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Association of Motor Abilities and Morphological Characteristics with Results on a Rowing Ergometer

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Abstract

This study aimed to determine the association of morphological characteristics and motor abilities on the results achieved on a rowing ergometer. The participants were 36 students of Faculty of Kinesiology of the University of Split, Croatia (21 males, 15 females). The sample of variables consisted of a total of 22 variables: 11 variables measuring morphological characteristics, 10 motor abilities (predictors), and the result on a rowing ergometer. The ergometer variable represented the test result achieved on a rowing ergometer at a distance of 2000 meters. The correlation between predictors and criterion was evidenced by Pearson's product-moment correlation. A big correlation was found between rowing 2000 m on an ergometer and wall squat, stand and reach, body height, foot-tapping and calf skinfold for men; and body height and mass, calf- and mid-upper-arm-circumference, biceps-, triceps-, subscapular- and calf-skinfold, medicine ball throw and wall squat test, for women. Success in rowing is directly dependent on morphological characteristics and motor abilities. For more detailed analysis, partial influences of each factor, psychophysical characteristics, technical and tactical abilities and external influence should be taken into consideration.

Keywords: *motor abilities, morphological characteristics, ergometer, rowing*

Introduction

When the structure of the movement is taken into consideration, rowing belongs to a group of monostructural, cyclic sports, characterized by repeated movement structure (McArthur, 1997). All official rowing races are held on 2000-meters courses and, depending on the discipline, they take between five and eight minutes (FISA, 2006). Rowing can be classified as an aerobic-anaerobic sport with a dominant aerobic energy component (Hagerman, Connors, Gault, Hagerman, & Polinski, 1978; Messonnier, Freund, Bourdin, Belli, & Lacour, 1997). At the start of the race, in the initial acceleration phase, energy needs are covered primally with the anaerobic alactic mechanism; after reaching the maximum speed and in a transitional phase, the anaerobic lactic system is the primary source of energy production; after 90 seconds of the race, the key role in energy production is taken by the aerobic energy mechanism (Hagerman, 1984). In addition to the energy component, an effective rowing technique is essential for success (Secher & Volianitis, 2009).

A rowing ergometer is a specific training machine that provides a good simulation of rowing stroke on the water and comparable amount of energy expended and, therefore, is most important training content when training on water is not possible for any reason (e.g., strong wind, big waves) (Schabort, Hawley, Hopkins, & Blum, 1999). It is often used during winter, in the preparation period, and when official rowing ergometer competitions are organized by FISA or national federations (FISA, 2006). Analyses of force production and movement of the stroke found that kinematic and kinetic variables are similar for rowing in the boat on the water and on the rowing ergometer; it thus represents an accurate simulation of rowing (Lamb, 1989; Mikulić, Vučetić, Matković, & Oreb, 2005). However, given the absence of a technical component, the result on the ergometer should not be taken as the only relevant predictor of rowing performance in the boat, but rather as an indication of the individual's current state of training.

Anthropological attributes are organized systems of all characteristics, abilities, and motor information, as well as their interrelations (Breslauer, Hublin, & Zegnal Koretić, 2014). Among

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others, morphological characteristics and motor abilities are parts of the anthropological status of each human being; their relationship to success in sport is a matter of interest to many researchers (Gardasevic et al., 2020; Krstulovic, Males, Zuvela, Erceg, & Miletic, 2010; Trninić, Jelaska, & Papić, 2009). Research studies done on rowers have shown that aerobic and anaerobic capacities, the strength of lower extremities, body mass and height are good predictors of rowing success (Claessens et al., 2005; Jürimäe et al., 2010; Secher, 1975).

Since, to author's knowledge, all of the studies done on this subject evaluate the performance of active rowers, this research aimed to determine the association of morphological characteristics and motor abilities on the results achieved in the test on a rowing ergometer at a distance of 2000 meters on a sample of students that have no previous experience in rowing.

Methods

Participants in this study were 36 students (21 men and 15 women) of third-year undergraduate study. During the eight-week course, students learned the technique of rowing on an ergometer and prepared physically for the final test of 2000 meters, which was part of their exam. All participants were clinically healthy at the time of testing.

The set of variables consisted of 11 variables of morphological characteristics, 10 variables of motor abilities, and the test of rowing on an ergometer for 2000 meters. The measured morphological characteristics were: body height, body weight, circumference of the upper arm in flexion, circumference of the lower leg, diameter of the elbow, diameter of the knee, biceps skinfold, triceps skinfold, scapular skinfold, abdominal skinfold and calf skinfold. All measures were taken on the dominant side of the body, were measured three times, and the arithmetic mean was taken as the final result. Motor abilities were measured with the following test: hand taping, leg tapping, broad jump, sitting medicine throw, pullups, sit-ups, rowing bar pull, Biering-Sorensen, wall squat and standing flexibility. Hand taping, leg tapping, broad jump, sitting medicine throw, and standing flexibility tests were measured three times, and the best results were taken as final, while pullups, sit-ups, rowing bar pull, Biering-Sorensen, and wall squat were taken only once because of the fatigue factor.

All testing was held in the Gusar Rowing Club for two days, as ergometer rowing was held on the first day and all other tests on the second day. Considering that higher grades in the course required better performance on the ergometer, we can assume that the motivation factor contributed to the "situational-competitive" conditions.

In statistical analysis, the descriptive statistics included the means and standard deviations presented as the true results for each variable, and the Kolmogorov-Smirnov test was used for testing normality of distribution. To identify the univariate associations between ergometer variable and morphological and motoric variables, Pearson's product-moment correlation was calculated. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

Results

The Kolmogorov-Smirnov test (Table 1) showed that variables broad jump and wall squat for men and pull ups and diameter of the elbow for women are not normally distributed, while all other variables have normal distribution. The most significant variability was found for sitting medicine throw and wall squat for men and Biering-Sorensen for women.

Table 1. Descriptive parameters

Variables	Men (n=21) M±SD	Women (n=15) M±SD	Kolmogorov-Smirnov test
hand taping	46.81±5.78	47.13±3.72	0.15
leg tapping	29.19±3.22	28.80±4.25	0.13
broad jump	236.67±19.70	187.67±16.37	0.09
sitting medicine throw	460.34±52.49	342.73±35.96	0.07
pull ups	13.71±4.45	1.13±2.53	0.19
sit ups	53.00±6.39	49.93±6.22	0.12
rowing bar pull	18.33±4.72	22.87±7.80	0.13
Biering-Sorensen	102.52±27.18	146.40±62.89	0.15
wall squat WS	86.09±47.78	80.73±30.57	0.13
standing flexibility	22.19±7.66	30.87±4.21	0.09
body height	180.21±6.87	170.17±6.31	0.09
body weight	77.68±7.94	64.71±8.84	0.12
circumference of the upper arm in flexion	35.24±2.62	29.59±2.08	0.07
circumference of the lower leg	38.41±3.08	37.07±2.43	0.12
diameter of the elbow	6.81±0.38	6.42±0.97	0.16
diameter of the knee	8.98±0.48	8.57±0.91	0.15
biceps skinfold	3.92±0.79	7.44±2.62	0.24
triceps skinfold	8.64±2.35	15.71±3.71	0.11
scapular skinfold	9.89±1.99	13.76±4.15	0.17
abdominal skinfold	4.52±0.99	8.97±3.56	0.22
calf skinfold	6.73±1.96	15.37±4.19	0.18
rowing 2000 m on ergometer	436.42±17.51	514.83±25.28	0.17

Results of correlation analysis (Table 2) showed big correlations between rowing on ergometer and wall squat, standing flexibility, body height, leg tapping and calf skinfold for men and sitting medicine throw, wall squat, body height, body weight, circumference of the upper arm in flexion, circumference of the lower leg, biceps skinfold, triceps skinfold, scapular skinfold, abdominal skinfold and calf skinfold for women.

Table 2. Correlation matrix (Pearson's product-moment correlation)

Variables	Men	Women
	rowing 2000 m on ergometer	
hand taping	-0.31	0.24
leg tapping	-0.45	-0.36
broad jump	-0.26	-0.23
sitting medicine throw	0.01	-0.67
pull ups	-0.37	0.14
sit ups	-0.25	-0.13
rowing bar pull	-0.03	-0.37
Biering-Sorensen	-0.23	-0.01
wall squat	-0.58	-0.62
standing flexibility	-0.55	0.33
body height	-0.46	-0.63
body weight	-0.41	-0.92
circumference of the upper arm in flexion	0.01	-0.68
circumference of the lower leg	-0.26	-0.75
diameter of the elbow	-0.04	-0.18
diameter of the knee	0.29	-0.26
biceps skinfold	-0.18	-0.51
triceps skinfold	0.07	-0.68
scapular skinfold	0.18	-0.56
abdominal skinfold	-0.31	-0.45
calf skinfold	-0.45	-0.56

Discussion

Men

The wall squat test is a measure of the isometric endurance of the lower leg muscles (Lubans et al., 2011). More stamina and strength in muscles can produce larger amounts of force, which can be transported in every stroke; research has shown that rowers with stronger legs have better results in races and on the ergometer (Jürimäe et al., 2010; Lawton, 2012). The correlation between the results on the wall squat test and the rowing 2000 m on ergometer can also be explained by the psychological aspect since the motivation to do the test at the maximum level can strongly affect the outcome (Marinović, 1990). A big correlation for men was also found for the test of standing flexibility, with which the flexibility of the posterior part of the body, mostly the lumbar spine and the hamstring muscles, was measured. Optimal flexibility of these muscles enables better body position of rower in the relaxing phase of the stroke and better preparation to generate more force in the propulsive phase (Kleshnev, 2016). Also, decreased flexibility of back and leg muscles can cause injuries because at the beginning of the stroke tense muscles pull the pelvis and increase flexion in lumbal part (Šimić, 2015). The leg tapping test was measured to show the speed of movement frequency of the lower extremities. Movement frequency velocity as a motor ability is defined by performing repetitive movements of constant amplitude as fast as possible (Sekulić, 2007). Considering that the high tempo of the strokes contributes to the speed of the boat, it is easy to conclude that maintaining a constant high speed of movement requires a constant high number of strokes, which in race races reaches an average of 40 strokes per minute (Kleshnev, 2016).

The influence of body height on rowing performance has been explored in numerous studies as the longitudinal dimensionality (length of extremities) has been noted as one of the most important predictors of rowing success (Bourgois et al., 2000; Bourgois & Vrijens, 2001; Claessens et al., 2005; Mikulić, 2008). Since the participants in this study were students, the correlation was smaller than in previously cited studies done on rowers but was also big. The association with results on the rowing 2000 m on ergometer was also found for the variable of skinfold measured on the calves. Successful rowers, runners, and cyclists are characterized by above-average percentages of Type I (slow) muscle fibres in the leg, with measured values up to 85% (Seiler, 2003). Although it is a general assumption that adipose tissue has a negative impact on performance (Jurov et al., 2020), researchers have identified, in a group of runners, high positive relation of quadriceps and calf skinfold and time on 1500 and 10,000 meters so it can be a useful predictor of athletic achievement in the previously mentioned endurance athletes (Arrese & Ostáriz, 2006).

Women

On a sample of female students, big correlations were found for most of the morphological variables and for wall squat and sitting medicine throw test. The relationship between wall squat test and results of 2000 metres on that rowing ergometer has already been explained on a sample of male students. Sitting medicine throw test is a measure of the explosive power of the upper body (Stockbrugger & Haennel, 2001). Although that segment of motor abilities is not of high importance for rowing success (Jürimäe et al., 2010), we can assume that the results of this test is associated by the higher amount of muscle mass in the upper body which also positively affects the results on the ergometer (Bourgois et al., 2000).

Confirmation of that finding can be seen by looking at correlations with morphological variables for which big negative relations were identified for body weight, body height, both circumferences (upper arm in flexion and lower leg) and all skin folds (biceps, triceps, abdominal, scapular and calf). Active muscular body mass is of great importance for rowing because of the possibility of generating greater force, which with longitudinal dimensionality creates the conditions for a longer stroke, greater propulsive force and greater speed of movement (Claessens et al., 2005). The term "body mass" does not reveal much because the amounts of muscle mass and adipose tissue in the total body mass are unknown. However, since ballast does not have a negative effect rowing on an ergometer, as would be the case with rowing on a rowing boat (Nevill, Beech, Holder, & Wyon, 2010), increased body mass can be seen primarily as a mechanism for achieving a stronger stroke force.

The findings of this study, although investigated on a sample of non-rowers, confirmed conclusions of previous similar studies which stated that the success in rowing, both in the boat and on the ergometer, depends directly on the morphological characteristics and motor skills.

However, for a more detailed analysis of "multidimensional" performance, it must be viewed through the specification equation, while analysing the partial impact of each factor, psychophysical characteristics, technical and tactical abilities and external influences individually.

The results of the conducted research will provide information for future research according to which researchers will be able to search for morphological, motor and psychosocial and other factors that define sports performance.

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Conflict of Interest
The authors declare the absence of conflict of interest.

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