BASIC ROWING TECHNIQUE LEARNING USING TIME DISTRIBUTION METHOD REALIZED AT DIFFERENT ASSIGNED SPEEDS

Abstract
The research included 44 students of final fourth year from the Faculty of Sport and Physical Education in Belgrade, without previous rowing experience, (25±2 years), (81±8 kg) and (184±7 cm). Students were practising rowing three times a week during 10 weeks period in a school rowboat with 12 seats on a smooth water. Students were not instructed how to distribute the force nor what stroke length to apply during the testing. Basic data were registered on a rowing ergometer Concept II. The instrument fitrower „Weba Sport“ was used in measuring stroke variables and the programme „Software Expert 1.2“ was applied for processing the data. Thirteen biomechanical stroke variables were observed. The test consisted of two consecutive measurements at assigned speeds indirectly enforced by the passing times on 500m as follows: 2min/500m and 1min 40sec/500m for duration of 30 seconds. Significant changes were found in all measured variables. The results proved that rowing speed is significant factor in teaching and training of rowing techniques. At first rowing begginers should be given the task of assigned speed and not the frequency of stroke. It is also better to assign them higher levels of assigned speed and not the frequency. Training course should start at assigning them lower speed and later increase the assigned speed. The greatest progress in learning absolute value of stroke variables were registered in power and force variables but the variation coefficients of these variables were significantly reduced. However the results show that the ratio of active and passive stroke phase remained unsatisffactory which means that learning rhythm requires longer period of time.

Key words: ROWING / MOTOR LEARNING / STROKE VARIABLES / RHYTHM / FREQUENCY / SPEED / POWER / FORCE

INTRODUCTION

Rowing is a sports branch characterized by the development of endurance during the optimal force investment of different intensity. The data collection about stroke variables, such as biomechanical, kinematic, physiological, and their analysis show feedback about rowers (Batschi et al., 2002; Baudouin & Howkins, 2002; Celentano et al., 1974; Lu et al., 1992; Redgrave's, 1995). Rowing technique and the methods for its optimization are the subject of biomechanical research-
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Maximal stroke frequency that leads to the positive influence to the boat speed as well as shown strength is 37 strokes per minute. Likewise, linear speed increase corresponds to the increase of shown strength to the speed level of 4.5 m/s that corresponds to passing time for 500m of about 1 minute and 40 seconds (Celentano et al., 1974).

During 2000m race, over speed and passing times at every 500m, as key times for stable condition sustaining and equalizing tempo during maximal effort, as well as for minimal energy losses, passing times of about 1 min 40 s are used. Limited frequency (no matter whether it is higher) at which there is no increase of boat speed is 36 strokes per minute (Kleshnev, 2008).

By observing the kinematic parameters on two levels of pressure, during learning rowing technique, it has been determined that longitudinal dimensions do not influence learning. Levels of pressure are defined indirectly through passing times at 500m, during which assigned times are used (2 min at 500, and 1 min. 40 s at 500m) (Redgrave’s, 1995).

According to earlier researches, elite rowers do not differ from the average in their ability to develop great force, but in their ability do develop great power, and higher values of shown strength are noted at higher assigned speed, because power is directly proportional to completed work, and inversely proportional to time for which the work is completed (Zatsiorsky & Yakunin, 1991). By analyzing strokes during showing strength and speed the limit value of speed is obtained, at which the boat speed is not increased although there is further strength value increase (Celentano et al., 1974).

Consulting the data of researches conducted so far (Ilic et al., 1996; Lisiecki & Rychlewski, 1986) it is perceived that a stroke is more consistent at higher speed and that the quotient of mechanical efficiency during continuous rowing is higher than at rowing with pauses (Bompa et al., 1990; Fukunaga et al., 1986). Therefore it is more convenient to assign speed and not stroke frequency to beginner rowers, especially if the task is to assign the higher level assigned speed (Rajkovic, 2005).

Interdependency and the level of consistency of variables are tested by introducing two motor assignments. For the first assignment an approximate limit of aerobic threshold is used that most often appears for rowers at passing time of 2 min / 500m, considering that this passing time for rowers represent
the limit between work in zones of small and medium intensity below which the training would influence the aerobic processes with high variability. The second assignment of 1min 40 s for 500m represents the level of pressure that is taken as approximate limit of aerobic threshold, and also represents the average/medium regatta passing time on 500m for rowers in most disciplines. These values of passing times are closely connected to the intensity of pressure, production and supply of energy during rowing race, as well as for dosing and programming the intensity of practicing. The subject of research in this work is learning of fundamental rowing technique and the influence of two levels of intensity of assigned intensities of learning rowing to the changes of researched biomechanical variables of strokes. The aim of work is to determine at which speed and in which interrelation of movement variables the locomotor apparatus is adapted better and to adjust efficient stroke in continuous strokes.

METHODS

Experimental method was applied in this research, with one group, with initial and final measuring and experimental factor of basic rowing technique learning. For obtaining basic data on initial and final measuring a rowing ergometer “Concept 2” was applied, and the instrument “Fitro power” by “Weba Sport” was used in measuring stroke variables in real time, connected to the computer with a sonde. The program “Software Expert 1.2” by “Weba Sport” was applied for processing the data (Grujic et al, 1999).

Research protocol

The first or initial measuring was done immediately after the completion of learning program. Experimental procedure was identical at initial and final measuring. The examinees were instructed neither how to distribute the force, nor what stroke length to apply during the testing. The test consisted of two measuring with assigned rowing speeds, indirectly through passing times on 500m. The first assignment had the passing time of 2min/500m, while the second assignment had the passing time of 1min 40 s/ 500m in the length of time of 30 s.

For 30 seconds the examinees completed 10 to 15 strokes. Given duration for each assignment represent the compromise between sufficient number of strokes and influences of factors that derange the stability of sports techniques such as fatigue, poor physical preparation and influence of psychological factors such as concentration, motivation and similar (Steinacker & Secher, 1993; Schmidt, 1990). Breaks during assignments lasted 15-20 seconds and were sufficient for complete recovery for a new assignment. During measuring one of the measurers stood by the examinee and registered entering the regime of assigned pressure during rowing, while the other started registering on the sign given by the first measurer, and conducted data activity on computer. Registering the tested stroke variables was initiated after establishing constant assigned value (O’Neill, 2003).

The sample of examinees

The experiment was realized on the sample of 44 students of final fourth year from the Faculty of Sport and Physical Education in Belgrade, without previous rowing experience, (25±2 years), (81±8 kg) and (184±7 cm).

The sample of variables

Since the limit of aerobic brink, the limit between work in zones of small and medium intensity, can be found among rowers in passing time of 2min / 500m that represents the approximate limit of aerobic threshold. Passing time of 1min and 40s/500m represents an approximate limit of anaerobic threshold for most of the rowers (O’Neill, 2003).

Taking into account the importance of the indicated values, assigned speeds were exactly in the given range as criterion variables.
In the context of predictor variables, the researches used to find different ways of measuring stroke variables, in the boat, on rowlock, outrigger, handle, blade, ergometer (Gombac, 1965; Grujic et al., 1999; Lu et al., 1992). A larger number of simultaneously observed stroke variables enable a better view on their interrelationship and dependency, as well as the very phenomenon of motor learning; and, in order to use international references, they shall be additionally marked by standard abbreviations. There are 13 stroke variables observed in this research. Four of them are time variables: time of active stroke phase (act time), time of passive stroke phase (pas time), rhythm or ratio (ratio), frequency of strokes (frq); three are power variables: power during average stroke (power avr t), power during active stroke phase (power avr a), maximum power (power peak); three are force variables: force during average stroke (force avr t), force during active stroke phase (force avr a), maximum force (force peak); two are speed variables: average realized speed of grip during active stroke phase (speed avr a), realized maximum speed of grip during active stroke phase (speed peak); and one is space variable – stroke length (stroke length).

**Statistical analysis**

Significant changes were tested by two-way T-test for dependable samples.

**RESULTS AND DISCUSSION**

Under the influence of experimental factor, there were statistically significant changes of values of all thirteen tested stroke variables at the final measuring.

**Time variables**

At the final measuring of time variables there were increased values of active stroke phase variable and passive stroke phase variable, and reduced values of variable and stroke frequency variable ratio. With the increase of assigned speed there came the decrease of active stroke phase time and passive stroke phase time, while ratio and stroke frequency showed increased values.

**Active stroke phase time**

Active stroke phase is in direct connection with the passive phase and expressing power on oar handle. At the final measuring the value of active stroke phase time was increased in both assignments while with the increase of assigned speed it was reduced (chart 1).

**Chart 1.** Presentation of active stroke phase time at initial and final measuring at two assigned values of stroke speed

Time of active stroke phase in regatta speed and frequency of 34.4 strokes per minute is about 700ms (Rajkovic, 2005). The approach of values for examinees to the aforesaid values indicates that higher of the two assigned speed is more appropriate as a task for acquiring this stroke variable (Ilic et al., 1996; Ilic & Vasiljev, 2003; Rajkovic, 2005). Since speed was an assigned value (constant), the increase of transit and increase of shown power and force with simultaneous decrease of active stroke phase time show the success of technical performance which is, among the rest, valued by shorter time of movements (Schmidt, 1990).

In previous researches (Smith & Spinks, 1995), a significant connection ($r = -0.73$, $p < 0.01$) between relation of active stroke phase time and total stroke time was also noted. This ratio shows whether there has been the increase of stroke efficiency under the influence of experimental factor.
The shown relation between active stroke phase time and total stroke time (chart 2) shows that there has been the increase of stroke efficiency under the influence of experimental factor.

**Passive stroke phase time**

The increase of passive stroke phase time at the final measuring shows the approaching of passive phase value to values achieved in regatta speed and frequency of 34.4 strokes per minute (Smith & Spinks, 1995), while with the increase of assigned speed the value of this phase time is reduced (chart 3), which was expected, taking into account that frequency represents the number of strokes in a unit of time (Celentano et al., 1974).

**Stroke ratio**

The value of ratio variable (the relation of active and passive stroke phase) shows that at the final measuring there was a reduced ratio value and that these values increase with the increase of assigned speed (chart 4). Although a movement can be seen in approaching the values of ratio which is most often noted during major competitions (1:2 and 1:1.5; Celentano, 1974), values got in percentages show an unfavourable ration. The term favourable ratio means the one which has shorter active phase time than the passive one (quotient value less than 1) (Nilsen, 2001). The obtained results show that the active stroke phase time at final measuring remained shorter than passive phase time in spite of the influence of experimental factor, and that can be concluded that the examinees did not acquire the knowledge about ratio during learning program, that ratio represents a complex task which demands previous acquiring of other technique elements and that this is a variable which needs a longer period of time to be learned. Besides, the qualities of rowboat “Galija”, in which practice was done – its weight, inertia, great hydrodynamic resistance – are the factors inappropriate for learning stroke ratio.
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**Stroke frequency**

The results of stroke frequency (number of strokes in the unit of time) at the final measuring show that the examinees solved the same assignment with smaller stroke frequency, while they increased the frequency with the increase of assigned speed (chart 5).

**Chart 5.** Presentation of stroke frequency at initial and final measuring, at two assigned values of stroke speed.

The same boat speed can be sustained by increasing stroke frequency, although stroke length is reduced (Rajkovic, 2005). Limit stroke frequency that does not lead to further speed acceleration is 36 or 37 strokes (O’Neill, 2003).

The examinees approached the values of regatta speed at higher assigned speed better at frequency of 34.4 strokes per minute, which shows that they rowed in more rational way, increased the efficiency of strokes and that higher assigned speed is more appropriate as an assignment for acquiring stroke frequency variable (Zatsiorsky & Yakunin, 1991). The examinees also sustained the assigned speed, i.e. passing time by greater number of strokes and by reducing the passive phase. Apart from the increase of stroke efficiency in which the assigned length is increased and greater power and force are shown at assigned (constant) speed, there is space for increasing the efficiency in increase of passive stroke phase time, which has been confirmed by numerous authors who researched stroke efficiency (Baudouin & Howkins, 2002).

**Power variables**

All power variables at final measuring: average power of complete stroke (chart 6), average active stroke phase power (chart 7), and peak power (chart 8) show the same tendency, both under the influence of experimental factor and at greater assigned speed.

**Chart 6.** Presentation of average power during complete stroke at initial and final measuring, at two assigned values of stroke speed

In all power variables at the final measuring there is a statistically significant increase of values (p<0.01). The increase of assigned speed results in the increase of all values of power variable both at initial and final measuring.

**Variables of power and force**

Initial conditions for stroke performance and their application through appropriate time scheme of applied muscle power show different effect of applied power during strokes.
fer from the average ones at their ability to develop great power, but at their ability to develop great power (Celentano et al., 1974; Zatsiorsky & Yakunin, 1991). The results of expressing power at the final measuring show that higher values of shown power are noted at greater assigned speed. The increase of shown power values with the increase of assigned speed is expected, since the power is directly proportional to work done and reverse proportional to time in which the work is done.

**Chart 8.** Presentation of peak stroke power at initial and final measuring, at two assigned values of stroke speed

By analyzing strokes at expressing power and speed a limit speed value was obtained, at which the boat speed was not increased despite further power values. It is in accordance with the results of researches completed so far (Williams & Scott, 1967) that a stroke is more consistent at higher speed (Ilic et al., 1996), and that the quotient of mechanical efficiency during a continuous rowing is greater than it is the case of rowing with breaks (Kleshnev, 2004).

**Force variables**

At the final measuring there was a statistically significant increase of shown force at both of the assigned speed, at all speed variables: average complete stroke force (chart 9), average active phase force (chart 10) and maximum (peak) force (chart 11). Likewise, with the increase of assigned speed, almost doubled values of expressed force were observed.

**Chart 9.** Presentation of average force during complete stroke at initial and final measuring, at two assigned values of stroke speed

![Chart 9](image)

Explanation for the obtained results, where at greater assigned speed there is a greater force value, lies in the transient regime of muscles, which are typical for cyclic movements such as rowing. Namely, greater assigned speed corresponds to transient regime of muscles, i.e. the intensity that corresponds to the time interval in which muscle force is adapting to a new degree of activation and time for relaxation.

**Chart 10.** Presentation of average force during active stroke phase at initial and final measuring, at two assigned values of stroke speed

![Chart 10](image)

In previous researches (Zatsiorsky & Yakunin, 1991) a significant connection was observed ($r=0.48$, $p<0.01$) between the relationship of average active stroke phase force, peak force and stroke efficiency.

Speaking about the average and peak force for technique improvement, in researches conducted so far (Smith & Spinks, 1995) it was recommended the increase of average force level, and especially the increase of relation of average and peak force.
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If the ratio of average and peak force is nearer to number one, stroke efficiency is greater.

From the results of relation of average force during active phase and peak stroke force (chart 12) it can be observed that, under the influence of experimental factor, the ratio came close to one, which shows that there was the increase of stroke efficiency.

Chart 12. Presentation of average active phase stroke ratio and peak force at initial and final measuring, at two assigned values of stroke speed

<table>
<thead>
<tr>
<th></th>
<th>initial</th>
<th>final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.27</td>
<td>0.33</td>
</tr>
<tr>
<td>2</td>
<td>0.29</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Task 2 min/500m, 1.4 min/500

Speed variables

Mechanism of speed sequence on the levels of single joints as well as its manifestation at the end of kinetic chain moving the oar in the same point is a closed mechanical system in which muscles do joined synergic activity in the shape of showing force. The final effect of sequencing single expressed power is a stable trajectory of strokes obtained through line speed which is changed during strokes in steady regime.

Active stroke phase speed and peak speed

Time profile of active stroke phase speed (chart 13) and peak speed (chart 14) are the assigned values (criterion variables), indirectly through passing time at 500m, and therefore there are no significantly important differences in results that are expected.

Chart 13. Presentation of average grip speed during active stroke phase at initial and final measuring, at two assigned values of stroke speed

<table>
<thead>
<tr>
<th></th>
<th>initial</th>
<th>final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5</td>
<td>1.65</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Task 2 min/500m, 1.4 min/500

However, although speed was an assigned value, there is a statistically important difference between assigned and reached speed at smaller assigned speed in both variables (charts 13 and 14)

Chart 14. Presentation of peak grip speed at initial and final measuring, at two assigned values of stroke speed

<table>
<thead>
<tr>
<th></th>
<th>initial</th>
<th>final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>2</td>
<td>2.3</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Task 2 min/500m, 1.4 min/500

It is assumed that this result was obtained because the strokes are in principle, less consistent at smaller speed (Mladenovic, 2006). Although there are smaller variations from average absolute values on the group level, the results obtained at smaller assigned speed show great differences and oscillations inside the group (Tables 1 and 2). On the basis of above mentioned, it can be concluded that the examinees presented greater assigned speed (Ilic & Vasiljev, 2003; Mladenovic, 2006). The same level of assigned speed can be preserved by merely changing the way of expressing force, with a smaller level of peak force, or with its longer preservation (Zatsiorsky & Yakunin, 1991).
Space variable

Exceptionally important variable is an oar handle transit intended for adequate and accurate quantification of mechanical work in both active (positive) and passive (negative) phase.

Oar handle transit

At the final measuring under the influence of experimental factor there was a statistically important increase in oar handle transit (Chart 15) at both assigned speeds, and with the increase of assigned speed, there comes the increase of this value.

Chart 15. Presentation of oar handle transit at initial and final measuring, at two assigned values of stroke speed

Using approximate values of angle and internal oar handle, an optimal value of oar handle transit length can be obtained, which is about 164 cm; and these values obtained at the final measuring (163.80 cm and 166.20 cm) have variate little from the optimal value, showing thus that oar handle transit variable is a learned one. Beside the increase of oar handle transit values, at higher assigned speed there came the decrease of active phase time and greater expressing power and force, which shows the increase of stroke efficiency (Stuble et al., 1980).

Stroke variability analysis

This analysis is also based on classification of variables according to their features into time variables, power and force variables, speed and space variables. Variability of results shows that rowing technique can be estimated not only based on their variation from absolute values, but also on the basis of result variability of examined stroke variables.

Under the influence of experimental factor (learning the basic rowing technique) variability was changing differently, as well as the range of tested stroke variables, while with the increase of assigned speed, changes in variation quotient value were noted in all thirteen variables (Tables 1 and 2).

Table 1. Results of initial measuring variation quotients at different speeds

<table>
<thead>
<tr>
<th>Variables</th>
<th>2min/500m initial</th>
<th>1min 40s/500m initial</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. time of active stroke phase (ms)</td>
<td>0.124</td>
<td>0.106</td>
</tr>
<tr>
<td>2. time of passive stroke phase (ms)</td>
<td>0.152</td>
<td>0.186</td>
</tr>
<tr>
<td>3. rhythm or ratio (%)</td>
<td>0.109</td>
<td>0.147</td>
</tr>
<tr>
<td>4. frequency of strokes (str/min)</td>
<td>0.133</td>
<td>0.137</td>
</tr>
<tr>
<td>5. power during average stroke (W)</td>
<td>0.152</td>
<td>0.181</td>
</tr>
<tr>
<td>6. power during active stroke phase (W)</td>
<td>0.187</td>
<td>0.211</td>
</tr>
<tr>
<td>7. maximum power (W)</td>
<td>0.207</td>
<td>0.210</td>
</tr>
<tr>
<td>8. force during average stroke (N)</td>
<td>0.142</td>
<td>0.155</td>
</tr>
<tr>
<td>9. force during active stroke phase (N)</td>
<td>0.178</td>
<td>0.187</td>
</tr>
<tr>
<td>10. maximum force (N)</td>
<td>0.203</td>
<td>0.193</td>
</tr>
<tr>
<td>11. speed of grip during active stroke phase (m/s)</td>
<td>0.034</td>
<td>0.430</td>
</tr>
<tr>
<td>12. maximum speed of grip (m/s)</td>
<td>0.021</td>
<td>0.410</td>
</tr>
<tr>
<td>13. stroke length (cm)</td>
<td>0.140</td>
<td>0.140</td>
</tr>
</tbody>
</table>
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During the assignment 2min/500m at time variables, no changes under the influence of experimental factor were noted only in the case of stroke ratio variable (Bompa, 1980), while there were reduced values of variation quotient in all other time variables: active stroke phase (Batschi et al., 2002), passive stroke phase (Baudouin & Howkins, 2002) and stroke frequency variable. Time variables variation quotients describe exceptionally homogenous units both at initial and at final measuring. Stroke ratio variation quotients show insufficient level of learning of this variable, which demands comprehension of all other elements of technique and a longer training period. One of the criteria for estimation of the learning level of this technique is equalization of active stroke phase (Sanderson & Martindale, 1986).

Table 2. Results of final measuring variation quotients at different speeds

<table>
<thead>
<tr>
<th>Variables</th>
<th>2min/500m final</th>
<th>1min 40s/500m final</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. time of active stroke phase (ms)</td>
<td>0.067</td>
<td>0.067</td>
</tr>
<tr>
<td>2. time of passive stroke phase (ms)</td>
<td>0.115</td>
<td>0.170</td>
</tr>
<tr>
<td>3. rhythm or ratio (%)</td>
<td>0.109</td>
<td>0.164</td>
</tr>
<tr>
<td>4. frequency of strokes (zav/min)</td>
<td>0.076</td>
<td>0.101</td>
</tr>
<tr>
<td>5. power during average stroke (W)</td>
<td>0.188</td>
<td>0.119</td>
</tr>
<tr>
<td>6. power during active stroke phase (W)</td>
<td>0.211</td>
<td>0.154</td>
</tr>
<tr>
<td>7. maximum power (W)</td>
<td>0.232</td>
<td>0.157</td>
</tr>
<tr>
<td>8. force during average stroke (N)</td>
<td>0.173</td>
<td>0.105</td>
</tr>
<tr>
<td>9. force during active stroke phase (N)</td>
<td>0.198</td>
<td>0.143</td>
</tr>
<tr>
<td>10. maximum force (N)</td>
<td>0.224</td>
<td>0.154</td>
</tr>
<tr>
<td>11. speed of grip during active stroke phase (m/s)</td>
<td>0.043</td>
<td>0.035</td>
</tr>
<tr>
<td>12. maximum speed of grip (m/s)</td>
<td>0.031</td>
<td>0.029</td>
</tr>
<tr>
<td>13. stroke length (cm)</td>
<td>0.080</td>
<td>0.070</td>
</tr>
</tbody>
</table>

Values of all power and force variables, complete stroke power, active phase power (Filter, 1997), peak power, complete stroke force, active phase force, peak force increased at the final measuring. The greatest influence of experimental factor on reduction of variability at final measuring is exactly in abovementioned variables. The reduction of variability with the increase of assigned speed is expected and in compliance with the researches connected to the mechanical efficiency and consistency of continuous strokes (Baudouin & Howkins, 2002).

At speed variables (active phase grip speed and peak speed) the variation quotient values are increased, although speed (indirectly, through passing time at 500m) was an assigned value, i.e. criterion variable. Speed variables describe exceptionally homogenous unit and quotient reduction is expected because this variable is also a criterion one. Although there were small variations from the absolute values on the group levels, the obtained results of variation quotient at smaller assigned speed indicate great differences in oscillations inside the group. Therefore we can conclude that the examinees managed higher assigned speed better, and that this speed is more convenient as an assignment for learning rowing technique elements after the initial phase of learning. Smaller assigned speed is appropriate in initial phase for operative mistake correction and initial learning during rowing.

Space variable of oar handle transit has reduced values of variation quotient at the final measuring under the influence of experimental factor (Kleshnev, 1995). The values of variation quotient at the final measuring describe a degree of successive movements’ consistency, so the reduction of variability with the increase of the assigned speed is expected and in compliance with the results of previous researches (Mitrovic, 2003; Mladenovic, 2006).
Oar handle transit confirmed again that it can be considered a valid parameter for estimation of rowing technique learning.

At the assignment of 1min 40s/500m the values of variation quotients of all stroke variables show reduction at the final measuring under the influence of experimental factor, apart from the stroke frequency variable. The reduction of variability under the influence of experimental factor is expected, but not the increase at higher assigned speed. Therefore, on the basis of the abovementioned, it can be concluded that higher assigned speed is not appropriate for stroke frequency variable learning and we can assume that it surpasses the critical value of 70% of peak speed (Ilic et al., 1996; Ilic & Vasiljev, 2003).

CONCLUSION

The following conclusions were made by following the changes of biomechanical variable values during rowing on rowing ergometer, in real time, at two levels of assigned speeds:

- An assigned speed is an important factor in rowing technique learning;
- Beginner rowers are better to be given the assigned speeds, and not stroke frequency, because all variable values at initial and final measuring at different assigned speeds have small variation quotient;
- As an assignment, it is more convenient to give a higher level of assigned speed out of two, because of small result dispersion at initial and final measuring;
- A beginner rower cannot control higher assigned speed by showing force on oar handle, so that they accomplish the task by higher stroke frequency;
- Stroke ratio was not adopted and it still remains inappropriate, i.e. active phase time lasted longer than passive stroke phase time.

The results and conclusions of this research can be applied to forming models and competitive normative, as well as detecting and eliminating variations from the ideal rowing technique model at all levels, from the beginning of training to elite technique.

REFERENCES


