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DRAG FACTOR ON ROWING ERGOMETER DURING 2000-M PERFORMANCE IN YOUNG ROWERS

FAKTOR ODPORA NA VESLAŠKEM ERGOMETRU MED VESLANJEM NA 2000 M PRI MLADIH VESLAČIH

ABSTRACT

Indoor rowing is relevant for indoor training and testing. Furthermore, international indoor rowing competitions are organized using the Concept2 rowing ergometer, which permits resistance adjustments via a vent damper. To set the damper lever, indoor rowers can vary the drag factor (df) by setting the flywheel cage from 95df to 220df.

To evaluate the relationship between 2000-m indoor rowing ergometer performance with different df and the body mass of young rowers.

On three separate occasions organized on consecutive days, fifteen youth male rowers (age: 16.1±1.1yrs; body mass: 72.7±9.6kg; height: 177.4±6.4cm) performed maximal 2000-m rowing ergometer performances on a Concept2 (mod.D) with a 110df, 130df, and 150df, respectively. Average times (T_{110}, T_{130} and T_{150}) and stroke rate (SR_{110}, SR_{130} and SR_{150}) were measured. Pearson's correlation was applied to examine the relationship between anthropometric characteristics of athletes and their 2000-m performances.

Slowest 2000-m rowing ergometer performances resulted in T_{110} (435.0±22.7s), intermediate in T_{150} (433.7±25.2s,) and fastest in T_{130} (419.1±24s) conditions. The highest SR emerged at 110df (SR_{110}=35.1±0.8n.min^{-1}), intermediate at 130df (SR_{130}=36.7±0.7n.min^{-1}), and lowest at 150 df (SR_{150}= 32.7±0.7n.min^{-1}). Rowing performances were significantly ($P<0.001$) correlated to body weight (T_{110}: r=0.79; T_{130}: r=0.86; and T_{150}: r=0.84), and height (T_{110}: r=0.78; T_{130}: r=0.83; T_{150}: r=0.85).

The fastest time and highest SR reached during 2000-m indoor rowing performances with a 130df setting could suggest coaches to favour this resistance level, independently from the anthropometric characteristics of youth athletes.

Key words: Drag factor, Indoor rowing, 2000-m time trial

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IZVLEČEK

Ergometrično veslanje je pomembno tako za treniranje kot tudi testiranje veslanja. Na mednarodnih tekmovanjih v ergometričnem veslanju uporabljajo veslaški ergometer Concept2, ki omogoča prilagoditve odpora s pomočjo dušilca. Za nastavitev dušilca lahko veslači spreminjajo faktor odpora (DF) tako, da pretok zraka skozi vztrajnik nastavijo na vrednost 95 do 220 DF.

Ugotoviti, kakšen je odnos med uspešnostjo na veslaškem ergometru na 2000 m z različnimi DF in telesno maso mladih veslačev.

V treh ločenih poskusih, ki so bili izvedeni v treh zaporednih dneh, je 15 mladih veslačev (starost: 16,1 ± 1,1 leto; telesna masa: 72,7 ± 9,6 kg; višina: 177,4 ± 6,4 cm) opravilo serijo veslanj na 2000 m na ergometru Concept2 (model D) z nastavitvami 110 DF, 130 DF in 150 DF. Merili smo povprečen čas (T_{110}, T_{130} in T_{150}) ter hitrost zavesljajev (SR_{110}, SR_{130} in SR_{150}). S Pearsonovo korelacijo smo preverili odnos med antropometričnimi značilnostmi športnikov in njihovo uspešnostjo na 2000 m.

Najpočasnejše ergometrično veslanje na 2000 m je pri T_{110} (435,0 ± 22,7 s), srednje hitro pri T_{150} (433,7 ± 25,2 s) in najhitrejše pri T_{130} (419,1 ± 24 s). Najvišja SR je bila ugotovljena pri 110 DF (SR_{110} = 35,1 ± 0,8 n.min^{-1}), srednja pri 130 DF (SR_{130} = 36,7 ± 0,7 n.min^{-1}) in najnižja pri 150 DF (SR_{150} = 32,7 ± 0,7 n.min^{-1}). Uspešnost veslanja je bila značilno ($P < 0,001$) povezana s telesno težo (T_{110}: r = 0,79; T_{130}: r = 0,86 in T_{150}: r = 0,84) in višino (T_{110}: r = 0,78; T_{130}: r = 0,83; T_{150}: r = 0,85).

Najhitrejši čas in najvišja SR, dosežena med ergometričnim veslanjem na 2000 m z nastavitvijo 130 DF, trenerjem nakazujeta, da je ta raven odpora najprimernejša ne glede na antropometrične značilnosti mladih športnikov.

Ključne besede: faktor odpora, ergometrično veslanje, časovni preizkus na 2000 m

INTRODUCTION

The Fédération Internationale des Sociétés d'Aviron (FISA) organizes International indoor and on water rowing competitions based on sex, age, weight categories (Fédération Internationale des Sociétés d'Aviron, 2017). In particular, international indoor and on water junior rowing events include sprint, team relay, and 2000-m events.

Rowing performances are based on coordinated muscle actions involving almost every muscle group in the body (Secher, 2000). To perform an open water race, rowers exert force on the blades at every stroke, and the stroke rate (SR) is crucial to determine the boat speed. Also, the shape and size of the blades are relevant to increase the speed of the boat (Nolte,2009), with larger blades in theory determining faster boat speeds (Kane, Jensen,Williams,Watts,2008). To simulate the movement of the blades and the resistance of on-water rowing, indoor rowing ergometers include air braked systems, which allow to modulate the resistance of rowing through the regulation of the amount of air passing through the fan (Mahony, Donne, O'Brien, 1999). Among air-braked indoor rowing ergometers, the Concept 2 apparatus (Concept2, Morrisville, VT, USA) permits to set resistance adjustments via a vent damper from level 1 to 10, corresponding to drag factors (DF) ranging from 100 to 220 DF (O'Neill & Sckeleton, 2004). Based on the athlete's age, sex, weight class, and fitness level, different DF adjustments have been suggested (O'Neil & Sckeleton, 2004; Hahn, Bourdon, Tanner, 2000). In particular, a 100 DF is recommended for youth and novice athletes, whereas a 140 DF is suggested for heavy weight experienced rowers.

In general, 2000m indoor rowing performance time is considered a good sport-specific indicator for the assessment of talented rowers' fitness level and their athletic development overtime, and to predict on water rowing performances (Mikulic, Smoljanovic, Bojanic, Hannafin, Pedisic,; Mikulic, 2011). Furthermore, indoor rowing tests with different DF settings have been used as sport-specific evaluations of the metabolic capacity of athletes (Metikos, Mikulic, Sarabon, Markovic,2015; Kane, Mac Kenzie, Jensen, Watts ;Mikulic, 2011; Hahn, Bourdon, Tanner, 2000; Mäestu, Jurimäe, Jurimäe 2005). Some authors claimed that a limitation in testing youth rowers could be the lack of an optimized resistance setting for each athlete (Mikulic, Emersic, Markovic, 2010). In particular, a protocol encompassing 160 DF for light-weight male rowers, 180 DF for heavy-weight male rowers, 140 DF for light weight female rowers and 150 DF for heavy weight athletes has been proposed (Kane, Jensen, Williams,Watts, 2008).

Some authors claimed that anthropometric (Jensen, Secher, Fiskerstrand, Lund 1984; Russell, Le Rossignol, Sparrow, 1998) and physiological (Ingham, Whyte, Jones, Nevill, 2002; Cosgrove Wilson, Watts, Grant,1999) characteristics of the athletes could contribute to indoor rowing performances. However, physiological parameters during indoor rowing performances resulted not significantly affected between 100 DF and 150 DF (Kane, Jensen, Williams,Watts,2008). Furthermore, there is a lack of information with respect to the relationship between anthropometric characteristics of athletes and rowing performance. This aspect is particularly relevant in the developmental years of youth athletes because sound training sessions should be evidence-based to promote health, safety, and development of sport skills of talented athletes (Capranica & Millard-Stafford, 2011).

Thus, the aim of our study was to evaluate the relationship between a 2000m indoor rowing ergometer performance with different DF settings in relation to the body mass of young rowers.

It has been hypothesized that the performance time (T) and the stroke rate (SR) were related to the athlete's body mass.

METHODS

Subjects

The present study was conducted in accordance with the Declaration of Helsinki. Participants had to meet the following inclusion criteria: 1) engagement in competitive rowing for a minimum of 4 years; 2) have routinely experienced indoor rowing training and testing; and 3) provide a written consent and a parental consent if younger than 18yrs; 4) declare a normal diet regimen. Fifteen young (16.1± 1.8yrs) males (height: 177.4±6.4cm; body mass: 72.7±9.6kg) Italian Rowing Championship finalists voluntarily participated in to the study.

Procedures

The athlete's standing height to the nearest 0.1 cm was measured using a calibrated stadiometer (Seca 220, Hamburg, Germany) and body weight was determined to the nearest 0.1kg on a balance scale (Seca 761, Hamburg, Germany). With a randomized study design, three testing sessions were organized during the preparatory period with a 24hr rest among the experimental sessions. This experimental time schedule prevented from confounding factors due to training effects. Participants performed 2000-m simulated races on an air-braked indoor rowing ergometer Concept 2 (mod. D) with a 110 DF, 130 DF, and 150 DF settings, respectively. A 20min warm up was administered before the testing sessions. Then, the athletes were asked to cover the 2000m distance as fast as possible and a verbal encouragement was provided during the test. The race time (T110, T130, and T130; s), and the stroke rates (SR110, SR130, and SR150; n.min-1) were considered as performance parameters.

STATISTICAL ANALYSIS

To determine the extent and direction of relationships between the athlete's body mass and the experimental variables (e.g., T and SR), Pearson's correlation coefficients (r) were calculated. Statistical significance was set at $p \leq 0.05$. All analyses were conducted using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). Figures were made with STATISTICA software (Vers 8.0, Tulsa, USA) and with SOFA Software (Free available online), respectively.

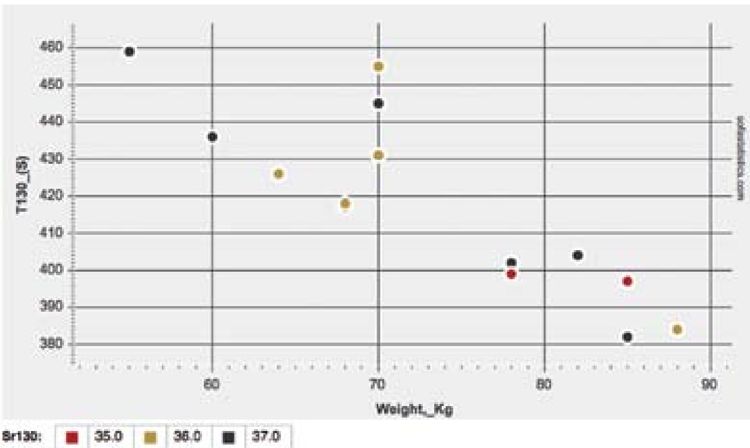
RESULTS

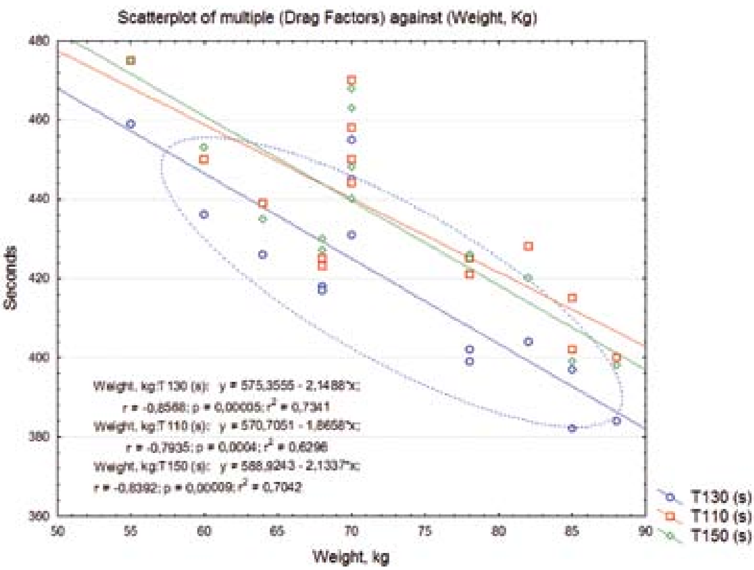
Table 1 reports the means ± standard deviations (SD) of T and SR performances, correlation coefficients (r) with respect to the athlete's body mass, and significant values (P). The indoor rowing performance resulted fastest at T130 (419.1±24.1s),intermediate at T150 (433±24.5s) , and slowest at T110 (435±22.7s). For SR, the highest values emerged at SR130 (36.7±0.7n.min-1), intermediate at SR110 (35.1±0.8n.min-1), and lowest at SR150 (32.7±0.7n.min-1), All the experimental variables showed significant correlations ($P<0.0001$; r range: 0.78-0.86), with the highest value emerging between body mass and the drag setting a T130.

Table 1. Means ± standard deviations (sd) of time race with drag factor 110 (T_{110}), 130 (T_{130}), 150 (T_{150}) and relative stroke rate (SR_{110}), (SR_{130}), (SR_{150}) and their correlation coefficients (r) and significant value (P) with respect to body mass

Means ± sd	R	P	
T_{110} (s)	435±22.7	0.79	<0.0001
T_{130} (s)	419.1±24.1	0.86	<0.0001
T_{150} (s)	433.7±24.5	0.84	<0.0001
SR_{110} (stoke/min)	35.1±0.8	0.78	<0.0001
SR_{130} (stoke/min)	36.7±0.7	0.83	<0.0001
SR_{150} (stoke/min)	32.7±0.7	0.85	<0.0001

Data are also reported in figures 1 and 2 to better identify the confidence intervals and the contribution of each SRs on each single attempt.





DISCUSSION

The main findings of this study are the significant correlations between 2000-m indoor rowing performances and the athletes' body mass, independently of the DF settings. Furthermore, the best performance emerged at 130 DF, with matching highest SR values.

The overall aim of competitive rowing is to accomplish the fastest race time. In general, rowing is considered as a strength-endurance type of sport, with 2000m rowing competition lasting 5.5–7.0min depending on a boat type, weather conditions, and athlete's capability to perform to his/her maximum potential (Steinacker, 1993). To help youth talented rowers achieving their optimal performances and an elite status, rowing at the optimal rhythm and stroke rate could provide the best stimulus for eliciting both physiological and technical adaptations (Buckeridge, Bull, McGregor,2015). In fact, rowing training sessions have to be focused on optimal relationship between metabolic aspects, strength, and technical skills (Mikulic, 2011). In considering that in adverse weather conditions rowers routinely train indoor, coaches need to plan sound sessions based on optimal DF ergometer settings. In fact, whilst an optimal boat setting is crucial for on-water rowing, indoor rowing ergometer settings are relevant to improve, train, and/or maintain agility and coordination rowing skills, as well as to ensure the best biomechanical and physiological responses (Rowing Biomechanics, 2011).

Based on the notion that the impulse generated during a stroke increases as a function of rowing resistance, some authors claimed that high DF settings of the ergometer may be advantageous for rowing performances (Kane,Mac Kenzie, Jensen, Watts,). In particular, evidence from an indoor rowing incremental test showed that increases of DF settings determined increases of drive time and force application, decreases of average handle velocity, and increases in blood lactate concentration (Kane, Mac Kenzie, Jensen, Watts, 2013). Conversely, high DF settings determine high forces located on the lumbar spine of the rowers, which could increase the risk of lower back injuries most common in this sport (Mahler,, Hunter, Lentine, Ward,1991). Therefore, coaches have to carefully evaluate the optimal DF setting of the indoor rowing ergometer to provide their athletes the best training stimulus under safe conditions. This aspect is particularly relevant in youth sports where there is a quest of appropriate evidence-based training plans to guarantee a healthy development of the athlete (Capranica &Millard-Stafford, 2011).

According to the Concept2 training guide (O'Neil & Sckeleton, 2004) and the Amateur Rowing Association (www.britishrowing.org), to simulate the resistance the of the blade during on water rowing, indoor ergometer DF settings between 130 DF and 140 DF should be used to construct ecological indoor training sessions. The present findings support the idea that 130 DF settings are the most suitable for both SR and T performances of youth indoor rowing. The participants of this study accomplished 2000m performances comparable to those reported for youth international elite athletes (Mikulic, Smoljanovic, Bojanic, Hannafin, Pedisic, 2009), substantiating their good athletic level as finalists of the Italian championship. However, a discrepancy between SR and T parameters was observed for DF settings lower (e.g., 110 DF) and higher (e.g., 150 DF) than the optimal one (e.g., 130 DF). This might indicate that the young rowers have still to develop technical capabilities to allow them a fine matching between the force applied to the paddle and the optimal propulsion of boat (Warmenhoven Cobley, Draper, Harrison, Bargary, Smith 2017). These findings caution scholars interested in evaluating the youth athlete's performance under indoor rowing controlled conditions to pay particular attention to the optimal DF settings that could enable the youth rower to achieve his/her fastest performance and highest SR. Logically, this aspect could be especially relevant when testing novice rowers who have limited technical capabilities. Furthermore, it has been hypothesized that young and light rowers might experience difficulties when trying to set the system in motion at the beginning of the test and also need prolonged acceleration phases (Mikulic, Emersic, Markovic, 2010). Unfortunately, the underlying biomechanical and physiological mechanisms of youth indoor rowing were beyond the purpose of this study. Thus, this hypothesis remains largely speculative and in need of further studies.

One limitation of this study is the relatively small experimental sample of talented athletes, which limits the generalizability of the present findings to youth rowers of different athletic levels. Another limitation is related to rowing data collected under controlled experimental conditions, extremely different from those experienced during on-water rowing where variable environmental conditions highly affect the balance of the boat (Mäestu, Jurimäe, Jurimäe, 2005; Smith & Hopkins, 2012). Finally, it is envisaged that future research considers performance variables related to the pacing strategies of the athletes as potential determinants of performance.

CONCLUSIONS

The present findings might contribute to the body of knowledge on youth rowing and provide valuable information to help coaches planning sound training sessions for their youth athletes. The fastest time and highest SR reached during 2000m indoor rowing performances obtained with a 130 DF setting support this resistance level, independently from the anthropometric characteristics of youth athletes.

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