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Editorial

Use of Ratings of Perceived Exertion in Rehabilitation Services: Past and Present Researches

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The concept of effort perception, introduced in the late 50's from scales measuring local fatigue or breathlessness [1] is an area of extensive research and has been applied in numerous sporting, pedagogical, ergonomic and clinical applications [2]. Generally, effort perception can be defined as the intensity of subjective effort, stress, discomfort and fatigue that is felt during physical exercise [3]. It involves the collective integration of afferent feedback from physiological stimuli (e.g., heart rate: HR, oxygen uptake: $\dot{V}O_2$, ventilation, muscular acidosis, blood glucose, body temperature) and feed-forward mechanisms to enable an individual to evaluate how hard or easy an exercise task feels at any point in time [4]. However, although physiological stimuli dominate the perceptual process, the latter is moderated by situational (e.g., knowledge of the exercise end point) [5-8] and dispositional (e.g., cognitive style) psychological factors [9-12]. Consequently, effort perception is considered as a complex psychophysiological variable. To quantify effort perception, a number of scales have been developed and validated [13-18]. However, Borg's Ratings of Perceived Exertion (RPE) Scale (1970) [4] has always been and remains the most commonly used scale in adults [8, 19-23]. The RPE scale is frequently administered in hospital and healthcare centers during graded exercise tests (GXT) and rehabilitation programs in order to optimize patients' care management [24]. The RPE scale is an easy tool to use. It is valid, reliable and sensitive during various exercise modalities and in various clinical populations. Indeed, the information delivered by the RPE scale can facilitate design and management of each step of a patient's rehabilitation program.

The RPE scale has been applied in a clinical context for over 50 years to evaluate the progression of a GXT [2-3]. Indeed, the higher the RPE, the closer the individual is to voluntary exhaustion. For example, a patient with chronic obstructive pulmonary disease (COPD) reporting RPE_{15} (effort considered as 'hard', equating to an exercise intensity of 85% of maximal aerobic capacity) during a GXT is closer to voluntary exhaustion than RPE_{13} (effort considered as 'somewhat hard', equating to 74% of maximal aerobic capacity) [25]. Consequently, the RPE score is considered as an indicator of exercise intensity and duration, independently of disease.

In a similar manner, in some clinical populations such as cardiac patients, it has been proposed that RPE between 15 and 17 during GXT, often implies cessation of the test at the next stage [2-3]. Consequently, from this information it is possible to anticipate the GXT end-point in cardiac patients. However, the identification of an accurate RPE score at the penultimate stage of a GXT remains to be determined, and is probably dependent on age, pathology and severity of the disease.

Similarly, a maximal RPE (i.e., close or equal to the theoretically maximal RPE: RPE_{20}) provides additional confirmation of voluntary exhaustion during a GXT, as in the case of some physiological variables (e.g., high respiratory exchange ratio or HR close to the theoretical maximal HR). However, RPE_{20} seems be rarely reported at maximal exercise, especially in older individuals and patients [25-27]. Consequently, further studies are needed.

The linear relationship between HR and indicators of exercise intensity (e.g., power output, velocity or $\dot{V}O_2$) obtained during a GXT is frequently used to compare the cardiorespiratory fitness in patients. However, this relationship cannot be applied as effectively in patients on beta blockers because the pharmacological actions of these drugs alters HR and hemodynamic response to exercise [2]. In this case, the use of RPE is especially relevant as it is not significantly affected by these drugs as the relationship between absolute and relative exercise intensity (expressed as percentage of maximal intensity) and RPE is sustained [28]. Therefore, for the same absolute exercise intensity, the cardiac patient with the lower RPE (rather than HR) is the one that has the better physical fitness.

Use of the relationship between RPE and $\dot{V}O_2$ obtained during GXT has been recommended to predict maximal oxygen uptake ($\dot{V}O_2max$) in paraplegic individuals [29-30], obese individuals [31], patients with type 2 diabetes [32] and patients with COPD [25]. In these studies, the linear relationship between RPE and $\dot{V}O_2$ is extrapolated to the $\dot{V}O_2max$, which often coincides with the theoretical maximal RPE (i.e., RPE_{20}). However, to improve the accuracy of predictions, authors have recently proposed the use of a 'perceptually regulated exercise test' (PRET), rather than traditional GXT [33]. The PRET involves asking the patient to self-regulate and maintain a series of submaximal exercise intensities corresponding to some pre-set overall RPE levels (e.g., RPE_9, RPE_{11}, RPE_{13}, and usually RPE_{15}). In other words, during each stage of PRET, the individual must produce and maintain an exercise intensity corresponding to clamped RPE level according to sensations emanating from the whole body. Therefore, PRET requires focusing very strongly on internal signals, which is supposed to improve the relationship between RPE and $\dot{V}O_2$, thus leading to a more accurate prediction of $\dot{V}O_2max$ from the extrapolation of this relationship [34]. However, further studies are needed.

Similarly, due to the cost and availability of gas analysis, the power output elicited at specific RPEs during submaximal GXT can be used to predict some physiological variables [31,35]. For example, Coquart et al. [31] predicted $\dot{V}O_2max$ from an equation including age and power output developed at RPE_{15} (i.e., effort considered as 'hard') in obese women. Estimation rather than measurement of actual $\dot{V}O_2max$ is particularly relevant in clinical populations due to possible adverse events during a maximal GXT (e.g., arrhythmia, myocardial infarction or even death). To date, predictive equations using anthropometric variables and power output have been proposed at given RPEs in healthy and obese individuals. Other specific equations should be developed according to disease.

It has long been known that the RPE alone may be used prescribe a personalized exercise intensity in healthy adults [36-38]. Research is needed to assess the use of RPE-regulated exercise prescription in cardiac patients. Research has also shown that children are capable of using perceived exertion to regulate exercise intensity during cycling [39-40], although the prescriptive validity of RPE was not confirmed during walking/running in obese children, suggesting an exercise modality effect. Consequently, even though the RPE scale seems a valid tool for the prescription of exercise intensity in the healthy individuals, additional studies should be conducted to clarify the circumstances in which RPE may be used to prescribe exercise intensity in patients.

Recently, on the basis of observations that effort perception may be use to quantify intensity during training session in athletes [41-43] compared the use of Foster et al.'s [44] session RPE method (product of exercise duration in minutes by RPE score) to a HR method in men with post-infarction heart failure. They observed a significant relationship between methods in a continuous and intermittent exercise program, providing further evidence that effort perception may be used to quantify workload during rehabilitation. Again, further research is needed to explore the efficacy of this approach in clinical populations.

The RPE collected during a post intervention GXT may be compared to RPE values at the commencement of rehabilitation to evaluate the impact of the exercise program [2-3]. Indeed, if a decreased RPE score for a given exercise intensity is observed after the rehabilitation program, this provides further confirmation that the patient has improved his or her physical fitness.

Finally, further interest in the use of RPE relates to its use in the determination of perceptual preference. The latter corresponds to the lowest RPE score (i.e., the lightest perceived exertion) for a given exercise. For example, Coquart et al. [45] showed that obese women (with and without type 2 diabetes) preferred intermittent rather than continuous exercise. The authors suggested that an intermittent exercise approach could increase compliance to a rehabilitation program, although they failed to confirm these results during walking [14]. Further studies are therefore recommended.

In summary, the use of effort perception is known to have numerous applications in sedentary, healthy and athletic individuals. Fewer studies have confirmed the validity of RPE applications in clinical populations. Further research is needed in this area before the use of RPE can be routinely applied in rehabilitation programs.

Abbreviations

COPD: Chronic Obstructive Pulmonary Disease

GXT: Graded Exercise Test

HR: Heart Rate

PRET: Perceptually Regulated Exercise Test

RPE: Ratings of Perceived Exertion

$\dot{V}O_2$: Oxygen Uptake

$\dot{V}O_2max$: Maximal Oxygen Uptake

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