

# Analysis on the relationship between stroke rate and distance per stroke and the effect on boat speed of Jiangsu rowing athletes of lightweight men's double sculls

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**ABSTRACT.** *Using the rowing stroke-watch SEIKO S141 to record the time and 10 stroke rates in each 500 meters split of the lightweight men's double sculls on water 2000 meters test competition, and calculate the average boat speed, stroke rate and distance per stroke in each 500 meters split. The results show that: the boat speed of each 500 meters split was descending gradually; the stroke rate changed reversely compared to distance per stroke in each 500 meters split; the boat speed of the last 500 meters split did not ascend following the ascending of the stroke rate; the average stroke rate of our athletes was significantly lower than the average stroke rate of the world's elite athletes during the whole 2000 meters.*

**KEYWORDS:** *rowing; lightweight men's double sculls; stroke rate; distance per stroke; boat speed*

## 1. Introduction

Rowing is one of the water sports. It is a sport in which one or more paddlers sitting on the boat use muscle strength to draw water through the leverage of the paddles and paddles to push the boat toward the back of the paddler. Classified by sports skill, it is a highly technical cyclical racing project [1]. During the 2000M race, the total number of paddles required by the rowers is about 200~250 paddles, and the completion time is about 5~8 minutes [2]. For the rowing project, the speed of the boat is the core factor in determining the performance of the race. The pitch and the distance are the two key factors determining the speed of the boat. The stroke rate refers to the number of complete paddle cycles completed by the athletes per unit time, reflecting the athlete's paddle action frequency; the pad distance refers to the distance that the boat advances for each complete paddle cycle, reflecting the paddle effect of each paddle of the athlete. The distance per stroke  $\times$  stroke rate = speed of the boat, therefore, the distance between the stroke and the pitch directly affects the speed of the boat. However, from the kinematics analysis of the rowing, these two factors also affect each other, and one of the factors will inevitably affect

another factor<sup>[3]</sup>. The purpose of this paper is to track and analyze the 2KM test of the men's light double-boats in the provincial rowing professional team to explore the relationship between the stroke rate and the distance of the 2KM competition of Jiangsu male and female athletes and their impact on the speed of the boat.

## 2. Research object and method

### 2.1. Research object

Jiangsu Province rowing men's lightweight double sculls (hereinafter referred to as men's light double-double LM2 ×) athletes on the water 2KM test competition, the average age of athletes  $24.7 \pm 0.58$ yr, height  $185.3 \pm 1.15$ cm, weight  $73.9 \pm 0.53$ kg; Level: 2 athletes, 1 at the national level.

### 2.2. Research methods

The tester followed the whole process of the 2KM test of the male and female athletes on the water in two passes (15 days apart). The SEIKO S141 pitch meter was used to record the time of each 500M section and 10 of each 500M section. Sub-stroke rate, calculate the distance per stroke (DPS), the stroke rate (SR), the speed of the boat (V) in Excel; use SPSS15.0 statistical software for data statistics, use the Kolmogorov-Smirnov method for normality test, and carry out Homogeneity test of variance. Data from different passages of the same boat were analyzed by One-Way ANOVA test. The data were expressed as mean  $\pm$  standard deviation,  $P < 0.05$  was taken as the significance level, and  $P < 0.01$  was the very significant level.

## 3. Result

### 3.1. Zhang/He LM2 × Changes in speed, stroke rate and DPS of different sections

Table 1 Boat speed, stroke rate and distance per stroke between Zhang/He LM2 × 500M sections (Grade: 6'47")

	500m	1000m	1500m	2000m	Full average
Time(s)	97	101	103	106	101.75
Boat speed (m/s)	5.15	4.95	4.85	4.72	4.91
Stroke rate (str/min)	$36.0 \pm 2.65$	$33.3 \pm 0.58$	$32.3 \pm 0.58$	$33.3 \pm 1.10$	$33.7 \pm 1.91$
Distance per stroke (m/str)	8.59	8.92	9.02	8.50	8.74

Note: \*:  $P < 0.05$ ; \*\*:  $P < 0.01$

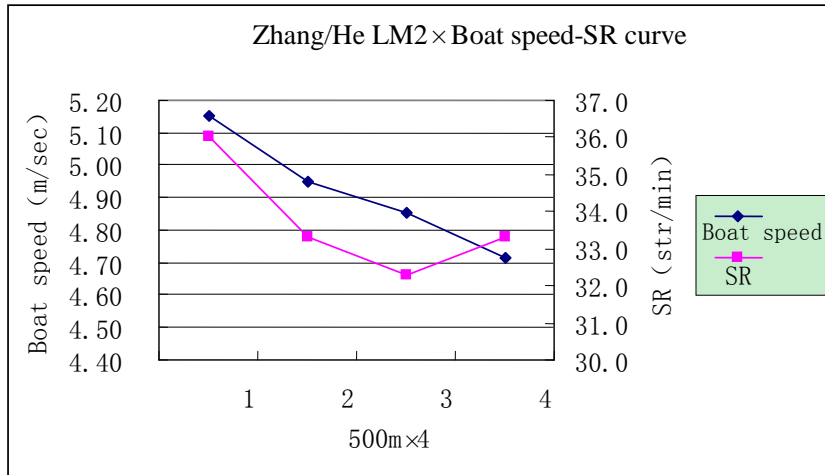


Figure.1 Zhang/He LM2 x 500M section boat speed-stroke rate curve

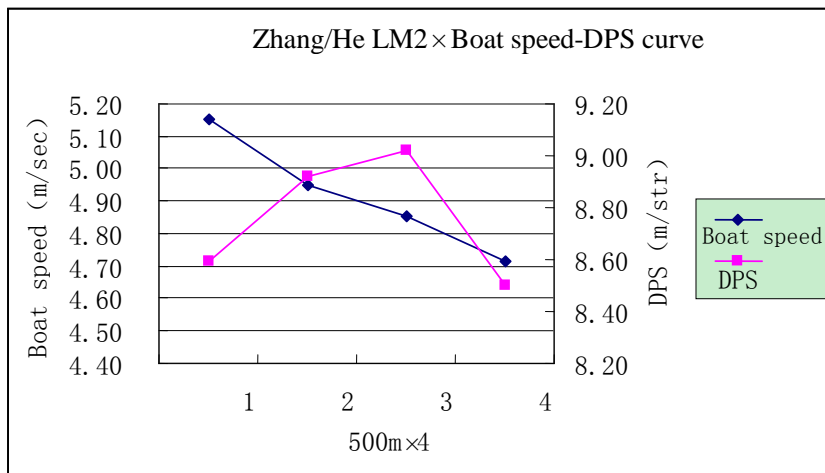


Figure.2 Zhang/He LM2 x 500M section boat speed-distance per stroke curve

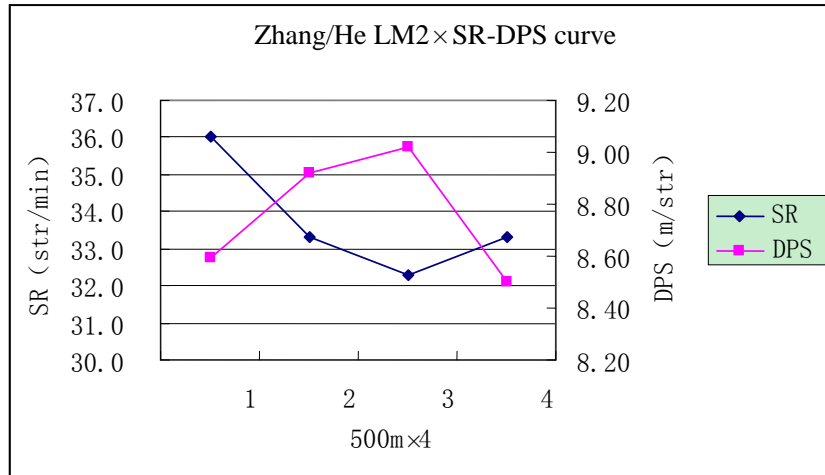


Figure.3 Zhang/He LM2 x 500M section stroke rate-distance per stroke curve

It can be seen from Table 1 and Figures 1, 2, and 3 that the speed of Zhang/He Men's light double-duty shows a decreasing trend, and the average speed of 2KM is 4.91m/s. The maximum speed of the boat appeared in the first 500m, and the lowest speed appeared in the last 500m. The maximum speed of the boat was 8.3% (5.15m/s vs 4.72m/s). There was no significant change in the stroke rate of the Zhang/He 500m section. The highest stroke rate appeared in the first 500m, the lowest stroke rate appeared in the third 500m, and the average stroke rate of 2KM was 33.7±1.91str/min. The spacing between the Zhang/He 500m section and the stroke rate showed the opposite trend. The middle height was high and the two heads were low. The third 500m section had the best paddle effect, and each paddle pitch reached 9.02m/str.

**3.2. Zhang/Wu LM2 x Changes in speed, stroke rate and DPS of different sections**

Table 2 Boat speed, stroke rate and distance per stroke of Zhang/Wu LM2 x 500M sections (Grade: 6'40")

	500m	1000m	1500m	2000m	Full average
Time (s)	96	98	102	104	100
Boat speed (m/s)	5.21	5.10	4.90	4.81	5.00
Stroke rate (str/min)	37.8±2.45	33.4±0.58*	32.4±0.87**	34.4±2.52	34.6±2.74
Distance per stroke (m/str)	8.27	9.17	9.08	8.39	8.67

Note: Compared with the first 500m, \* :P<0.05; \*\* :P<0.01

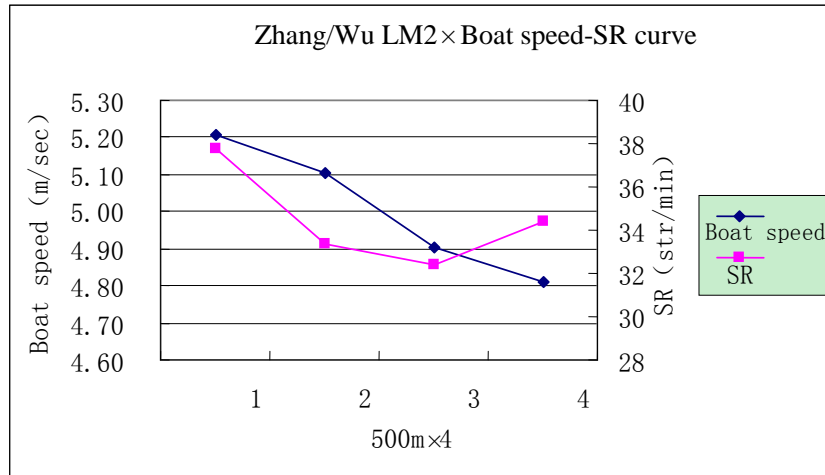


Figure.4 Zhang/Wu LM2 x 500M section boat speed-stroke rate curve

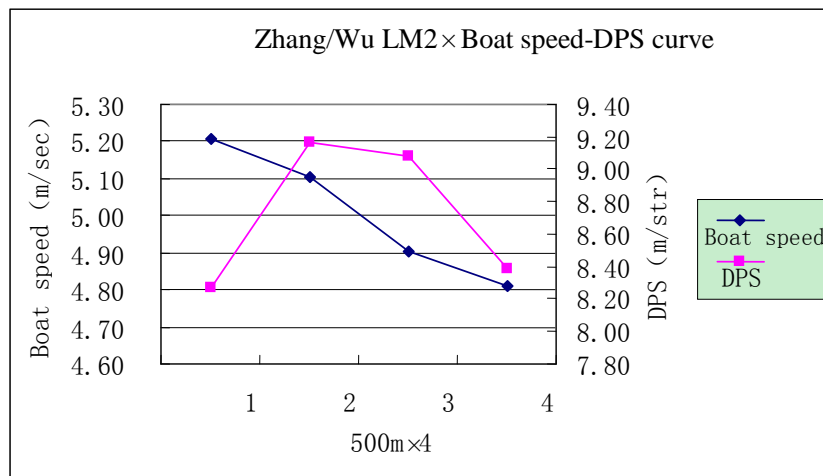


Figure.5 Zhang/Wu LM2 x 500M section boat speed-distance per stroke curve

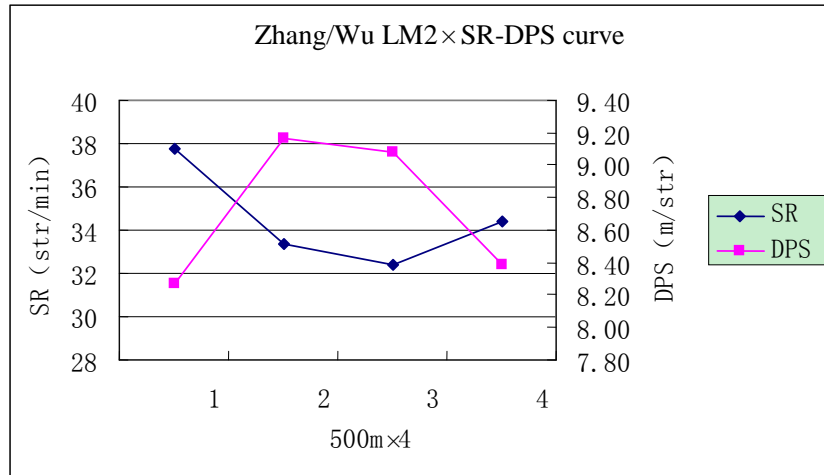


Figure.6 Zhang/Wu LM2 x 500M section stroke rate-distance per stroke curve

It can be seen from Table 2 and Figure 4, 5, 6 that the speed of Zhang/Wu Men's light doubles also shows a decreasing trend, and the average speed of 2KM is 5m/s. The maximum speed of the boat appeared in the first 500m, and the lowest speed appeared in the last 500m. The maximum speed of the boat differed from the minimum speed by 7.7% (5.21m/s vs 4.81m/s). The stroke rate of the second and third 500m of Zhang/Wu is significantly lower than the stroke rate of the first 500m ( $33.4 \pm 0.58 \text{str/min}$ ,  $32.4 \pm 0.87 \text{str/min}$  vs  $37.8 \pm 2.45 \text{str/min}$ ), ie on the way the stroke rate at the stroke stage is significantly lower than the stroke rate at the start segment. The change of the distance between the 500m sections of Zhang/Wu is inverted "U" shape, the middle is high, the two ends are low, and the maximum value appears in the second 500m, which is 9.17m/str.

### 3.3. Speed Changes of the national team LM2 x in different sections

Table 3 The speed of the national team LM2 x 500M sections in the first round of the 2012 World Cup (Grade: 6'20")<sup>[4]</sup>

	500m	1000m	1500m	2000m	Full average
Time(s)	91	96	98	95	95
Boat Speed (m/s)	5.49	5.21	5.10	5.26	5.26

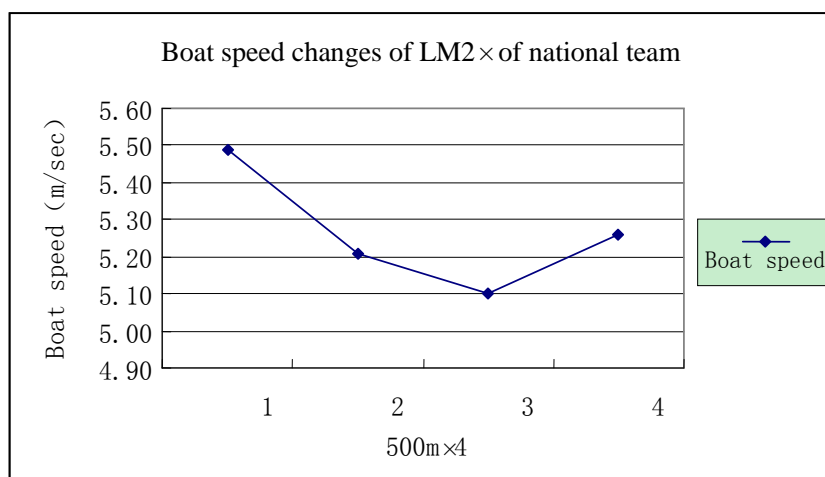


Figure.7 National team LM2 × 500M section boat speed curve

It can be seen from Table 3 and Figure 7 that in the final of the first race of the 2012 Rowing World Cup, the speed of the national team's male and female athletes showed a trend of first drop and then rise, and the average speed of the 2KM whole course was 5.26m/ s. The maximum speed of the boat appears in the first 500m section, the starting segment; the second highest speed occurs in the last 500m section, the sprint section. The maximum speed of the whole boat is 7.1% (5.49m/s vs 5.10m/s).

### 3.4. Average stroke rate of the top three of each class of Olympic Games and World Championships

Table 4 List of the top three average stroke rate for the 2000 Olympic Games, the 2002 World Championships, and the 2004 Olympic Games<sup>[3]</sup>

Year	Average stroke rate(str/min)						
	W1×	M1×	W2-	M2-	W2×	M2×	M4-
2000	33.5	35.9	38.4	38.8	35.8	38.0	40.1
2002	33.9	36.4	36.2	38.6	35.7	38.3	41.7
2004	35.0	36.7	37.6	39.1	36.3	38.3	39.8
Year	LW2×	LM2×	LM4-	W4×	M4×	W8+	M8+
2000	36.8	38.9	40.5	36.2	40.2	39.3	40.7
2002	35.7	38.6	40.8	38.4	40.3	39.7	40.4
2004	35.9	38.9	40.4	37.5	37.4	38.2	38.8

As can be seen from Table 4, the average stroke rate of the top three players of

all types of boats in the 2000 Sydney Olympic Games is 38.08str/min. The average stroke rate of the top three in the 2002 World Championships is 38.19str/min, the top three in the 2004 Athens Olympic Games. The average stroke rate is 37.85str/min. Among them, the average stroke rate of men's light doubles are 38.9str/min, 38.6str/min, 38.9str/min, and the overall fluctuation between 38~39str/min, the change is not large.

## 5. Discussion

It can be seen from Figure 3 and Figure 6 that the stroke rate and the pitch of the two boats of Zhang/He and Zhang/Wu Men's light in our province basically show opposite trends: the pitch frequency decreases, and the pitch increases. The stroke rate is increased and the pitch is reduced. There are reports in the literature<sup>[5]</sup>, in the single-item group at each level, the world's excellent boat stroke rate and the height of the distance are negatively correlated ( $-1 < r < -0.813$ ;  $P < 0.01$ ). There is a research derivation formula<sup>[3]</sup>,  $DPS_1 / DPS_0 = (R_0 / R_1)^{2/3}$ , that is, as the pitch frequency increases, the pitch of the pad is reduced by the square root of the square of the pitch ratio. It can be seen that it is difficult to increase the speed of the boat by simultaneously increasing the pitch and the pitch. It can be seen that the final decision on the speed of the boat does not depend on the increase of the single index of the pitch or the pitch, but whether the pitch and the pitch are in the best match.

As shown in Figure 3, in the first stop of the 2012 Rowing World Cup, the national team's men's light and double athletes' speed showed a trend of first drop and then rise. The highest speed appeared in the starting segment, and the second highest speed appeared in the final sprint section, which basically reflects the speed characteristics and laws of modern high-level rowing competitions. At present, the speed of men's light and light in both provinces shows a decreasing trend, and the speed of the boat is also unstable, with a large fluctuation range (8.3%, 7.7% VS 7.1%). The reason for this may be related to the matching of the stroke rate and the pitch. As can be seen from Figure 1-1 and Figure 2-1, the speed of the last 500m passage of the male and female athletes in our province did not increase with the increase of the stroke rate, indicating another factor in this phase - the distance Its reduction largely limits the speed of the boat.

As can be seen from Table 4, the average stroke rate of the world's top male and light players is between 38 and 39 str/min. At present, the average stroke rate of 2KM for both male and female boats in our province is  $33.7 \pm 1.91$ str/min and  $34.6 \pm 2.74$  str / min (see Table 1, Table 2), significantly lower than the average stroke rate of the world's outstanding male and light athletes, the gap is large. High stroke rate is an important feature of excellent rowing technology and a key factor in winning the game. This is especially important in the starting and final sprint phases of the 2KM race. It becomes the player to open the opponent in the starting segment. The sprint section surpasses the important part of the opponent. In order to make a breakthrough in the performance of the male and female athletes in our province, it is necessary to upgrade the stroke rate to a platform, especially in the final sprint



stage.

### References

- [1] Bangpa (United States), Huff (United States (2011). Cycle-Motion Training Theory and Method. Beijing: Beijing Sport University Press.
- [2] Feng Lianshi, Feng Meiyun, Feng Weiquan (2006). Physiological and Biochemical Monitoring Methods for Sports Training. Beijing: People's Sports Publishing House.
- [3] Volker Nolte. Rowing Faster (2011). Second Edition. United States: Human Kinetics.
- [4] [www.worldrowing.com](http://www.worldrowing.com). Rowing World Cup I 2012, Belgrade, Results.
- [5] Lin Huijie et al (2009). Study on the Relationship between the Stroke rate and the Pitch of the World's Elite Rowers and Its Impact on the Speed of the Boat. Sports Science, vol.29, no.10, pp. 61-64.