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Validity of the Borg 6–20 categories obtained in incremental testing for prescribing aerobic exercise intensity: a systematic review

review paper
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DANILO EDSON DE SOUZA[1], EDUARDO ZAPATERRA CAMPOS[1], REGINALDO GONÇALVES[2], JEFERSON MARCEDO VIANNA[3], JORGE ROBERTO PERROUT DE LIMA[3], TONY MEIRELES SANTOS[1], VINICIUS OLIVEIRA DAMASCENO[1]

[1] Department of Physical Education, Federal University of Pernambuco, Recife, Brazil
[2] Department of Sports Science, Federal University of Minas Gerais, Belo Horizonte, Brazil
[3] Department of Sports Sciences, Federal University of Juiz de Fora, Juiz de Fora, Brazil

ABSTRACT

Purpose. Self-regulation of exercise intensity with the Borg 6–20 scale seems a promising alternative, since the magnitude of effort is regulated by internal factors inherent to the individual and their perception of effort during the activity. In order to verify this hypothesis, some studies have tested the validity of the Borg 6–20 scale for prescribing exercise intensity. The study aim was to review the literature and verify the validity of the Borg 6–20 scale in aerobic exercise prescription.

Methods. The PICOS strategy was used to conduct the search for evidence concerning the objectives of the review as recommended by PRISMA-P. The level and quality of evidence were analysed by using the Cochrane Collaboration's recommendation for systematic reviews.

Results. A total of 1434 references were found. After applying the criteria of inclusion, 15 studies were considered eligible for review. These studies generally tested the validity of intensity-regulated prescriptions with rating of perceived exertion (RPE) by comparing physiological and performance measures obtained in incremental tests or conventional prescriptions with the measures generated by prescriptions regulated with the Borg 6–20 scale. In addition, some studies evaluated the reliability and reproducibility of RPE-regulated prescriptions by comparing physiological and performance measures obtained from different intensity-regulated exercise sessions with the Borg 6–20 scale.

Conclusions. According to the studies investigated in this systematic review, the recommendation of the Borg 6–20 scale in exercise prescription is not yet a valid alternative to describe similar intensity magnitudes to physiological and performance variables.

Key words: rating of perceived exertion, self-regulation, internal load, intensity

Introduction

The literature has indicated that self-regulation of aerobic exercise intensity with subjective rating of perceived exertion (RPE) scales is informed by a centrally adjusted exertion model, in which perceived exertion in exercise situations is the result of the interaction between brain activity and the afferent nerve stimuli which translate changes in peripheral metabolic compounds and cardiovascular responses as exercise is performed [1, 2]. Unlike in the traditional physiological model, the tolerable duration of exercise is limited by the central nervous system and peripheral factors through the deficit in oxygen delivery to tissues and the metabolic and ionic changes observed in active muscles during effort. New central control models based on perceived exertion may provide a unified theory of exercise tolerance, since RPE is a key tool for voluntary control of intensity [3, 4].

Correspondence address: Danilo Edson de Souza, Federal University of Pernambuco, Avenida Professor Moraes Rego, 1235 – University City, Recife – PE, Brazil, 50670-901, e-mail: daniloeds@gmail.com, https://orcid.org/0000-0002-8295-9578

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Self-regulation of exercise intensity by using the Borg 6–20 scale based on central models of effort control seems a valid alternative, since the magnitude and perception of effort are regulated by internal factors inherent to the individual during activity. In order to verify this hypothesis, some studies have tested the accuracy of the Borg 6–20 scale for training prescription using predefined categories of this scale to guide intensity in strength [5] and aerobic training programs [6–8].

On the other hand, the literature has presented a contradictory panorama about the safety of exercise self-regulation using only the Borg 6–20 scale as an intensity control tool for special groups. For Maciel et al. [9], applying only RPE for monitoring, load control, and prescription of strength training in patients who had undergone anterior cruciate ligament reconstruction may lead to under- or overdosing of resistance exercises and therefore impair the rehabilitation process. In contrast, other research has shown that the Borg 6–20 scale can be an effective tool in prescribing exercise in the treatment of pathologies such as diabetes mellitus [10], Parkinson's disease [11], heart disease [12–17], and cancer [18].

The literature also presents some studies that have tested the accuracy of Borg categories 6–20 obtained in graded tests for exercise intensity prescription by comparing measures such as heart rate (HR), oxygen consumption ($\dot{V}O_2$), and cycle ergometer power generated in incremental exercise tests with measures obtained in intensity prescriptions determined by RPE [19–25]. Dunbar et al. [19] and Kang et al. [22], respectively, observed that self-regulated exercise performed on a treadmill and cycle ergometer with Borg 6–20 categories equivalent to 50% of $\dot{V}O_2$peak, and 50% and 70% of $\dot{V}O_2$peak showed no significant differences for measures of $\dot{V}O_2$, HR, and power compared with the values reported in the incremental stress test.

In contrast to these findings, Marriott and Lamb [24] demonstrated that self-regulation with categories 11, 13, 15, and 19 of this RPE scale was associated with different HR and power measurements on a cycle ergometer. Similarly, Kang et al. [23] observed differences in comparisons of these measures in exercise sessions lasting 20 and 40 minutes for performing exercise at self-regulated intensity in categories related to 50% and 75% of $\dot{V}O_2$peak. To this same end, other research has tested the validity of self-regulation exercise intensity with the Borg 6–20 scale by comparing perceptually regulated prescriptions with conventional prescriptions regulated by HR, ergometer power, and treadmill speed [26–28]. These comparisons revealed no significant differences between the perceptual prescription method and the others which used physiological and performance measures to adjust exercise intensity.

Two narrative reviews [29, 30] addressed this issue, discussing the premise that ensures the use of the Borg 6–20 scale for self-regulation exercise intensity. For Birk and Birk [30], the prescription with the Borg 6–20 scale is an effective strategy because it satisfactorily describes estimating the $\dot{V}O_2$peak percentage. On the other hand, Dishman [29] emphasizes that the scientific scenario described at the time did not ensure the effectiveness of the Borg 6–20 prescription. Despite the broad bibliographic survey carried out in these studies, criteria similar to those recommended for a systematic review were not established, such as the selection of articles with clearly founded scientific basis. Moreover, in our view, the scientific productions which followed the last review published on the subject may indicate a different panorama from that presented more than 2 decades ago, thus limiting decision making on recommending this tool for exercise prescription focused on improving aerobic fitness. Therefore, the objectives of this research were to review the studies that have tested the validity of the Borg 6–20 scale for aerobic exercise prescription, and to define a consistent scientific position on whether or not to recommend this subjective RPE scale for this purpose.

Material and methods

Research strategy

The Population, Intervention, Comparison, Outcomes, and Study (PICOS) strategy was used to conduct the search for evidence concerning the review objectives as recommended by the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) [31]. No filters were applied to exclude articles during the search. Studies with characteristics different from the criteria selected for this review were subsequently excluded. Studies cited in the references of the articles found in the indexing databases were also considered.

Information sources

The search strategy included the following dimensions: exercise, prescription, perceived exertion, and the Borg scale. With this, we used combinations of keywords in PubMed, Scopus, Web of Science, and SPORTDiscus, as exemplified in PubMed: (((“Exercise/methods”

[MeSH]) OR prescription[Title/Abstract]) OR "exercise prescription"[Title/Abstract]) AND ((("perceived exertion"[Title/Abstract] OR "Borg scale"[Title/Abstract]) OR RPE[Title/Abstract])) and Scopus: TITLE-ABS- KEY (prescription) OR TITLE-ABS-KEY("exercise prescription") AND TITLE-ABS("Borg scale") OR TITLE-ABS ("perceived exertion") OR TITLE-ABS(RPE).

Selection process

Database searching, reading, identification, screening, quality assessment, and data extraction were conducted independently by 2 independent reviewers (DS and VD). In any case of disagreement, a third experienced reviewer made the final decision.

Data collection process

All titles were initially selected by the reviewers during electronic searches to identify relevant documents by using the export features of the databases in a spreadsheet (Microsoft Excel, 2013) containing the indexing base, the journal, the article title, the authors' names, and the year of publication in columns to later exclude manuscripts which would not fit the purpose of this study. The following criteria were applied: (1) duplicate publications; (2) studies which did not prescribe using RPE; (3) studies which did not prescribe aerobic exercise using the Borg 6–20 scale; (4) studies that involved participants with some type of heart disease; (5) studies with chronic design; (6) review studies or commentaries.

Data items

Study types

Experimental, randomized clinical, or non-randomized clinical studies were selected without restriction as to publication date. Unpublished papers, theses, or abstracts published in conference proceedings were disregarded.

Population

Studies that involved inactive, recreationally active, or athletically active individuals of both genders, regardless of age group, were included. Studies among participants with some type of heart disease were excluded from this review.

Interventions

The papers were required to analyse the validity of Borg 6–20 data obtained in incremental testing for prescribing aerobic exercise intensity, comparing physiological variables and performance obtained in incremental testing or conventional prescriptions with self-regulated prescriptions applying the Borg 6–20 scale.

Comparison

Comparing conventional prescriptions with self-regulated prescriptions using the Borg 6–20 scale was demanded.

Outcomes

The outcome analysed in this review was the correlation level between physiological and performance measures obtained in prescription with Borg 6–20 and conventional prescriptions.

Risk of bias in studies

The studies included in this systematic review were assessed for risk of bias in accordance with the Cochrane Collaboration's recommendation for systematic reviews [32], including the following items: (a) sequence generation (selection bias); (b) blinding of participants and personnel (performance bias); (c) outcome assessment (detection bias); (d) incomplete outcome data (attrition bias); and (e) selective reporting (reporting bias). These aspects were categorized for risk of bias as low risk of bias and high risk of bias. Two researchers, blinded to information which could identify the authorship of the articles (authors, affiliates, journals), independently assessed the risk of bias of the articles. One researcher experienced in systematic reviews subsequently resolved any disagreements.

Ethical approval

The conducted research is not related to either human or animal use.

Results

Research results and study characteristics

A total of 1434 references were found. After applying the criteria established as guiding criteria for inclusion, 15 studies were considered eligible for review [19–28, 33–37]. The description of article selection

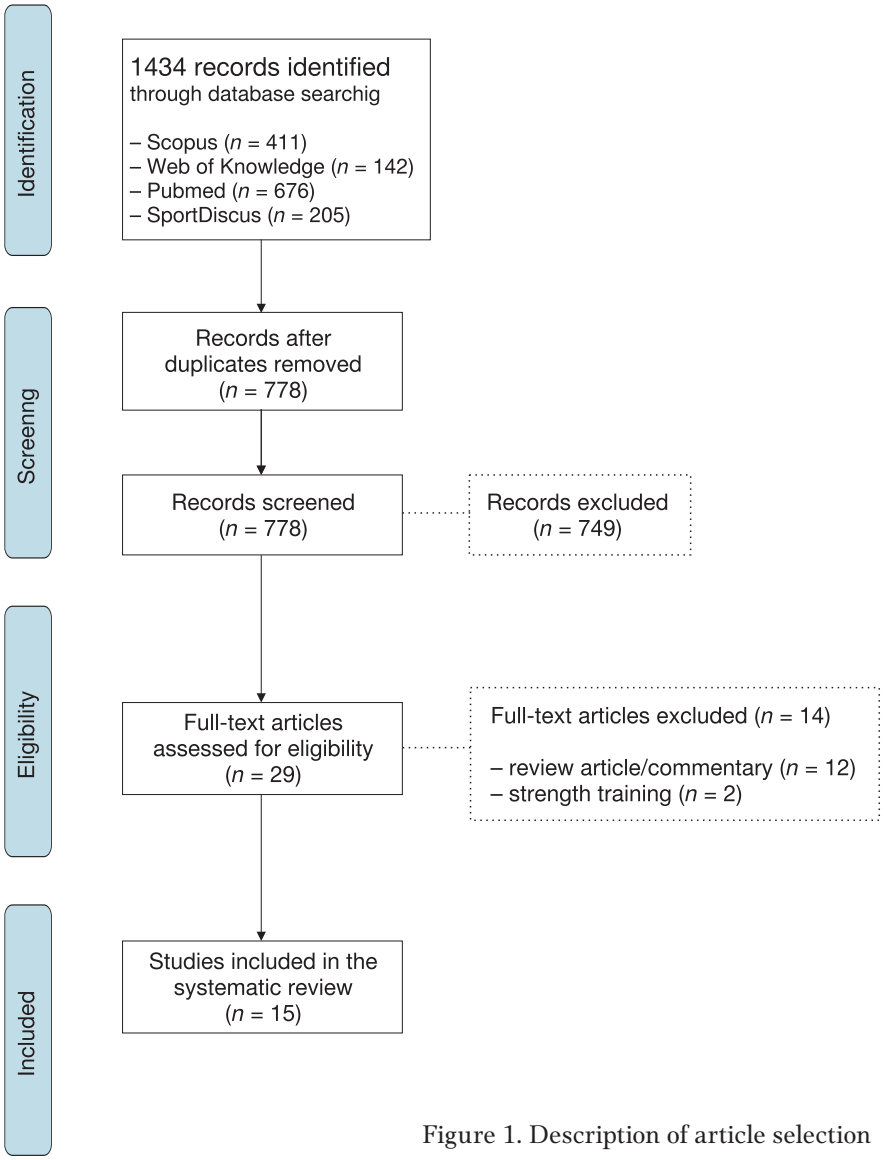

Figure 1. Description of article selection

and the number of studies excluded at each stage are reported in Figure 1.

The selected articles are dated from 1980 to 2021 and involve a population set of 207 individuals, composed of healthy people (n = 109), physically active individuals (n = 53), athletes (n = 9), people with spinal cord injury (n = 16), and overweight children (n = 20). From the total of the studies selected, 7 tested the validity of the Borg 6–20 prescription scale by comparing physiological, performance, and RPE measures obtained in a graded test with measures derived from perceptually self-regulated prescriptions [19–25] (Table 1). Four studies tested the validity of this tool by observing whether or not there was a difference between prescriptions self-regulated by RPE and prescriptions regulated by physiological and performance indicators [26–28, 35] (Table 1). Furthermore, 2 tested the reliability [34] and reproducibility [33] prescriptions (Table 1). Regardless of the design, the studies compared measures such as HR, $\dot{V}O_2$, power on ergometers, and speed on a treadmill generated in aerobic fitness tests or conventional exercise prescriptions, with the indicators obtained in perceptually self-regulated prescriptions using categories from the Borg RPE 6–20 scale.

Regarding the statistical treatment, 69% of the studies did not declare the performance of a test to verify the data normality hypothesis. All of the studies tested the hypothesis of a difference between the mean of the physiological measure, considered the gold standard, and the RPE from parametric or non-parametric inferential tests, and only 30.7% used the correlation to establish validity measures between the physiological measure criterion and RPE. In this same direction, only 15% of the studies presented the absolute and relative errors (Table 1).

Table 1. State of the art

Reference	Study design	Gold standard	Psychometric properties of study	Normality of test	Inferential test	Post-hoc test	Correlation test	Absolute error / relative error
Dunbar et al. 1992 [19]	ES	VO_2, HR, PO	Validity	No declared	One-way ANOVA with repeated measures	Tukey post-hoc test and Scheffé's method	No declared	No declared
Dunbar et al. 1994 [20]	ES	VO_2, HR, PO, speed	Validity	No declared	One-way ANOVA with repeated measures / *t*-tests	Dunnett post-hoc test	No declared	No declared
Glass et al. 1992 [21]	ES	VO_2, HR	Validity	No declared	Two-way ANOVA with repeated measures	Newman-Keuls post-hoc test	No declared	No declared
Kang et al. 1998 [22]	ES	VO_2, HR, PO	Validity	No declared	Dependent *t*-test	–	No declared	No declared
Kang et al. 2009 [23]	ES	VO_2, HR, PO	Validity	No declared	One-way ANOVA with repeated measures	Scheffé's post-hoc test	No declared	Bland-Altman analysis
Marriott and Lamb 1996 [24]	ES	HR, PO	Validity	No declared	ANOVA with repeated measures	Tukey post-hoc test	Correlation coefficients	No declared
Ward and Bar-Or 1990 [25]	ES	HR	Validity	No declared	One-way ANOVA / Student's *t*-test	Newman-Keuls post-hoc tests	No declared	No declared
Ciolac et al. 2015 [26]	CS	HR, speed	Validity	Kolmogorov-Smirnov test	Paired Student's *t*-test	–	No declared	No declared
Goosey-Tolfrey et al. 2010 [27]	CS	VO_2, HR, [BLa^-]	Validity	Shapiro-Wilk test	Student's dependent *t*-tests, two-way ANOVA with repeated measures	No declared	No declared	No declared
Smutok et al. 1980 [35]	ES	HR, speed	Validity	No declared	Regression analyses	No declared	No declared	No declared
Paulson et al. 2013 [28]	CS	VO_2, HR, PO, speed, [BLa^-]	Validity	Shapiro-Wilk test	One-way ANOVA with repeated measures / non-parametric Friedman tests and Wilcoxon test	No declared	Pearson's product-moment correlation	No declared
Marçal et al. 2021 [36]	CS	HR, speed	Validity	Shapiro-Wilk and Levene's tests	Two-way ANOVA with repeated measures (intervention vs. time)	Bonferroni post-hoc test	No declared	No declared
Eston and Williams 1988 [34]	ES	VO_2, HR	Reliability	No declared	ANOVA with repeated measures, independent *t*-tests	No declared	No declared	No declared
Hartshorn and Lamb 2004 [33]	ES	VO_2, MHRR, PO	Reproducibility	Shapiro-Wilk test	Intraclass correlation coefficients / two-way (subjects × trials) mixed ANOVA	No declared	Pearson correlation coefficient	Limits of agreement, Bland-Altman analysis
O'Grady et al. 2021 [37]	ES	VO_2, HR, PO	Reliability and reproducibility	Mauchly's test	Intraclass correlation coefficients / two-way (duration × intensity) mixed ANOVA	Bonferroni post-hoc test	Greenhouse-Geisser correction	No declared

ANOVA – analysis of variance, [BLa^-] – lactate concentration, CS – crossover study, ES – experimental study, HR – heart rate, MHRR – maximum heart rate reserve, PO – power output, VO_2 – volume of oxygen

Incremental testing and exercise intensity prescription RPE

Seven studies tested the validity of the Borg 6–20 scale for aerobic exercise prescription, comparing data generated in incremental tests performed on a treadmill, cycle ergometer, and row ergometer with data obtained from perceptually self-regulated prescriptions with the Borg 6–20 scale [19–25]. Only RPE categories 7, 9, 10, 11, 12, 13, 15, 16, 17, and 19, those relative to 50%, 60%, and 70% of $\dot{V}O_2$peak, 75% of HRreserve, were considered.

The most common physiological measure among the studies was HR, as 7 studies tested the scale validity using this measure as the criterion [19–25]. From these studies, only Kang et al. [22] observed no differences greater than 5.00 bpm between estimation and prescription with categories relative to 50% and 70% of peak $\dot{V}O_2$. Dunbar et al. [19], Marriott and Lamb [24], and Ward and Bar-Or [25] showed a contradictory picture, presenting differences ranging from 0.40 bpm to –26.85 bpm in prescriptions relative to 50% and 70% of $\dot{V}O_2$peak and previously established categories, respectively. Glass et al. [21] revealed mean differences of 6.90 bpm between estimation and perceptually regulated prescription with categories relative to 75% HRreserve. Dunbar et al. [20] implied no validity data or differences between the distinct interventions.

The 5 studies which used $\dot{V}O_2$ as a validation criterion measure indicated the legitimacy of categories relative to 50%, 60%, and 70% of $\dot{V}O_2$peak, and 75% HRreserve in the presented analyses; these prescriptions showed differences between 0.00 and 0.73 $l \cdot min^{-1}$ [19, 20, 22], between 1.60 and 2.60 $ml \cdot kg^{-1} \cdot min^{-1}$ [23], and 3.00 $ml \cdot kg^{-1} \cdot min^{-1}$ [21], respectively.

Five studies investigated power in cycle ergometers and presented a contradictory picture regarding the validity of the Borg 6–20 scale for exercise self-regulation, with differences between estimation and output ranging from 0.30 to 52.20 [19, 20, 22–24].

Prescribing with incremental test data and prescribing exercise intensity with RPE

Five studies tested the validity of the Borg 6–20 scale by comparing physiological and performance measures generated by conventional exercise prescriptions with perceptually regulated prescriptions [26–28, 35, 36]. These studies considered categories 9, 10, 11, 15, 16, and 17, and equivalent of 50% and 70% of $\dot{V}O_2$peak and speeds of 4.7, 6.5, 9.7, 11.3, and 12.9 $km \cdot h^{-1}$. HR was the most used criterion measure for validation of the RPE scale. The 4 studies showed parity between the measurements obtained in the different prescription types, presenting differences from 0.00 to –6.00 bpm [26–28, 36]. In contrast to these findings, Smutok et al. [35] demonstrated through regression analyses that HR measurements from RPE-regulated intensity prescriptions could be significantly different from those obtained during conventional prescriptions. $\dot{V}O_2$ and lactate concentration were measured as validity criteria in 2 studies [27, 28], and no significant differences were found in either study between $\dot{V}O_2$ values in exercises performed on a hand cycle ergometer (RPE 50% $\dot{V}O_2$peak prescription 1.44 $l \cdot min^{-1}$ and power prescription 1.35 $l \cdot min^{-1}$; RPE 70% $\dot{V}O_2$peak prescription 2.00 $l \cdot min^{-1}$ and power prescription 1.90 $l \cdot min^{-1}$) [27] and on an ergometric treadmill for wheelchair (RPE 70% $\dot{V}O_2$peak prescription 1.12 $l \cdot min^{-1}$ and speed prescription 1.09 $l \cdot min^{-1}$) [27] and on a treadmill for wheelchair (RPE 70% $\dot{V}O_2$peak prescription 1.12 $l \cdot min^{-1}$ and velocity prescription 1.09 $l \cdot min^{-1}$) [28]. Similarly, lactate measurements also showed no differences (RPE 50% $\dot{V}O_2$peak prescription 1.99 $mmol \cdot l^{-1}$ and power prescription 1.82 $mmol \cdot l^{-1}$; RPE 70% $\dot{V}O_2$peak prescription 4.04 $mmol \cdot l^{-1}$ and power prescription 3.07 $mmol \cdot l^{-1}$ [27]; and RPE 70% $\dot{V}O_2$peak prescription 1.14 $mmol \cdot l^{-1}$ and potency prescription 0.98 $mmol \cdot l^{-1}$ [28]).

Three studies tested the validated Borg 6–20 scale using performance measures as criteria [26, 28, 36]. Ciolac et al. [26] identified that there was no significant difference in treadmill speed between self-regulated prescriptions, respectively, with RPE categories between 9 and 11 and prescriptions regulated with 50% of HRreserve (RPE prescription 5.7 $km \cdot h^{-1}$ and HR prescription 5.7 $km \cdot h^{-1}$), and for RPE categories between 15 and 17 and prescriptions regulated with 70% of HRreserve (RPE prescription 7.8 $km \cdot h^{-1}$ and HR prescription 8.2 $km \cdot h^{-1}$). Similarly, Marçal et al. [36] observed no significant difference between high-intensity interval exercise prescriptions autoregulated by RPE and prescriptions adjusted with HRreserve at the same intensity level. These findings reaffirm what had already been observed by Paulson et al. [28] on the accuracy of prescriptions with RPE to describe the same speed of prescriptions imposed at 70% $\dot{V}O_2$peak for dislocation on an ergometric treadmill for wheelchair users (RPE prescription 1.8 $m \cdot s^{-1}$ and speed prescription 1.6 $m \cdot s^{-1}$).

Reliability and reproducibility

So far, only 3 studies have investigated the reliability [34, 37] and reproducibility [33, 37] levels of self-regulated intensity exercise prescriptions with the Borg 6–20 scale.

Eston and Williams [34] tested the reliability of prescriptions performed on cycle ergometers using categories 9, 13, and 17 to regulate exercise intensity. The analyses in this study showed satisfactory correlation levels for $\dot{V}O_2$ between the 3 trials performed for each RPE category (r = 0.83, 0.94). Similarly, Hartshorn and Lamb [33] tested the reproducibility of prescriptions made on a cycle ergometer with self-regulated intensities for categories 9, 13, 15, and 17, showing an intraclass correlation coefficient between 0.45 and 0.86 for $\dot{V}O_2$ in the comparison of 3 trials performed for each RPE category. Confirming these findings, O'Grady et al. [37] examined individual variability in physiological response to prescribed exercise with RPE categories 9, 13, and 17 of the Borg 6–20 scale and identified that prescriptions with high effort and long durations resulted in greater consistency on both an in- and inter-athlete basis.

Risk of bias in individual studies

The studies included in the present review reported a poor level of evidence, as less than 55% of the studies demonstrated a low risk of bias when considering randomized sequential generation. Similarly, less than 55% of the studies made it clear that the participants had been adequately blinded to the intervention procedures. In contrast, 100% of the studies exhibited a low risk of bias for incomplete outcome data and selective reporting criteria. With regard to detection bias, 100% of the studies showed an unclear risk of bias. Figures 2 and 3 describe these results.

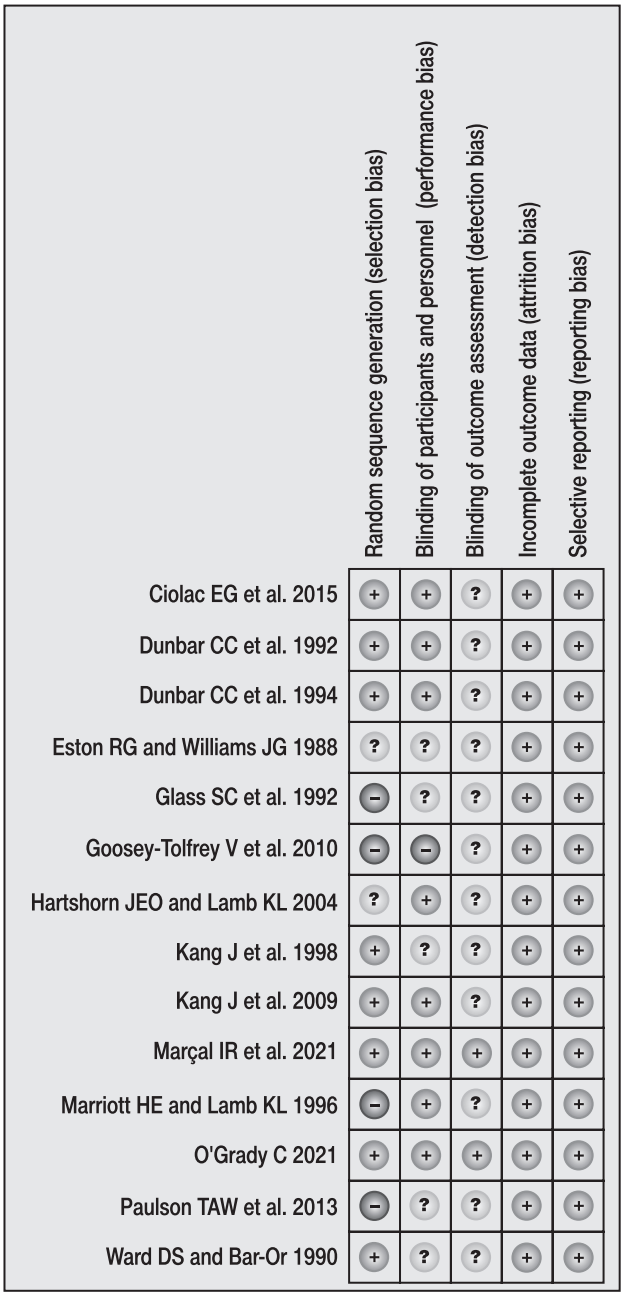

Figure 3. Risk of bias summary

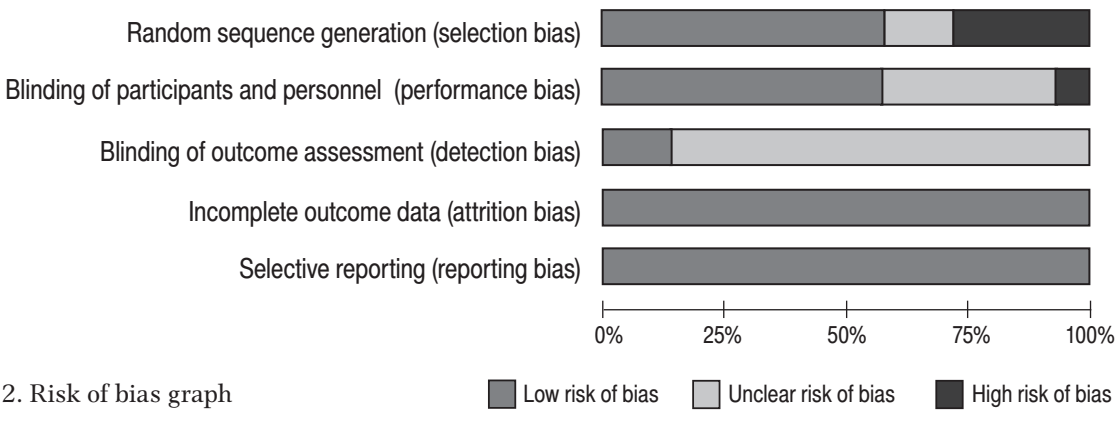

Figure 2. Risk of bias graph

Discussion

The objective of this investigation was to systematically review the literature and determine the validity of the Borg 6–20 scale used in incremental tests to prescribe aerobic exercise intensity. There is an idea that an individual is able to use their sensorial cortex to interpret physiological changes (peripheral and central) during exercise and then to self-regulate the intensity using the RPE scale. However, most of the studies analysed showed that the recommendation of this tool for exercise prescription may not be an accurate strategy if compared with conventional prescriptions based on physiological and performance variables [16, 19, 22, 26–28, 36].

Thus, the results presented in this review differ in part from the assumptions raised in the critical reviews by Birk and Birk [30] and Dishman [29] on the validity of prescribing exercise intensity with RPE. Our evidence shows that perceptually self-regulated exercises may have different levels of HR, $\dot{V}O_2$, and power than those estimated by stress tests and prescriptions regulated with physiological and performance variables.

However, the state of the art generally presents a controversial picture about the validity of the Borg 6–20 prescription to describe HR obtained from incremental tests and exercise prescriptions with a conventional intensity control mechanism. Some intercurrences may occasionally attribute bias to these findings, since some studies compare measurements obtained in the laboratory with those generated in field environments, with consequent exposure to physiological and environmental modulators that contribute to significantly different measures of internal load [25]. Another fact which may disqualify these findings is related to the exclusion of studies that analysed the effectiveness of the scale in prescribing exercise in populations formed by individuals with heart disease who used medications to modulate cardiac function [12–17]. In our view, these studies should not use the same validity metrics as those listed in this review, given that the physiological changes caused by the medications may lead to bias in decision making about recommending this strategy if these studies are analysed together. Therefore, HR measurements alone do not seem to be as reliable to confirm the validity of perceptual scales. On the other hand, studies with intensities relative to percentage fractions of HRreserve are still insufficient for decision making on the subject.

In contrast to these findings, promising results were presented by preliminary studies on intensity prescription with the Borg 6–20 scale for individuals with spinal cord injury, regardless of the injured region [27, 28]. HR measurements in these studies were similar in the different prescription types with an intensity equivalent to 50% and 70% $\dot{V}O_2$peak. The same was confirmed by $\dot{V}O_2$, lactate concentration, and power measurements [27, 28].

Perceptually controlled exercise prescriptions with the Borg 6–20 scale seem to describe the $\dot{V}O_2$ obtained in incremental tests well, as well as prescriptions with conventional intensity control mechanisms. Although Kang et al. [22] and Dunbar et al. [19] present a contradictory picture regarding prescriptions at different intensities, most studies have shown that exercises regulated with the Borg 6–20 scale describe a $\dot{V}O_2$ generically identical to that of conventional prescriptions, especially for intensities relative to percentage fractions of $\dot{V}O_2$peak.

With reference to performance variables, the scarce number of studies indicates a contradictory scientific panorama regarding the validity of the Borg 6–20 scale to describe velocity and power magnitudes similar to those obtained in prescriptions with conventional intensity control mechanisms and incremental tests. This scenario limits the decision making about the use of this RPE scale for exercise prescription with emphasis on improving sports performance, since athletes and coaches usually use performance variables to monitor and adjust training loads.

The studies selected in this systematic review may present results with some limitations for an adequate interpretation of the analysed outcomes. It is important to consider that some studies did not establish scientifically acceptable criteria for the category choices of the Borg 6–20 scale in their analyses, which may compromise the real classification of the magnitude of effort. Another fact which may limit interpretation of the results is related to the statistical analyses, since only 2 studies presented the limits of agreement through the Bland-Altman technique and the absolute and relative errors. All of the other studies used correlation, regression, parametric (*t*-test, ANOVA) or non-parametric (Wilcoxon) hypothesis tests to investigate the criterion and Borg measure validity. To our understanding, the lack of presenting absolute and relative errors makes it difficult to analyse the real accuracy of the Borg scale against the physiological variables. In this same sense, it is unanimous among statisticians that the correlation between 2 variables is not synonymous with equivalence in the measure which one wishes to validate.

Another limitation in making a decision about whether or not to recommend the Borg 6–20 scale for

self-regulation of exercise intensity can be seen in studies with a chronic design [6–8, 17]. In our opinion, the findings of these studies have no competence to recommend the use of this RPE scale for this purpose since chronic adaptations of the training process may be linked to several factors inherent to the quality level that prescriptions self-regulated with subjective RPE reflect on prescriptions regulated with physiological or performance variables.

Future studies should investigate the outcomes of $\dot{V}O_2$, lactate concentration, and performance-related variables, considering the limitations of the literature presented herein to qualify the information and expand the state of the art on the topic.

Conclusions

According to our investigation, the recommendation of the Borg 6–20 scale for exercise prescription is not yet a valid alternative. This is based on the consideration that the studies which demonstrated accuracy to describe similar intensity magnitudes to physiological and performance variables have limitations which prevent a categorical assessment for using the Borg 6–20 scale in prescribing aerobic exercise intensity.

The promising results found for $\dot{V}O_2$ should be investigated, since the studies that analysed this variable are scarce and present characteristics which may attribute bias to the measurements, such as the intentional choice of categories of the RPE scale. These results must still be confirmed by studies which do not present this limitation.

On the basis of the data from this systematic review, the Borg 6–20 scale does not present validity for prescribing aerobic exercise intensity. New studies should consider the limitations presented in the literature in order to better qualify the information on the efficiency of the Borg 6–20 scale for prescribing aerobic exercise intensity.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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