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Letter to editor

Discussion of "Concurrent and Construct Validation of a Scale for Rating Perceived Exertion in Aquatic Cycling for Young Men"

Dear Editor-in-chief

We have read with great interest the article by Colado and Brasil (2019) titled Concurrent and Construct Validation of a Scale for Rating Perceived Exertion in Aquatic Cycling for Young Men that was recently published in Journal of Sports Science and Medicine. We enjoyed very much the construct of validity for correlating RPE derived effort for Aquatic Cycling. Construct validity was established by correlating RPE derived from the Aquatic Cycling Scale (0–10) from the Borg (6 –20) Scale. It treats about a topic of interest from several practical points of views (exercising subjects, therapists, researchers in physiology, water coaches etc.). Nevertheless, the paper needs some improvement in the use of technical terms to better understand the interpretation of correlating the Aquatic Cycling Scale (ACS) with oxygen uptake, pulmonary ventilation (VE), heart rate (HR), and blood lactate concentration (BL) responses to the maximal load-incremental test.

Firstly, it is necessary to clarify the sentence whether it is beats/minute or revolutions on per minute (rpm). The term beats/minute could be confused with the terms used to define the heart rates. It is recommended in a more technical context to use revolutions per minute (rpm). We do not understand the definition of the cadence/rpm that is presented in the paper. We believe that the beat represents one beat for the left leg and one beat for the right leg (one beat left, one beat right). This would make better sense, since it would represent at 100 beats an rpm at 50. In fact, in another paper published in EJSS by the same authors in 2013, the cadence is rightly reported and, as illustrated in Fig. 1 of that paper, ranges from 60 to 90 rpm.

In the current 2019 JSSM paper, in the section "Experimental protocol session", the authors mention that, as quoted, the subjects were advised to perform one complete pedaling cycle (i.e., 0–360º) in 1 beat, considering that the beat is a steady pulse that is repeated cyclically during one minute and this determine the pace of the movement (for example, 100, 115, 130, etc. beats or pulses per minute). The statement leads to confusion for the reader and erroneously suggests pedaling cadences (rpm) that vary from 100 to 190 rpm. World cyclists on dryland do not reach 190 rpm and typically maintain 100-110 rpm during outings. As well, is it an increment of 15 rpm or 15 beats per min? It is very confusing and unclear. In fact, only elite athletes can reach and sustain cadences close to 100 to 130 rpm on dryland as mentioned in many scientific studies conducted with cyclists (Coyle, 2005; Lucia et al., 2003; Schumacher and Mueller, 2002).

In that sense, it has also been well documented that young men with high levels of weekly physical activity and only elite cyclists are able to reach cadences higher than 90 rpm until a maximum of 135 rpm during one-minute efforts in aquatic environment (Garzon et al., 2015a; Giacomini et al., 2009; Yazigi et al., 2013).

Thus, in all humility, we believe that the paragraph in the JSSM paper has to be revised in order for practioners to use the Aquatic bike (Hydrorider) correctly. Practioners will expect their users to pedal at a cadence of 190 rpm, or even less, for example, 120 rpm for 2 minutes, which is unrealistic.

On the other hand, although the results of the study show that validation criteria stipulated that during the load incremental aquatic cycle maximal test, the RPE derived from the ACS would distribute as a positive linear function of VO_2, VE, HR, and BL responses, and that the RPE derived from the ACS and Borg scales would be positively correlated. Our research group has demonstrated that external power output pedaling rate (Pext) relationship and oxygen consumption (VO2) on an immersible ergocycle (IE) is curvilinear (Garzon et al., 2015a; 2015b).

In agreement with other studies, the Pext increases in water as a function of velocity of movement that is to say on pedaling cadence (rpm) (Bressel et al., 2012; Chen et al., 1996; Poyhonen et al., 2000). Therefore, we consider necessary to be cautious when we talk about efforts at submaximal intensities in water because cardiopulmonary responses are different during exercise on immersible ergocycle (IE) (Garzon et al., 2015b).

In another article published to demonstrate the relationship between various expressions of relative exercise intensity percentage of maximal oxygen uptake (%VO_2max), percentage of maximal heart rate (%HRmax), %VO_2 reserve (%VO_2R), and %HR reserve (%HRR)) in order to obtain the more appropriate method for exercise intensity prescription when using an immersible ergocycle (IE) we showed that linear regressions obtained on IE and DE to predict %VO_2R from %HRR, can be considered the most accurate for exercise training prescription for either exercise modality (IE and DE) (Garzon et al., 2017). Therefore, matching exercise intensity on IE from the RPE derived from the ACS as a positive linear function of VO_2 may represent a potential bias and would lead to a higher relative percentage of exercise intensity in the water condition.

In conclusion, in all modesty, we believe that those methodological considerations should be taken into account for the interpretation of the results presented by (Colado and Brasil, 2019).

Mauricio Garzon ✉ **and Alain Steve Comtois**
Department of Physical Activity Sciences, University of Quebec in Montreal, Canada
✉ **Mauricio Garzon**
E-mail: garzon_camelo.mauricio@uqam.ca

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Authors' response

Dear Editor-in-chief

We would like to thank Dr. Garzon and Dr. Comtois for their interest in our recently published manuscript entitled "Concurrent and Construct Validation of a Scale for Rating Perceived Exertion in Aquatic Cycling for Young Men". We would like to thank them for their positive words regarding the topic that we have chosen in our article. We are in agree that it can be of interest from several practical points of views, and moreover, as they have well indicated, it can be very useful for different profile of professionals and users.

Regarding their specific comments emphasized in their observations, it is necessary to point out that the technical term "beats per minute" (bpm) has been used in the last decades for monitoring intensity during different types of exercises both in dry land as in the aquatic medium (Aquatic Exercise Association, 2010; Alberton et al., 2011; 2013; 2015; 2016; 2019; Barbosa et al., 2009; 2010; Colado et al., 2008; 2009; Grier et al., 2002; Kravitz et al., 1997; Pinto et al., 2015; 2016; Raffaelli et al., 2010). More concretely for cycling activities, the technical terms of revolution per minute (rpm) or bpm have been frequently used, so that the rpm can be half, the same or double the bpm (Barbado, 2005). In fact, in previous studies, we have used rpm (Yazigi et al., 2013) or bpm (Pinto et al., 2016) for monitoring the intensity of the aquatic cycling exercise, indicating with them the cadence of the aquatic pedaling exercise. Taking in account their considerations about our article, we think that maybe the main inconvenient in the redaction of our study (Colado and Brasil, 2019) is that we have use both terms together and, as they have indicated, it should have been probably necessary to have shown some complementary information at the end of page 697 and beginning of 698 for transmitting more accurately our procedure, and with this facilitate a detailed interpretation of the vale results of our study. According to this, we think that this possible ambiguity highlighted with these terms could be avoided with this additional information:

- Sentence "The subjects were advised to perform one complete pedalling cycle (i.e., 0–360 º) in 1 beat, considering that the beat is a steady pulse that is repeated cyclically during one minute and this determine the pace of the movement (for example, 100, 115, 130, etc. beats or pulses per minute)" can be better understood if it is rewritten as: "*The subjects were advised to perform one complete pedalling cycle in two beats (one beat for the left leg and one beat for the right leg), considering that the beat is a steady pulse that is repeated cyclically during one minute and this determine the pace of the movement (for example, 100, 115, 130, etc. beats or pulses per minute (bpm))*".
- Sentence "This aspect is usually employed during aquatic cycling activities when music is used for monitoring the exercise intensity thought the pedalling cadence" can be better understood if it is rewritten as: "*This aspect is usually employed during aquatic cycling activities when music is used for monitoring the exercise intensity through the pedalling cadence*".
- Sentence "Therefore, a complete pedalling cycle of 360º has been considerate as the equivalent to a revolution per minute in our study" can be better understood if it is rewritten as: "*Therefore, a complete pedalling cycle of 360º has been considered as the equivalent to a revolution per minute (rpm) in our study, for example 160 bpm would be the equivalent of 80 rpm*".
- According to these clarifications, rpm should be replaced by bpm through all the text when we are talking about pedalling cadence of this aquatic cycling activity.

In consideration with their second observation, as they well explained, some previous studies have shown that due the specific properties of the aquatic medium the physiology responses could be different to this observed in dry land (Garzon et al., 2015b), and this could provoke a more specific non-linear physiology response to the aquatic cycling exercise (Garzon et al., 2015a). According to this, our study have presented a linear and non-linear regression analysis for analyzed if the physiology responses matching with the perceptual responses during the maximal load-incremental test. In consequence, and in the line that they have previously observed, the non-linear regression analysis performed in our study have obtained even higher positive values in the majority of the variables analyzed than with respect the linear regression analysis (Figure 3 and 5; Colado and Brasil, 2019). It can also be observed this non-lineal response of the physiologic variables analyzed in the figure 4 of our study (Colado and Brasil, 2019). They have indicated that matching exercise intensity on aquatic cycling exercise with the rating perceived exertion (RPE) derived from our RPE scale may represent a potential bias. However, in the same way that in our study, it must be also point out that other numerous previous results have supported the use of RPE scales to monitor the relative intensity of training during head-out water-based aerobic exercises in people of different age and physical level, in which physiologic variables were also employed for the validation, as for example was the case of the VO_2 (Alberton et al., 2016; Fujishima and Shimizu, 2003; Olkoski et al., 2014; Pinto et al., 2015; Shono et al., 2000). More concretely, Robertson et al. (1995) stated that Borg's 15-category scale for rating of perceived exertion was a valid psychophysical tool to measure perceptions of exertion during semi-recumbent immersed ergometer exercise. Matching between physiologic variables, for example VO2, obtained at different pedalling cadences with the RPE values was employed in this study (Robertson et al., 1995). In definitive, we would like to remember that the concurrent validation of the Aquatic Cycling Scale (ACS) has been performed matching the perceptual responses with different physiologic variables (i. e. oxygen uptake, pulmonary ventilation, heart rate, and blood lactate concentration), and all of them have obtained positive values in the different correlation and regression analyses performed in our study. It is true that the different variables have shown different correlation and regression values, but the most important is that all them together have corroborated ACS as a proper tool for discriminating between intensities trough a continuum during the aquatic cycling exercise.

From a wider point of view, and considering very positively their recommendations to our article, we are in agreement with their previous indications about the possibility of taking in account the rpm as valid monitoring tool of the intensity during the aquatic cycle activities because can predict the VO2 consumption during the effort (Garzon et al., 2017b). In consequence, when aquatic cycling exercise is performed pedalling in a bicycle that not allowed to modified the size of its components, the rpm cadence could change the specific intensity of the exercise and this could be determinate with equations for the corresponding prescription of that exercise (Garzon et al., 2017b). However, although in determinate commercially available models of aquatic bicycles the only method to either increase or decrease the intensity of exercise is by varying the rpm (Garzon et al., 2015a; 2017b), from our point of view, this is not the reality for the most aquatic bicycles worldwide, as is for example the specific case of some models of the brand of the aquatic bicycles that it has been habitually used in some previous specific studies (Garzon et al., 2015a; 2015b; 2017a; 2017b). Even more, the resistance to a given movement in the aquatic medium (drag force) depends of the device surface and shape, the hydrodynamic form of the body, body position, etc. (Borreani et al., 2014; Garzon et al., 2015a; Colado and Brasil, 2019; , Colado et al., 2009). Thus, excepted that the same person performs the same aquatic cycling exercise, without modified the material, and its body position and anthropometric characteristics, is very difficult that the external resistance always be the same, and this is unfortunately a requisite for using determinate equations with accuracy. It is well known that some of these requisites are modified during a lot of aquatic cycling activities, this is very different from sports cycling activities in which the same positions are usually maintained for long periods of time (Barbado, 2005).

From other perspective, it must be considered that sometimes exercisers are training with partners or in a massive group situation where a fixed pedalling cadence is performed for everyone. In this very practical situations, and due to usually the different exercisers can have different physical conditioning levels, they need to change the resistance of the aquatic cycling activity increasing or reducing the drag forces by means of the modification of the mobile parts of the aquatic bicycle, which permits to have a bigger or lower drag force (resistance), thus achieving a better adaptation of the exercise for each of the exercisers. In this usual practical case in the aquatic settings worldwide, it is needed also tools that can help to monitoring the quality of the stimulus of the training. Thus, in these specific cases, and taking in account the necessity of easy and cheap procedures that can be employed in any place and for any person, besides to employ heart rate as indicator of level of intensity, is need other tools, as is the case of the RPE scale. With the RPE scale the technicians and the users could have a good estimation of the intensity of the exercise, and in this way they could do the practice more efficient and safety.

In definitive, we think that if all this considerations are analyzed from a global point of view, Aquatic Cycling Scale is other type of accurate tool that can help easily to monitor the safety and efficiency of the practical applications of the aquatic cycling activities.

We would like to thank Dr. Garzon and Dr. Comtois for providing some important reflections on our study and its findings. We take the opportunity for congratulate them for their value research about the physiological responses during the aquatic cycling. We hope to have clarified their considerations with our commentaries.

Juan C. Colado [1]✉ and Roxana M. Brasil [1,2]
[1] Research Unit in Sport and Health, Research Group in Prevention and Health in Exercise and Sport, University of Valencia, Spain; [2] Celso Lisboa University, Rio de Janeiro, Brazil
✉ **E-mail:** juan.colado@uv.es

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