RELATIONSHIP BETWEEN THE NATIONAL EVALUATION SYSTEM AND THE PERFORMANCE OF BRAZILIAN ROWERS

RELAÇÃO ENTRE O SISTEMA NACIONAL DE AVALIAÇÃO E DESEMPENHO DE REMADORES BRASILEIROS

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Fábio Barreto Maia da Silva[1]
(Physical Education Professional)
Marcela Sacramento Campos[2]
(Physical Education Professional)
Guilherme Ribeiro Soares[3]
(Physical Education Professional)
Antonio Carlos Gomes[4]
(Physical Education Professional)
Fernando Carmelo Torres[5]
(Physician)

1. Club de Regatas Vasco da Gama, Nautical headquarters, Rio de Janeiro, RJ, Brazil.
2. Clube de Regatas Guanabara, Rowing Department, Rio de Janeiro, RJ, Brazil.
3. Confederação Brasileira de Remo, Florianópolis, SC, Brazil.
4. Academia Brasileira de Treinadores do Comitê Olímpico do Brasil (ABT-COB), Rio de Janeiro, RJ, Brazil; Center for Studies on Exercise and Training Physiology - Universidade Paulista (CEFIT-UNIP), São Paulo, SP, Brazil.
5. Academia Brasileira de Treinadores do Comitê Olímpico do Brasil (ABT-COB), Rio de Janeiro, RJ, Brazil; Center for Studies on Exercise and Training Physiology - Universidade Paulista (CEFIT-UNIP), São Paulo, SP, Brazil.

Correspondence:
Fábio Barreto Maia da Silva
Rua Visconde de Sepetiba, 50, apartamento 803, Niterói, RJ, Brazil. 24020-206.
fbms78@hotmail.com

ABSTRACT

Introduction: The National Rower Evaluation System [*Sistema Nacional de Avaliação do Remador*] (SNAR), adopted by the Brazilian Rowing Confederation, aims to establish a national ranking, and is a prerequisite to participation in National Championships and Selective Games, in its different categories, as well as for joining the Brazilian Rowing Team. Objective: This study aimed to analyze the relationship and the prediction of the SNAR results with competitors' times in a Brazilian Rowing Championship (CBR). Methods: The investigation involved 11 female rowers (18.00 ± 0.89 years) and 16 male rowers (18.18 ± 0.91 years), participants in a CBR, in the junior category. The research was qualitative, with content analysis of the data available on the Confederation's website. Results: In the junior female category, of the ten variables studied, three showed a correlation $r \geq 0.50$; in the junior male category, nine showed a correlation $r \geq 0.50$. The multiple linear regression equation, with all the variables studied, showed R2 = 0.86 and SEE = 5.30, in the female category; and R2 = 0.90 and SEE = 3.56, in the male category. Conclusion: Based on our results, the tests indicated by SNAR can be an important source of information, offering significant support for managers, athletes and coaching staff, for use in performance diagnosis and in particular, competition prognosis. It can also be used to adapt training schedule where necessary. ***Level of evidence I; Diagnostic studies-Investigation of a diagnostic test.***

Keywords: Performance; Predictions and Projections; Rowing.

RESUMO

Introdução: O Sistema Nacional de Avaliação do Remador (SNAR), adotado pela Confederação Brasileira de Remo, tem como finalidade estabelecer um ranking nacional, sendo pré-requisito à participação em Campeonatos e Seletivas Nacionais, em suas diferentes categorias, bem como para ingresso na Seleção Brasileira de Remo. Objetivo: Este estudo visou analisar a relação e a predição dos resultados do SNAR com os tempos dos competidores num Campeonato Brasileiro de Remo (CBR). Métodos: A investigação envolveu 11 remadoras (18,00 ± 0,89 anos) e 16 remadores (18,18 ± 0,91 anos), participantes de um CBR, na categoria júnior. A pesquisa foi qualitativa, com análise de conteúdo dos dados disponíveis no site da Confederação. Resultados: Na categoria júnior feminino, das dez variáveis estudadas, três apresentaram correlação $r \geq 0,50$; na categoria júnior masculino, nove apresentaram correlação $r \geq 0,50$. A equação de regressão linear múltipla, com todas as variáveis estudadas, apresentou $R^2 = 0,86$ e SEE = 5,30, na categoria feminino; $R^2 = 0,90$ e SEE = 3,56, na categoria masculino. Conclusão: Os resultados obtidos sugerem que a análise dos testes indicados pelo SNAR pode ser uma fonte importante de informações, oferecendo subsídios relevantes a dirigentes, atletas e comissão técnica, tanto de diagnóstico de desempenho como, especialmente, de prognóstico em competição, além de permitir eventuais adaptações no planejamento de treino, quando necessárias e possíveis. ***Nível de vidência I; Estudos diagnósticos–Investigação de um exame para diagnóstico.***

Descritores: *Desempenho; Predição; Remo.*

RESUMEN

Introducción: El Sistema Nacional de Evaluación del Remador (SNAR), adoptado por la Confederación Brasileña de Remo, tiene como finalidad establecer un ranking nacional, siendo un requisito previo para la participación en Campeonatos y Selectivas Nacionales, en sus diferentes categorías, bien como para ingreso en la Selección Brasileña de Remo. Objetivo: Este estudio tuvo como objetivo analizar la relación y la predicción de los resultados del SNAR con los tiempos de los competidores en un Campeonato Brasileño de Remo (CBR). Métodos: La investigación involucró a 11 remadoras (18,00 ± 0,89 años) y a 16 remadores (18,18 ± 0,91 años), participantes de un CBR, en la categoría junior. La investigación fue cualitativa, con análisis de contenido de los datos disponibles en el sitio web de la Confederación. Resultados: En la categoría junior femenina, de las diez variables estudiadas, tres presentaron correlación $r \geq 0,50$; en la categoría junior masculina, nueve presentaron correlación $r \geq 0,50$. La ecuación de regresión lineal múltiple, con todas las variables estudiadas, presentó $R^2 = 0,86$ y SEE = 5,30, en la categoría femenina; $R^2 = 0,90$ y SEE = 3,56, en la categoría masculina. Conclusión: Los resultados obtenidos sugieren que el análisis de los tests indicados por el SNAR puede ser una fuente importante de informaciones, ofreciendo subsidios relevantes a los dirigentes, atletas y a la comisión técnica, tanto de diagnóstico de desempeño como, especialmente, de pronóstico en competición, además de permitir eventuales adaptaciones en la planificación de entrenamiento, cuando sea necesario y posible. ***Nivel de evidencia I; Estudios diagnósticos-investigación de un examen para diagnóstico.***

Descriptores: *Desempeño; Predicción; Remo.*

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INTRODUCTION

Rowing is a modality of force resistance, which consists of covering a lane of 2000 meters (Olympic distance), as quickly as possible.[1] In official competition, the motor capacity force must be applied efficiently, both on the upper and lower limbs,[2] to produce enough energy to maintain the boat performance. According to Steinacker,[3] the race involves about 70% of the rower's muscle mass, which develops an average power between 600-700 *watts* at the start, 450-600*watts* at the initial phase, 350-450 *watts* during the race, and 400-550 *watts* in the final stage. It is estimated that the contribution of the energy systems, during the performance in the 2000 meters in the boat, is 87% of the aerobic system, 6% of the lactic anaerobic and 7% of the alactic anaerobic.[4]

However, evaluating an athlete on the boat becomes a difficult task, as water performance is affected by environmental conditions such as wind, rain and cold.[5] In view of these influences, the rowing ergometer has been used as a strategy to maintain physical fitness[5] and still allows the objective assessment of metabolic and cardiorespiratory responses,[5-8] as well as performance.[5,6,9-11] Traditionally, the tests used in the rowing ergometer are the 2000 meters against the clock, the maximum incremental effort test [6] and the modified 30-second Wingate test. [11] A review article on rowing evaluation found greater reliability in the maximum test of 2000 meters on the rowing ergometer, due to the control of environmental effects.[6] Some results on the rowing ergometer can be considered as important predictors of the boat performance on the water.[9,12-14]

Certain research attempts to predict rowing performance through anthropometric variables, [15,16]upper limb power [11]lower limb strenght[17] and tests on the rowing ergometer [1,6,18]. Therefore, the Brazilian Rowing Confederation adopts the National Rower Evaluation System (SNAR), for athletes interested in competing in the Brazilian Rowing Championship (CBR) and the National Selective Championship, in its different categories, also serving as a complementary assessment for joining the Brazilian Rowing Team.

Therefore, we seek to relate, statistically, if one or more parameters of the SNAR could estimate the performance of the rower in an individual competition, relating the data of this system with the *ranking* of the results in CBR of the same year, in individual boats in the junior category (athletes until 18 years old), male and female.

MATERIALS AND METHODS

The research was quantitative, with content analysis of the SNAR and CBR data, in 2015, junior category, available on the website of the Brazilian Rowing Confederation. For this work, the results of 27 athletes of individual boats were collected, with 11 athletes in the junior female category (1xJRF) and 16 athletes in the male junior category (1xJRM), who met the adopted inclusion criteria: having participated in the junior CBR 2015; having the results of this championship and SNAR 2015 displayed on the website of the Brazilian Rowing Confederation. Therefore, if a given SNAR test result was not available for all athletes, this parameter would be excluded from the analyses. The research was approved by the committee of ethics and research of Universidade Estácio de Sá/UNESA/RJ, CAAE: 55169616.4.0000.5284.

National Rower Evaluation System

The Brazilian Rowing Confederation thus determines how the SNAR should be applied and ordered: 1st day: 6000 meter test; 2nd day: 100 meters and maximum strength (deadlift, squat and bench press); 3rd day: 500 meters; 4th day: 2000 meters; 5th day: rowing at low intensity (recovery); and 6th day: 30 minutes. Respecting the inclusion and exclusion criteria, data from the 30-minute test were not used, as they were not available on the website, and also the results of the strength tests, as some of the CBR participants did not have complete information. The data used in the study were: age; body weight; time and power in the 100 meters; time and power in the 500 meters; time and power in the 2000 meters; and time and power in the 6000 meters, totaling 10 variables.

The times of the championship were converted into *ranking* and we used the final classification in the championship as a criterion of performance in the water.

Statistical analysis

The website data was transferred to SPSS17 (Chigago, IL, USA). All times were converted to seconds and the times of the boats in the CBR were classified in *ranking*. Kolmogorov Smirnov was used to test the assumption of normality, which indicated that all 10 variables distributed in the categories were normal. Descriptive statistics were calculated for each category using Pearson's correlation coefficient (r) to examine the SNAR data and the CBR time *ranking* . The simple linear regression analysis was based on the variable that presented a correlation $r \geq 0.50$. The relationships were classified as follows: weak correlation (r= 0.10 to 0.30), medium (r= 0.40 to 0.60) and strong (r= 0.70 to 1).[19] Multiple linear regression was calculated, with the *ranking* of times as the dependent variable and the SNAR results as independent variables, with the Stepwise model applied to identify which variable would be the most important in each category. In addition, a multiple linear regression analysis was carried out, without applying any model, with all SNAR variables, to predict the *ranking* of times. The reliability of the regression models was expressed by the coefficient of determination ($R^{2)}$ and the standard error of the estimate (SEE).

RESULTS

The SNAR 2015 data and the *ranking* of the 2000 meters in CBR, in the 1xJRF category, are presented in Table 1 and, in the 1xJRM category, in Table 2. The simple linear regression equations that showed a correlation $r \geq 0.50$ are shown in Table 3.

The variables power and time in the 6000 meters and power in the 500 meters, in the female category, had, in isolation, a significant influence on the *ranking* of times. In the male category, the variables power and time in the 2000 meters, power and time in the 6000 meters, power in the 500 meters, body weight and age alone influenced the *ranking* of times in the championship. Thus, a linear regression model was fitted with the application of the Stewise model. In the female category, the constant variable was the power in the 6000 meters, with the highest determination coefficient and the lowest standard error of the estimate (R^2 =0.66; SEE = 2.60), explaining 66% of the variation of

Table 1. Descriptive statistics and Pearson's correlation coefficient (r) for the ranking of competitors' times in the Brazilian Rowing Championship: female junior individual boat category (1xJRF). *N*=11.

Variables	Mean	Standard Deviation	Minimum	Maximum	r (ranking of times in CBR)	P-value
Age (years)	18.00	0.89	16.00	19.00	0.23	0.48
Body Weight (kg)	62.70	8.27	51.90	77.00	-0.24	0.47
Time_100m (s)	0.20	0.009	0.19	0.22	0.46	0.14
Power_100m (W)	338.54	47.75	263.00	421.00	-0.41	0.20
Time_500m (s)	92.18	10.56	85.20	122.40	-0.11	0.73
Power_500m (W)	272.54	43.98	185.00	328.00	-0.52	0.09
Time_6000m (s)	1553.94	76.81	1466.40	1751.40	0.63	0.03*
Power_6000m (W)	159.09	19.49	111.00	185.00	-0.66	0.02*
Time_2000m (s)	469.20	24.61	443.40	508.20	0.49	0.12
Power_2000m (W)	199.45	25.32	153.00	231.00	-0.48	0.12
Boat time (s)	524.56	25.11	493.20	569.40	0.93	0.01**

* $p \leq 0.05$; ** $p \leq 0.01$.

the championship time *ranking*, with the equation: RT (s) = 24.082-0.114 * power_6000m. For men, the power in the 2000 meters had R^2=0.76; SEE = 3.16, corresponding to 76% of the *ranking* variation, with the equation: RT (s) = 37.034-0.083 * potency_2000m.

The multiple linear regression equations with all SNAR data, as a prediction of the time *ranking* in CBR, without applying any model, are shown in Table 4.

In the multiple regression model, the determination coefficient explained the variation in the ranking of times for the female category by 86% and, in the male category, by 90% (R^2=0.86; SEE = 5.30; R^2= 0.90; SEE = 3.56).

Table 2. Descriptive statistics and Pearson's correlation coefficient (r) for the ranking of the competitor's times in the Brazilian Rowing Championship: male junior individual boat category (1xJRM). *N*=16.

Variables	Mean	Standard Deviation	Minimum	Maximum	r (ranking of times in CBR)	P-value
Age (years)	18.18	0.91	16.00	19.00	-0.50	0.04*
Body Weight (kg)	78.07	8.10	67.30	97.30	-0.58	0.01*
Time_100m (s)	0.16	0.001	0.15	0.18	0.62	0.01*
Power_100m (W)	613.56	69.81	514.00	782.00	-0.61	0.01*
Time_500m (s)	81.97	14.43	75.60	135.60	-0.16	0.53
Power_500m (W)	479.25	54.27	378.00	554.00	-0.61	0.01*
Time_6000m (s)	1287.15	50.63	1212.60	1392.00	0.72	0.01**
Power_6000m (W)	276.18	30.30	216.00	332.00	-0.74	0.01**
Time_2000m (s)	390.33	18.76	370.80	432.00	0.74	0.01**
Power_2000m (W)	345.56	44.03	263.00	416.00	-0.76	0.01**
Boat time (s)	477.60	20.35	441.60	505.80	0.96	0.01**

* p≤0.05; ** p≤0.01.

Table 3. Regression equations predicting the ranking of boat times in the Brazilian Rowing Championship, based on SNAR data (for variables that showed a correlation *r* ≥ 0.50).

Category	Regression equations	R^2	SEE
1xJRF	RT = 24.082-0.114 * power_6000m	0.66	2.60 *
1xJRF	RT = -38.600+0.028*time_6000m	0.63	2.70
1xJRF	RT = 16.803-0.040*power_500m	0.52	2.97
1xJRM	RT = 37.034-0.083*power_2000m	0.76	3.16*
1xJRM	RT = -73.557+0.204*time_2000m	0.74	3.27
1xJRM	RT = 40.627-0.116*power_6000m	0.74	3.29
1xJRM	RT = -81.737+0.069* time_6000m	0.72	3.37
1xJRM	RT = -69.317+468.423*time_100m	0.62	3.84
1xJRM	RT = 34.032-0.042*power_100m	0.61	3.89
1xJRM	RT = 34.372-0.054*power_500m	0.61	3.87
1xJRM	RT = 35.328-0.344*body weight	0.58	3.98
1xJRM	RT = 56.025-2.613*age	0.50	4.25

1xJRF junior female category; 1xJRM junior male category; RT ranking of times; R^2coefficient of determination; and SEE standard error of the estimate. *Equations with application of the Stepwise model.

Table 4. Multiple regression equations, predicting the ranking of boat times in CBR, based on SNAR data.

Category	Regression equations	R^2 SEE
1xFJR	RT = 32.089 + (-0.088*age) + (-0.323*body weight) + (1794.664*time 100m) + (0.320*power 100m) + (0.000*time 500m) + (0.093*power 500m) + (-0.222 *6000m time) + (-0.928*6000m power) + (0.006*2000m power)	0.86 5.30
1xMJR	RT = 574.245 + (-2.957*age) + (-0.187*body weight) + (1197.134*time 100m) + (0.093*power 100m) + (-0.105*time 500m) + (0.041*power 500m) + (-0.573*6000m time) + (-0.927*6000m power) + (0.480*2000m time) + (0.128*power 2000m)	0.90 3.56

1xJRF junior female category; 1xJRM junior male category; RT ranking of times; R^2 coefficient of determination; and SEE standard error of the estimate.

DISCUSSION

The distance of 2000 meters in rowing provides considerable exhaustion in the anaerobic and aerobic metabolic systems.[10] Previous studies have examined the correlation between physiological aspects and performance on the rowing ergometer[19]and, currently, this correlation remains in the studies.[12,18,20,21] Other authors have identified differences in the movement of the arms[22] and the profile of the strenght and acceleration in the stroke, between the rowing ergometer and the boat on the water.[23] Even with these differences, the rowing ergometer is widely used by technicians and rowers, and the maximum test of 2000 meters is the most common measure of performance.[8,12] In addition, there is a knowledge gap between the relationship and the prediction of time and power in 100 meters, time and power in 500 meters, and time and power in 6000 meters, with the *ranking* of times in the 2000 meters of the individual boat.

This study showed that athletes in the 1xJRM category showed a strong correlation with time and power in the 6000 meters (r = 0.72; r = -0.74), time and power in the 2000 meters (r = 0.74; r = -0.76) and also a medium correlation with age, body weight, time and power in the 100 meters and power in the 500 meters (r = -0.50; r = -0.58; r = 0.62; r = -0.61; r = -0.61, respectively), all with statistical significance (p≤0.05) with the *ranking* of times in the competition.

According to Warmenhoven et al.,[14] the time and power in the 2000 meters in the rowing ergometer are correlated with the time in the 2000 meters in the individual boat. In another study, Mikulic et al.[12] showed a strong correlation in 24 rowers in the junior category, between the *ranking* of the individual boat times with the 2000 meters time on the rowing ergometer (*r*= 0.80; *p*≤0.01). In addition, in the data by Nevill et al.,[13] 49 rowers in the junior category showed a correlation between the average speed in the 2000 meters in the rowing ergometer with the average speed in the 2000 meters in the individual boat (*r*= 0.53).

This study also found that the relationship between body weight and the *ranking* of times shows a negative correlation, suggesting that the mass has a significant drag effect in this *ranking*, corroborating the results of studies[14,15] in which negative correlations were identified with body weight (*r*= -0.50).

Some studies [21,24,25] have demonstrated significance and negative correlation between age and time on the rowing ergometer, suggesting that the effect of age on performance on rowing results, whether in water or on the rowing ergometer, is also a factor to be considered. In this work, this was observed in the 1xJRM category, where there was a negative correlation between age and time *ranking* in the championship.

In addition, in the 1xJRF category, the variables showed an average correlation between the *ranking* of times in the championship with time and power in 6000 meters, power in 500 meters, time and power in 2000 meters, and time and power in 100 meters. Mikulic et al.[12] demonstrated a correlation, in 13 female junior rowers aged 17.6 ± 0.7 years, between the *ranking* of the individual boat times and the 2000 meters time on the rowing ergometer (*r*= 0.92; *p*= <0.001).

Simple linear regression analyses were used to prove the percentage of variation, among the variables that showed a correlation *r*≥0.50. In all of them, the standard error of the estimate (SEE) helped in the fit of the regression line, that is, we can describe the variation in the *ranking* of times as the dependent variable, as shown in table 3. In the 1xJRM category, the time in the 2000 meters explained 74% of the variation in the *ranking* (R^2 =0.74and SEE = 3.27). These results are similar to the data presented by Mikulic et al.[12] (R^2=0.65; SEE = 5.9). Still in this category, the power in the 2000 meters presented a forecast of R^2 =0.76 and SEE = 3.16, explaining, therefore, 76% of the *ranking* variation, identifying this result as the best explanatory parameter of the *ranking* variation of the times in the championship. In an article by Riechman et al.,[11] it was also shown that the power of 2000 meters can be a predictor of this variation (R^2 =0.75and SEE = 6.37). In addition, in these rowers, the time and power in the 6000 meters explained 72% and 74% of the variation in the *ranking*, respectively.

In the 1xJRF category, the time and power in the 6000 meters, and the power in the 500 meters could explain 63%, 66% and 52% of the variation in the *ranking*, respectively. These data show that the power in the 6000 meters (R^2=0.66; SEE = 2.60) can be considered as the most adequate.

Multiple linear regression analysis, using all variables, was able to explain 90% (R^2 = 0.90; SEE = 3.56) of the variation in the *ranking* of times in the championship, in the 1xJRM category, and 86% (R^2=0.86; SEE = 5.30), in the 1xJRF category. Thus, the hypothesis adopted by SNAR, that the combination of test results can be a good predictor to achieve a better position in the championship is supported for both categories.

For the other equations, no studies were found to compare the results.

Two situations involved in this study must be remembered as potential limitations in their analyses. The first was the 40-day period between the SNAR tests and CBR 2015, in which changes in performance could be underway. However, these realization dates are determined by the Confederation, and this type of information, with a time interval, is officially available, and it is worth checking, as done in this research, if even so they can be relevant as performance predictors. The second limitation, although all test results were performed on the Concept2 rowing ergometer (Morrisville, VT, USA), appears due to the differences between models (D and E), with the final performance times in the 100 meters, 500 meters, 2000 meters and 6000 meters, in the rowing ergometer, being able to present eventual variations due to mechanical differences between the devices.

CONCLUSION

After these analyses, it was found that both categories showed correlation and strong prediction of parameters adopted by SNAR with the *ranking* of times in CBR. A practical application of this study includes the possibility for managers, technicians, physical trainers and other professionals involved in the training of rowers, including themselves, to evaluate these parameters indicated by SNAR, including even their opponents, in a broader and more interpretative, diagnostic and prognosis perspective, which extrapolates and expands the original and restricted objectives of this system. In addition, we can also choose, among these tests, those that demonstrate the best correlation with test performance, being able to use the data obtained in the evolutionary monitoring of training, as well as make adaptations to this planning, if necessary.

Other studies correlating rower performance in water and physiological, biochemical, biomechanical and motor variables are necessary, in addition to expanding the number of rowers and categories surveyed, in order to identify which parameters can satisfactorily predict their competitive performance of these athletes.

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