SPECIFIC AND NON SPECIFIC ROWING FIELD EVALUATION CORRELATED WITH ERGOMETER ROWING PERFORMANCE

Caroline Giroux[1], Abderrahmane Rahmani[1], Frédéric Chorin[1], Julien Lardy[1], Hugo Maciejewski[2-3]

[1] LUNAM Université, Université du Maine, Laboratory, 'Motricité, Interactions, Performance', EA 4334, Avenue Olivier Messiaen, 72085 Le Mans Cedex 9, France
[2] French Rowing Federation, Boulevard de la Marne, 94736 Nogent-sur-Marne, France
[3] Laboratory of Exercise Physiology, EA 4338, University of Savoie Mont Blanc, Le Bourget-du-Lac, France

This study aimed at testing the possible correlation between rowers' ability to generate power during a rowing Wingate test or a squat jump test and a rowing ergometer performance. Mean power developped during the Wingate test (P_{WIN}), force, velocity and power output in squat jump (F_{SJ}, V_{SJ} and P_{SJ}) and mean power (P_{1500}) sustained during an all-out 1500-m sprint ergometer were measured in fourteen young rowers (15.3±0.6 yr, 178.5±8.8 cm, 67.9±10.8 kg). P_{WIN} was significantly correlated to P_{1500} (r=0.90, P<0.001). F_{SJ}, V_{SJ} and P_{SJ} were also significantly correlated to P_{1500} (r=0.54-0.87, P<0.001). Rowers presenting the highest power capacities, in either Wingate or squat jump test, were also the ones showing the best performances. In young rowers, the power capacity highlighted by Wingate and squat jump tests, are determinants for success in rowing performance.

KEYWORDS: rowing, jump performance, Samozino's method

INTRODUCTION: Rowing is a strength endurance whole-body activity consisting in achieving 2000 m (Olympic distance) as fast as possible. During those 2000 m, rowers should apply high level of force both to the handle and the foot stretchers (Buckeridge, Bull & McGregor, 2014) to produce high amounts of power (300-450 W on average and 600-700 W in the start phase, Steinacker, 1993). Hip and knee extensors, which are highly solicited during a rowing exercise, mainly contribute to the global power production (Guével, Boyas, Guihard, Cornu, Hug, et al., 2011). Thus, rowers' anaerobic capacities, and especially lower limbs muscle capacities, seem determinant for rowing performance.

Anaerobic capacities have been widely investigated through the Wingate test classicaly performed on a cycle ergometer. Recently, a modified Winget test on a rowing ergometer has been used to report rowers' anaerobic capacities (Mikulic & Markovic, 2011). This test seems to be relevant to study rowers physical capacities as power outputs assessed during a rowing Wingate test seemed to be related to a 2000-m ergometer performance (Riechman, Zoeller, Balasekaran, Goss & Robertson, 2002). While the Wingate test is relatively simple to implement, rowing technical abilities influence the performance on this test.

To assess lower limbs muscle power capacities, the body weighted squat jump is a particularly popular movement that doesn't require any technical abilities. Jump height has been correlated to the level of performance in many sports, including rowing (Battista, Pivarnik, Dummer, Sauer & Malina, 2007). Nowadays, force, velocity and power output during squat jump exercices can be simply estimated thanks to anthropometrical measurements and jump height (Samozino, Morin, Hintzy & Belli, 2008). Moreover, power output in jumping exercices has been reported to be correlated with *in situ* performance (Cronin & Hansen, 2005). As lower limbs contribute widely to power production in rowing, power output capacity evaluated in squat jump could be correlated to rowing performance. To our knowledge, no study has investigated that hypothesis. Moreover, the identification of correlations between, force, velocity and power output in squat jump and rowing performance would support the fact that squat jump test could be an interesting mean to assess muscular qualities relevant to rowing performance in novice practionners.

Therefore, the aim of this study was i) to test the possible correlation between rowers' ability to generate maximal muscular power during Wingate test and rowing performance on ergometer, ii) to test the possible correlation between rowers' ability to generate maximal muscular force, velocity and power output during squat jump tests and rowing ergometer performance.

METHOD: *Subjects.* Fourteen young trained rowers participated in this study (age: 15.3 ± 0.6 yr, height: 178.5 ± 8.8 cm and body mass: 67.9 ± 10.8 kg). They all competed in the French Rowing Championships the year preceding the experimentation during which nine of them were medallists. The study protocol was explained to the subjects, their parents and their coaches before they gave their written informed consent.

Experimental design. The procedure included three sessions seperated by several days. During the first session, a 1500-m all-out exercice on a rowing ergometer (Model D, Concept2, Morrisville, VT, USA) was performed by the participants, after a standardized 20-min warm-up on the ergometer. The distance of 1500-m is commonly used to evaluate rowing performance in young french rowers.
During the second session, participants performed squat jump exercices. After a 5 min warm-up, subjects had to perform three maximal squat jumps with hands on their hips. Starting position was fixed to 90° knee flexion and carrefully checked for each trial.
The third session consisted in an all-out 30 s Wingate test performed on the same rowing ergometer that in the first session. During these 30 s, rowers had to sail the longest possible distance.

Data collection and processing. During the 1500-m all-out ergometer exercice, the mean power sustained (P_{1500} in W) and the performance time (T_{1500} in s) were recorded. P_{1500} was considered as the performance criterion for this exercise.
During the squat jump session, jump height was determined using an OptoJump Next optical measurement system (Microgate, Bolzano-Bozen, Italy). The best of the three performances (highest jump) was considered for further analysis. The force (F_{SJ}, in N), velocity (V_{SJ}, in $m.s^{-1}$) and power output (P_{SJ}, in W) developped during the squat jump were determined based on the Samozino's method equations (Samozino, et al., 2008), as follow:

$$F_{SJ} = m.g\left(\frac{h}{h_{PO}} + 1\right)$$

$$V_{SJ} = \sqrt{\frac{g.h}{2}}$$

$$P_{SJ} = m.g\left(\frac{h}{h_{PO}} + 1\right)\sqrt{\frac{g.h}{2}}$$

where m is the subject's body mass (in kg), g the gravitational acceleration (9.81 $m.s^{-2}$), h_{PO} the vertical push-off distance (in m) and h the jump height (in m).

During the Wingate test, the mean power sustained (P_{WIN}) and the distance covered (in m) were also measured. P_{WIN} was considered as the performance criterion for this test.

Statistical analysis. Data are expressed as mean ± standard deviation (SD). Correlation between P_{WIN} and P_{1500} were studied using linear regression models fitted by the least squares method. Correlation between the mechanical outputs of the squat jump (F_{SJ}, V_{SJ} and P_{SJ}) and P_{1500} were also investigated. Bravais pearson correlation coefficient (r) were calculated for all correlations. Statistical significance was set at $P < 0.05$.

RESULTS: In average, 159.8 ± 11.8 m were travelled during the 30-s Wingate test and the mean power output (P_{WIN}) was 429.4 ± 92.0 W.
Force, velocity and power output duiring the squat jump exercices were respectively 1138 ± 224 N, 1.13 ± 0.08 m·s^{-1} and 1302 ± 321 W.
Rowers performed the 1500-m all-out ergometer exercice in 325.8 ± 19.8 s and sustained a mean power output of 279.6 ± 49.1 W.
P_{WIN} was significantly correlated to P_{1500} (r=0.90, *P*<0.001) (Figure 1A). Squat jump test parameters (F_{SJ}, V_{SJ} and P_{SJ}) were also significantly correlated to P_{1500} (r=0.54-0.87, *P*<0.001) (Figure 1B).

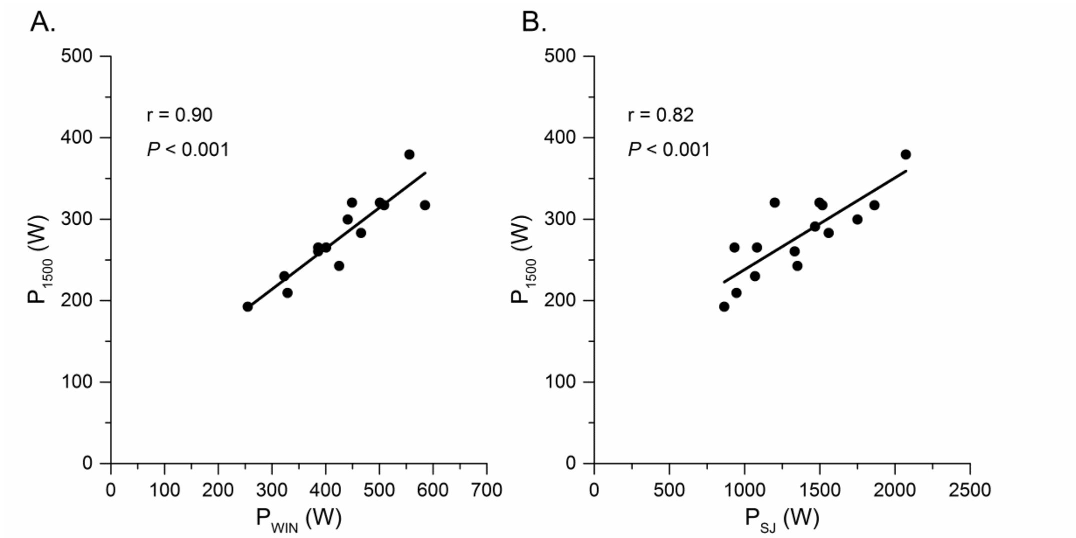

Figure 1. Correlation between A. power developped during Wingate exercice (P_{WIN}) and power sustained during rowing ergometer exercices (P_{1500}) and B. power developped during squat jump exercice (P_{SJ}) and power sustained during rowing ergometer exercices (P_{1500}, P_{100}).

DISCUSSION: The present study aimed at testing the possible correlations between a rowing ergometer performance in young competitive rowers and their ability to generate maximal muscular power during a Wingate test on the one hand, and a squat jump test on the other hand. The main results were that the mean power sustained during an 1500-m all-out ergometer exercise (P_{1500}) are correlated to both Wingate and squat jump tests parameters (P_{WIN} and P_{SJ}, V_{SJ}, F_{SJ}, respectively). Rowers who developped the highests power output in either the Wingate test or the squat jump test, were also the ones sustaining the highest mean power in the rowing ergometer test. In other words, the anaerobic capacity and the lower limbs muscle power abilities highlighted respectively by the Wingate test and the squat jump test are both determinants for success in a 1500-m rowing ergometer exercise. This finding is in accordance with previous investigations. Indeed, Riechman et al. (2002) showed that the variation in a 2000-m indoor rowing performance could be predicted by the power developped during a rowing Wingate test. However, while the jump height in squat jump has been correlated to the 2000-m rowing performance performance (Battista, et al., 2007), our study is the first to compare the power output (and not only jump height) in squat jump and rowing ergometer exercices.
From a pratical point of view, the results of the present study argue in favor of using the Wingate test and the squat jump test to identify promising young rowers. Squat jump test present a certain interest in non experienced athletes as it do not involved any specific technical abilities. Thus said, squat jump can not yet be used to monitor the level of performance of more experienced rowers. Indeed, as the experiment was conducted on young rowers, the observed correlations between lower limbs muscle capacities and rowing ergometer performance might only be due to the intrinsec muscle qualities of the participants. Put another way, jumping performance might not be related to rowing

performance in elite or highly trained athletes because of the specific technical and training adaptations associated to the chronic practice of rowing. Therefore, the results of the present study needs to be confirmed in elite or sub-elite rowers.

REFERENCES:

Battista, R. A., Pivarnik, J. M., Dummer, G. M., Sauer, N. and Malina, R. M. (2007). Comparisons of physical characteristics and performances among female collegiate rowers. *J Sports Sci, 25*, 651-7

Buckeridge, E. M., Bull, A. M. and McGregor, A. H. (2014). Foot force production and asymmetries in elite rowers. *Sports Biomech, 13*, 47-61

Cronin, J. B. and Hansen, K. T. (2005). Strength and power predictors of sports speed. *J Strength Cond Res, 19*, 349-57

Guével, A., Boyas, S., Guihard, V., Cornu, C., Hug, F. and Nordez, A. (2011). Thigh Muscle Activities in Elite Rowers During On-Water Rowing. *Int J Sports Med, 32*, 109,116

Mikulic, P. and Markovic, G. (2011). Age- and gender-associated variation in maximal-intensity exercise performance in adolescent rowers. *Int J Sports Med, 32*, 373-8

Riechman, S. E., Zoeller, R. F., Balasekaran, G., Goss, F. L. and Robertson, R. J. (2002). Prediction of 2000 m indoor rowing performance using a 30 s sprint and maximal oxygen uptake. *J Sports Sci, 20*, 681-7

Samozino, P., Morin, J. B., Hintzy, F. and Belli, A. (2008). A simple method for measuring force, velocity and power output during squat jump. *J Biomech, 41*, 2940-5

Steinacker, J. M. (1993). Physiological aspects of training in rowing. *Int J Sports Med, 14 Suppl 1*, S3-10

Acknowledgement

This study was supported by grants from the Région Pays de la Loire (project ANOPACy), the French Ministère de la ville, de la jeunesse et des sports, and the INSEP. ANOPACy is cofunded by the European Union. Europe commits itself to Pays de La Loire through Regional development european funds. ANOPACy was also labeled by the Pôle de compétitivité industriel EMC2.