

COMPARATIVE RESEARCH ON THE STROKE RHYTHM OF MEN AND WOMEN KAYAKERS IN THE INTERNATIONAL COMPETITION

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The text studied the stroke rate and rhythm of men and women kayakers in the world cup competition on the base of defined division of time phase for each stroke. It is found that the time proportion of the pull and air-work phase in the two sides of men kayakers are both 65% to 35%, while the time proportion of the same phase in the right-side of women kayakers is 66% to 34%, and that in the left-side is 69% to 31%; the power time proportion in the right-side of men kayakers is 40% and in the left-side is 41%, while that in the right-side of women kayakers is 39% and in the left-side is 41%. Men kayakers command a better symmetry and consistency between the left and right side in stroke rhythm than women kayakers. Men kayakers increase the stroke rate mainly accompanied with shortening the air-work time proportion while women kayakers mainly with shortening the pull time proportion.

KEY WORDS: kayak, stroke rate, rhythm, time proportion

INTRODUCTION: The basic action element of flat water kayak is one cycle of stroke, which can be finely divided into different action stages. The effective art will be reflected in the stroke rhythm, which is showed by the rational time proportion of each action stage in one cycle of stroke. One of the standards to judge the art is the stroke rhythm.

There are research reports about the stroke rhythm in some literatures on the kayak art (Sanders 1992, Baker 1999, Mann 1980, Plagenhoef 1979). However, the similar method were adopted, that is to divide the action of one cycle of stroke into the pull phase and the air-work phase and study the time proportion between the two phases in one cycle of stroke. In fact, for a single stroke cycle, there are more delicate divisions in both the pull phase and the air-work phase. The purpose of this text is to study the time proportion of each action phase and make a comparison of stroke rhythm by analyzing the corresponding data between men and women kayakers in the international races in the use of delicate division of stroke phase.

METHODS: The object is the men and women kayakers who struggled into the 4×200m relay final A and final B in the Duisburg World Cup in Germany in 2004. There are 64 kayakers in final A and final B with 32 men and 32 women from 11 countries. The paddling period is divided into four space marking points and four phases. The four marking points are defined on the base of the positions of paddle shaft: ①the level point ② the water-in point ③the vertical point ④the water-out point .The four sequence phases are: ①the preparation phase: from the level point to the water-in point ②the catch phase: from the water-in point to the vertical point ③the power phase: from the vertical point to the water-out point ④the recovery phase: from the water-out point to the level point. Thus, according to the above division, the pull phase in water consists of the catch phase and the power phase, while the air-work phase consists of the preparation phase and the recovery phase. Both the water-in point and water-out point are visually identified according to the tip of paddle, while the level point and the vertical point are identified on the basis of relative angle calculation of the oar shaft responding to the horizontal line using SIMI software.

In this research the oar shaft level position is used as the standard to divide cycles of stroke, i.e. the calculation of each cycle is from the level point to the level point, both of which are of the same side that can be watched; and the stroke rate will be finally got from the conversion of the time for one cycle of stroke. The time proportion for each phase showed in percentage. A video camera is used for shooting on the bank of the courses. The primary optical axis is fixed to the vertical plane of central course and the shooting place is fixed in the position

about the middle of the 200m courses. If one kayak is hidden from another, the data of the kayaker will be lost. Video records were adopted into the computer and the corresponding time was analyzed by fields with SIMI-TWIN Motion and got finally with the precision of 0.02 second. SPSS 10.0 was used in the data statistics, including difference test of stroke rate and action rhythm in both side for men and women kayakers as well as mutual comparison between man and women kayakers in both sides, also correlation analysis between stroke rate and time proportion for men and women kayakers in both sides has been done.

Table 1 Comparison of stroke rate and action rhythm in both sides for men kayakers.

| sex | | side | n | Mean | Std. | t |
|-----|--------------------|-------|----|--------|--------|-------|
| man | stroke rate | right | 15 | 141.2 | 10.98 | .096 |
| | | left | 15 | 140.9 | 8.20 | |
| | preparation phase% | right | 15 | 19.29% | .03726 | -.044 |
| | | left | 15 | 19.34% | .03021 | |
| | catch phase% | right | 15 | 25.17% | .02757 | .377 |
| | | left | 15 | 24.82% | .02335 | |
| | power phase% | right | 15 | 39.66% | .03928 | -.669 |
| | | left | 15 | 40.57% | .03446 | |
| | recovery phase% | right | 15 | 15.88% | .02360 | .755 |
| | | left | 15 | 15.27% | .02014 | |
| | pull phase% | right | 15 | 64.83% | .04944 | -.356 |
| | | left | 15 | 65.38% | .03363 | |
| | air-work phase% | right | 15 | 35.17% | .04944 | .356 |
| | | left | 15 | 34.62% | .03363 | |

Table 2 Comparison of stroke rate and action rhythm in both sides for women kayakers.

| sex | | side | n | Mean | Std. | t |
|-------|--------------------|-------|----|--------|--------|---------------------|
| woman | stroke rate | right | 16 | 128.2 | 5.60 | -.066 |
| | | left | 16 | 128.4 | 7.28 | |
| | preparation phase% | right | 16 | 18.71% | .02577 | 1.056 |
| | | left | 16 | 17.12% | .02690 | |
| | catch phase% | right | 16 | 27.48% | .04101 | -.628 |
| | | left | 16 | 28.39% | .04158 | |
| | power phase% | right | 16 | 38.75% | .04431 | -1.190 |
| | | left | 16 | 40.52% | .03961 | |
| | recovery phase% | right | 16 | 15.06% | .01983 | 2.479 ^a |
| | | left | 16 | 13.36% | .01900 | |
| | pull phase% | right | 16 | 66.23% | .03627 | -2.094 ^a |
| | | left | 16 | 68.92% | .03629 | |
| | air-work phase% | right | 16 | 33.77% | .03627 | 2.094 ^a |
| | | left | 16 | 31.08% | .03629 | |

^a. independent sample T test p<0.05 significance difference

RESULTS: Alternative paddling in the both sides is adopted in kayak. It is generally accepted that paddling with symmetry and consistency in both sides is the reasonable art. Kayak 4×200m relay is held in the 200m courses and the team kayakers have to paddle back and forth in the courses just as the swimmers do in the relay. So the pictures shot by the video camera consist of two halves: one is the right side of the kayakers with the motion direction from the left towards the right, and the other is the left side of the kayakers with the motion direction from the right towards the left. To test the differences between the arts in the two sides of the kayakers, the group comparison of kayakers' across data was adopted. The result is showed in Table 1 and Table 2. Unit for the stroke rate is stroke /minute. The result of data comparison of men and women kayakers on the same side is showed in Table 3.

Table 3 Corresponding comparison of stroke rate and action rhythm in the same side between men and women kayakers.

| | sex | n | right side t | n | left side t |
|---------------------|-------|----|--------------------|----|---------------------|
| stroke rate | man | 15 | 4.108 ^a | 15 | 4.494 ^a |
| | woman | 16 | | 16 | |
| preparation phase % | man | 15 | .506 | 15 | 1.577 |
| | woman | 16 | | 16 | |
| catch phase % | man | 15 | -1.824 | 15 | -2.924 ^a |
| | woman | 16 | | 16 | |
| power phase % | man | 15 | .603 | 15 | .032 |
| | woman | 16 | | 16 | |
| recovery phase % | man | 15 | 1.047 | 15 | 2.725 ^b |
| | woman | 16 | | 16 | |
| pull phase % | man | 15 | -.901 | 15 | -2.806 ^a |
| | woman | 16 | | 16 | |
| air-work phase % | man | 15 | .901 | 15 | 2.806 ^a |
| | woman | 16 | | 16 | |

a. independent sample T test $p < 0.01$ very significance difference

b. independent sample T test $p < 0.05$ significance difference

Table 4 Correlation analysis between stroke rate and time proportion of each phases.

| sex | side | r* p** | preparation phase% | catch phase% | power phase% | recovery phase% | pull phase% | air-work phase% |
|-------|-------|-----------|-----------------------|-----------------|-----------------|--------------------|----------------|--------------------|
| men | right | r | -0.205 | 0.266+ | 0.125 | -0.195 | 0.248+ | -0.248+ |
| | | p | 0.463 | 0.338 | 0.657 | 0.487 | 0.373 | 0.373 |
| | left | r | -0.044 | 0.103 | 0.026 | -0.099 | 0.099 | -0.099 |
| | | p | 0.876 | 0.716 | 0.925 | 0.727 | 0.727 | 0.727 |
| women | right | r | 0.387+ | 0.077 | -0.261+ | -0.081 | -0.231+ | 0.231+ |
| | | p | 0.138 | 0.776 | 0.329 | 0.767 | 0.389 | 0.389 |
| | left | r | -0.05 | -0.035 | -0.191 | 0.546++ | -0.248+ | 0.248+ |
| | | p | 0.853 | 0.899 | 0.478 | 0.029 | 0.353 | 0.353 |

r*: Pearson cross product correlation coefficients, p**: test probabilities

++: $p < 0.05$, +: $p < 0.4$

Correlation analysis between stroke rate and the time proportion of different phases has been done to see the influence factors of stroke rate from action rhythm in two sides for men and women kayakers. The related result is showed in Table 4. For $\alpha = 0.4$, $p < 0.4$ suggests that the chance is 40% of the occurrence of the "first kind of mistakes" in the correlation test of Table 4, that is the probability of "riding the truth"- taking the non-correlativity for correlativity through testifying the correlation coefficients.

DISCUSSION: The performance of 200 m relay is presented by the speed and power abilities. The shooting place is in the middle of the courses about 100 m from the starting line, just covering the distance during which the kayakers start and accelerate to their maximum speed and thus the paddlers' highest stroke rate is reflected. The data in this research show that the mean stroke rate of men single-paddlers is higher by 10% than that of women single-paddlers in the world great competition. No difference exists in the statistics of stroke rate between the right and left side for men and women kayakers.

The time proportions of pull and air-work phases for men kayakers and women kayakers on both sides is accorded with literature reports (Sanders 1992, Baker 1999). The time proportion of power phase on the right and left side are respectively 40% and 41% for men kayakers, while the data is 39% on the right side and 41% on the left side for women

kayakers, this course is the main phase to impel the kayak forward. Moreover, the action rhythm of men kayakers on one side is in harmonious with the other, due to their good symmetry, there is no difference in the time proportions of different phases on both sides, women kayakers is inferior in symmetry and consistency to men kayakers.

Compared on the same side, say, on the right, men and women kayakers have the same action rhythm and no differences arise in time proportions of all phases. The only difference caused by sex is the stroke rate. On the left side, there are extremely significant differences in the time proportions of pull, air-work, catch phases and also significant difference exists in the time proportion of preparation between men and women kayakers. The time proportion of catch phase of women kayakers on the left side is higher than that of men kayakers, and this is mainly where the difference lies between men and women kayakers on the left side.

On the significant level $\alpha = 0.05$, only women kayakers' stroke rate on the left side is dramatically related to the time proportion of recovery phase, $r = 0.546$, which shows medium direct proportion, that is, the stroke rate of women kayakers on the left side is directly proportional to the time proportion of recovery phase. If the significant level is $\alpha = 0.4$, when both men and women kayakers raise their stroke rate, the time proportion of pull phase and air-work phase between the two sexes tend to be changing in different directions. On both right and left sides for women kayakers, with the increase of the stroke rate, the time proportion of pull phase tends to decrease. Possibly women kayakers reduce the time for one cycle of stroke mainly by reducing that of pull phase. However, with the increase of the stroke rate of men kayakers on the right side, the time proportion of air-work phase tends to decrease. Possibly men kayakers reduce the time for one cycle of stroke mainly by reducing that of air-work phase. The result for men kayakers on the right side is the same with that of Baker (1999). The correlation analysis on men kayakers on the left side is not very significant although the same tendency with the right side can also be perceived, these tendency on both sides of men kayakers is just the opposite to the results of women kayakers.

CONCLUSION: Analysis on the stroke rate and action rhythm of men and women kayakers in the international competition shows:(1) No differences exist in the comparison of the stroke rate on both sides of men kayakers as well as women kayakers. The measurement of the stroke rate will be available on both sides in world competition. (2) differences exist in the action rhythm of women kayakers on both sides and it means possibly the synchronism of specialized development and technique improvement of women kayakers on both sides is not as good as those of men kayakers. (3) When the stroke rate is increased, women kayakers are likely to lose good efficiency in water while men kayakers do better.

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