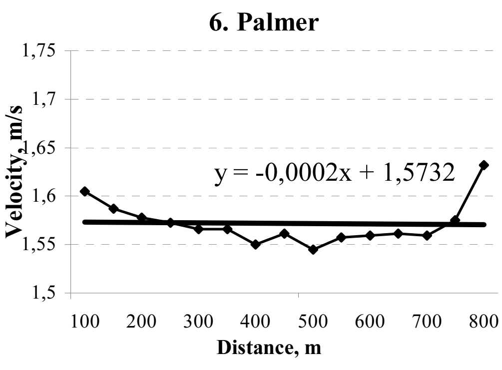
1,55
1,5
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m

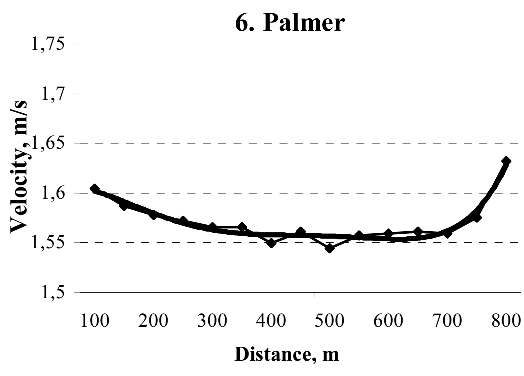

4. Potec
1,75
1,7
1,65
1,6
1,55
1,5
y = -0,0037x + 1,6106
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m

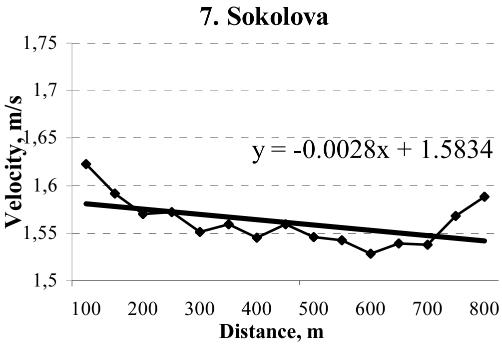

4. Potec
1,75
1,7
1,65
1,6
1,55
1,5
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m

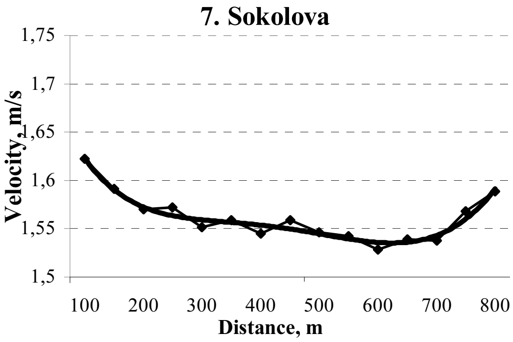

5. Li
1,75
1,7
1,65
1,6
1,55
1,5
y = 0.0001x + 1.5717
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m

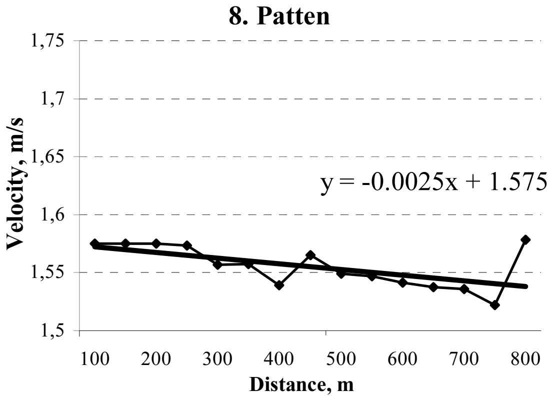

5. Li
1,75
1,7
1,65
1,6
1,55
1,5
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m


6. Palmer
1,75
1,7
1,65
1,6
1,55
1,5
y = -0,0002x + 1,5732
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m


6. Palmer
1,75
1,7
1,65
1,6
1,55
1,5
Velocity, m/s
100 200 300 400 500 600 700 800
Distance, m







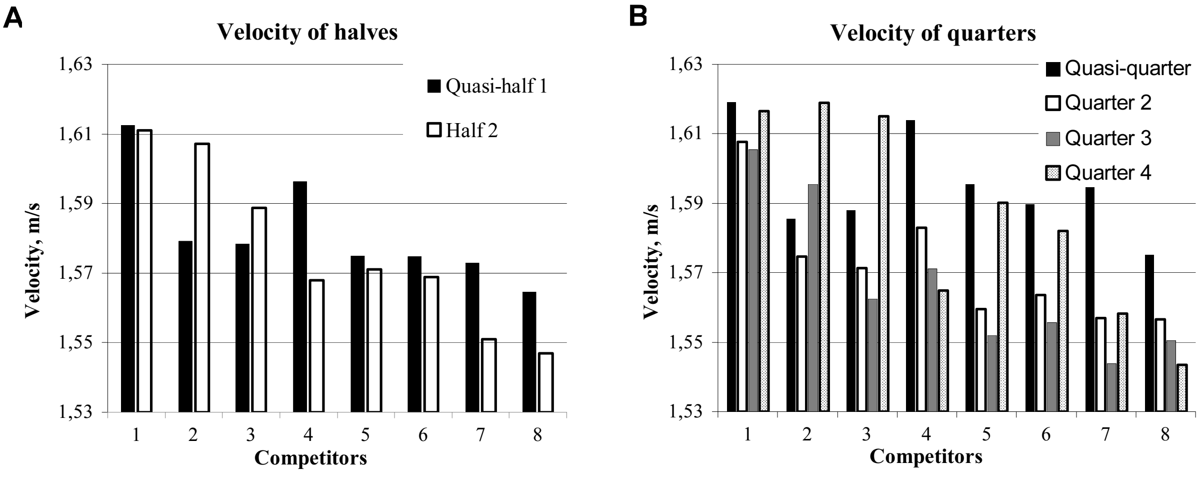


Fig. 2. Mean velocities for halves and quarters. The first half and the first quarter is without the first 50 m. Numbers 1–8 are consecutive places obtained in the competition

Looking at the bars depicting mean velocity of QH and H segments (Fig. 2A) one can see only two swimmers from places 2 and 3 swam the second part of the distance faster than the first one but the best swimmer covered the second part of a distance slightly slower. Looking at the bars depicting velocity of QQ and Q segments (Fig. 2B) one can observe that only the winner keeps similar velocity for all quarters and swimmers no. 2, 3, 5, 6 have a tendency of swimming the middle segments slower but the first and the last segment faster. Again, swimmers no. 4, 7 and 8 swam the fourth part of the entire distance the most slowly.

In Table 1 detailed results of mean velocity are presented. The data of indices can be assessed only with the knowledge of tendencies of velocities obtained. It is very significant that the best swimmer has the lowest VDI (0.001) in her record race. It is important to know that for record results velocity for halves, quarters must be kept relatively steady. Other swimmers had very high indices, sometimes over 1.

Tab. 1. Result time (min:sec) for the entire distance and mean velocity (m/s) for the entire distance, halves and quarters and their indices: VDI - velocity differences' index; RVDI – relative velocity differences' index

No.	Name	Result time	Entire distance	Quasi-entire distance	Quasi-half 1	Half 2	Quasi-quarter 1	Quarter 2	Quarter 3	Quarter 4
1	2	3	4	5	6	7	8	9	10	11
1	Adlington	08:14,10	1.620	1.612	1.613	1.611	1.619	1.608	1.606	1.616
	VDI, RDVI				*0.001*	*0.001*	*0.131*	*0.081*		
2	Filippi	08:20,23	1.600	1.594	1.579	1.607	1.585	1.575	1.595	1.619
	VDI, RDVI				*0.392*	0.246	*1.074*	*0.666*		
3	Friis	08:23,03	1.592	1.584	1.578	1.589	1.588	1.571	1.563	1.615
	VDI, RDVI				*0.055*	*0.034*	*1.608*	*0.998*		
4	Potec	08:23,1	1.591	1.581	1.596	1.568	1.614	1.583	1.571	1.565
	VDI, RDVI				*0.402*	*0.254*	*1.448*	*0.899*		
5	Li Xuanxu	08:26,3	1.581	1.573	1.575	1.571	1.595	1.559	1.552	1.590
	VDI, RDVI				*0.007*	*0.005*	*1.428*	*0.886*		
6	Palmer	08:26,4	1.581	1.572	1.575	1.569	1.590	1.564	1.556	1.582
	VDI, RDVI				*0.017*	*0.011*	*0.755*	*0.469*		
7	Sokolova	08:29,8	1.570	1.561	1.573	1.551	1.595	1.557	1.544	1.558
	VDI, RDVI				*0.242*	*0.155*	*1.436*	*0.891*		
8	Patten	08:32,4	1.562	1.555	1.565	1.547	1.575	1.557	1.551	1.543
	VDI, RDVI				*0.154*	*0.099*	*0.558*	*0.346*		

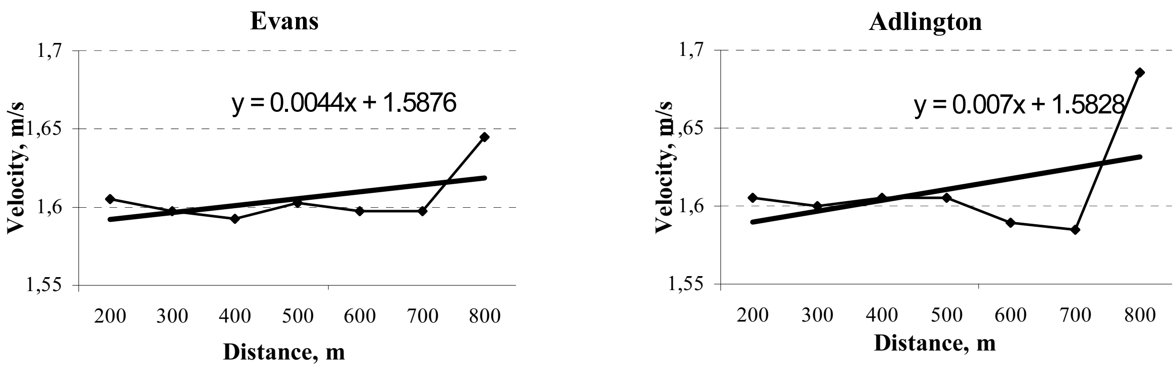


Fig. 3. Mean velocities for 100 m segments of the quasi-entire distance of 800 m and lines of linear regression for record-holder swimmers. Only split times for 100 m parts were available for record race from 1989

When partial velocities for every 100 m in two record races (J. Evans 1989, R. Adlington 2008) were compared, one can observe more steady partial velocity in Evans's than in Adlington`s race. Adlington decreased velocity in the 6th and 7th part and considerably increased the last 100 m part of the distance (Fig. 3).

One can see (Fig. 4) that Adlington and Evans had similar characteristics of velocity for halves. Adlington had higher velocity for each half. An analysis of velocity for quarters showed that the champion swam the last part with the highest velocity. It is very specific that two record-holders (the previous and the present ones) have a very similar tendency of velocity distribution (for halves and quarters).

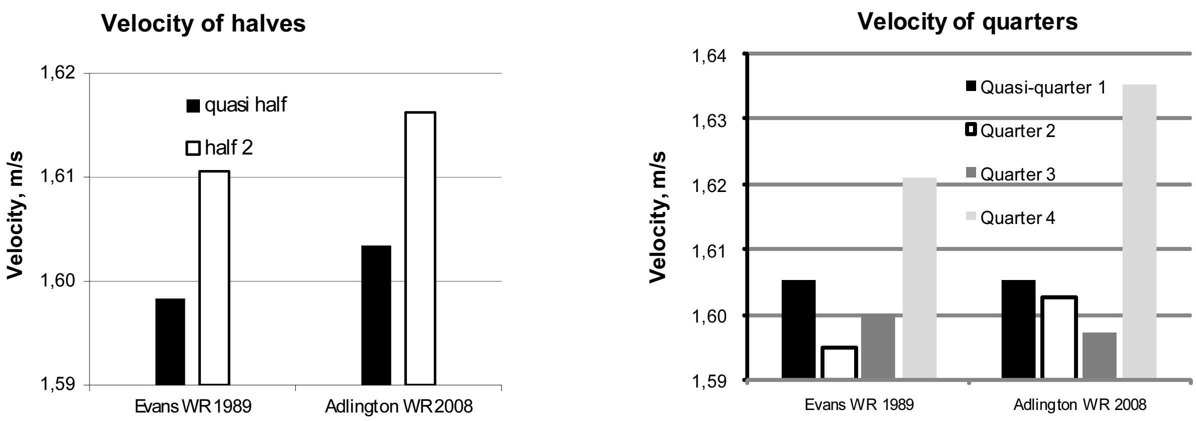


Fig. 4. Mean velocities for halves and quarters for record-holder swimmers

Conclusion

The most important thing to obtain excellent results in women 800 m swimming is to achieve a good distribution of velocity of movement along the entire distance of swimming. The general trend is to swim a little faster within the second half of distance in comparison with the first quasi-half. One can observe a tendency to swim slower for middles quarters and faster for the first and the last quarters.

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