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Original research

Does rating of perceived exertion result in target exercise intensity during interval training in cardiac rehabilitation? A study of the Borg scale versus a heart rate monitor

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ABSTRACT

Objectives: To assess whether rating of perceived exertion using the Borg 6–20 scale is a valid method for achieving target exercise intensity during high-intensity interval training in cardiac rehabilitation.
Design: A single-group cross-over design.
Methods: Ten participants (56 (6.5) years) who were enrolled in a high-intensity interval training cardiac rehabilitation program were recruited. A target exercise intensity of Borg 17 (very hard) was used for exercise intensity guidance in the initial four exercise sessions that took place before a cardiopulmonary exercise test, as in usual care rehabilitation. The heart rate was recorded and blinded to the participants. After performing the test, the participants were then instructed using heart rate monitors openly for exercise guidance in four subsequent exercise sessions, at an intensity corresponding to 85–95% of peak heart rate.
Results: The mean exercise intensity during high-intensity bouts was 82% (6%) of peak heart rate for the rating of perceived exertion and 85% (6%) using heart rate monitors ($p = 0.005$). Bland–Altman limits of agreement analysis with a mean bias showed a bias of 2.97 (−2.08, 8.02) percentage points for the two methods. Exercise intensity was highly repeatable with intra-class correlations of 0.95 (95% CI 0.86–0.99, $p < 0.001$) and 0.96 (95% CI 0.88–0.99, $p < 0.001$) in the exercise sessions using rating of perceived exertion and percentage of peak heart rate for intensity control, respectively.
Conclusions: Rating of perceived exertion results in an exercise intensity below target during high-intensity interval training bouts in cardiac rehabilitation. Heart rate monitoring should be used for accurate intensity guidance.

1. Introduction

Aerobic exercise is an important component in cardiac rehabilitation due to its beneficial effects on mortality and morbidity.[1] Exercise intensity appears to influence the amount of cardioprotective benefits achieved from aerobic exercise.[2,3] Several studies have shown that high-intensity interval training (HIT) is more efficient compared to continuous moderate intensity exercise to improve VO_{2peak},[4] cardiac function[5] and blood pressure.[6] As exercise guidelines in cardiac rehabilitation suggest exercise intensities up to 95% of peak heart rate (HR_{peak}),[7,8] HIT has gradually been implemented in clinical practice.

There are several methods for exercise intensity estimation. HR_{peak} is seldom known in patients entering cardiac rehabilitation, as cardiopulmonary exercise testing is not required before starting exercise-based cardiac rehabilitation.[7] Thus, the ability to use the recommended estimates for exercise intensity[8,9] prescribed as a percentage of HR_{peak}, heart rate reserve, peak oxygen uptake (VO_{2peak}) or VO_2 reserve are not present. Instead, subjective methods to guide exercise intensity are frequently used, such as rating of perceived exertion (RPE)[10] or the talk test (TT).[11] RPE is an accepted method for subjective estimates of exercise effort and intensity in both healthy people and patient populations.[8,12,13] In cardiac rehabilitation, the Borg 6–20 scale[10] is most commonly used. The method is reliable[12] in healthy adults and valid[14] for exercise intensity prescription in patients taking cardio-selective beta-blockers, but the results are equivocal. Whaley et al.[15] observed significant inter-individual variability at relative exercise intensities of 60% and 80% of maximal heart rate reserve, both in healthy individuals

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and cardiac patients. At the highest intensity, more than half of the cardiac patients reported an RPE outside the range of 14–17. Furthermore, Buckley et al.[16] found that RPE at 67% of peak work load during treadmill walking was significantly lower during two subsequent exercise sessions at the same work load. In a review from Chen et al.,[17] the authors concluded that the RPE response is mediated by beta-blockade, particularly at higher intensities and that habituation is necessary to improve the accuracy of RPE as an exercise prescription method.

In patients with coronary artery disease (CAD), HIT is typically performed as four four-minute bouts of high-intensity exercise (85–95% of HR_{peak}), separated by three minutes of active recovery periods at 70% of HR_{peak}.[7] Exercise intensity at 85–95% of HR_{peak} is associated with Borg RPE 16–17 (hard to very hard).[9] However, the ability of RPE 17 to achieve the target exercise intensity during HIT in cardiac patients has not been assessed. Hence, the aim of this study was to evaluate whether RPE is a valid method for determining exercise intensity in HIT during group exercise training in cardiac rehabilitation. Our main hypothesis was that RPE-guided HIT would be adequate for reaching the lower limits of the target exercise intensity (85% of HR_{peak}) during bouts, but that heart rate (HR) monitors would result in higher intensity.

2. Methods

The study had a non-randomized, single-group, cross-over design. As we wanted to assess exercise intensity without any bias, we first recorded HR (blinded to the participants) during four HIT sessions where exercise intensity was guided by RPE (usual care). Four exercise sessions were chosen to assess repeatability as well. After the 4th exercise session, a cardiopulmonary exercise test (CPET) was performed to determine HR_{peak} and VO_{2peak}. After the CPET, four additional exercise sessions were performed. In these sessions, the participants knew their individual target limits of 85–95% of HR_{peak} and used the HR monitors openly to achieve this.

The study protocol was approved by the Regional Ethical Committee for Medical Research (2011/2632A) before inclusion started, and written informed consent was obtained from the participants before entering the study. The study was registered in ClinicalTrials.gov (NCT01550081).

The participants were recruited from the outpatient cardiac rehabilitation program at St. Olav's Hospital, Trondheim, Norway, in March and April 2012. The patients were referred to cardiac rehabilitation for clinical reasons, typically due to a recent cardiovascular event (<3 months), such as myocardial infarction or myocardial revascularization. The inclusion criteria were age over 18 years, enrollment in cardiac rehabilitation and ability to perform a symptom-limited CPET. The exclusion criteria were unstable angina, severe arrhythmias, heart failure, severe valve disease, known pregnancy and drug abuse.

The study participants continued their cardiac rehabilitation program together with the other patients, consisting of a total of 24 HIT sessions (2 × 12 weeks). The participants maintained the same medication regimen as normal (Table 1), and the regimens or doses were not altered during the study period for any of the participants. The exercise sessions were performed as circuit exercise in groups, consisting of four four-minute bouts of high-intensity exercise at 85–95% of HR_{peak}. Each session started with a 15-min warm-up guided by a physiotherapist. The warm-up consisted of aerobics at a low to moderate intensity, with gradually increasing intensity up to RPE 12–13. The warm-up was held constant throughout all exercise sessions. The bouts of high-intensity exercise consisted of walking/running on treadmills, or cycling on stationary bikes. The choice of device was optional; however, most patients preferred the treadmills. The physiotherapist guiding the exercise sessions encouraged the participants to exert themselves to RPE 17 when they started on the high-intensity bout and to reach this effort level within one to two minutes. After each high-intensity bout, there was a period of three minutes of active recovery, aimed at RPE 13.[14] These breaks consisted of core stability exercises. After the last bout, there was a cool down period of 10 min. Absolute workload was not recorded.

Table 1
Clinical characteristics of the participants.

Male/female	9/1
Age (years)	56.4 (6.5)
Height (m)	1.78 (0.05)
Bodyweight (kg)	82.7 (6.8)
- Calculated muscle mass (% of bodyweight)	38.2 (3.1)
- Calculated fat percentage (% of bodyweight)	23.3 (5.4)
Body mass index (kg/m^2)	26.1 (2.4)
Resting blood pressure (mmHg)	
- Systolic	131 (8.5)
- Diastolic	85 (7.7)
Resting heart rate (beats per min)	65 (10)
Diagnosis	
- Myocardial infarction	5
- Coronary artery bypass graft	3
- Stable angina	2
Medication	
- Beta-blockers	8
- Statins and antithrombotic medication	10
Hypertension	3
Diabetes mellitus type 2	2

Continuous data are given as the mean (SD); categorical data are given as numbers.

Resting HR and blood pressure were measured with an OSZ5 automated blood pressure monitor (Welch Allyn, Germany). Measurements were made after 10 min of rest, and the average of three records is reported. Body weight was measured, and body composition was calculated using an Omron Body composition monitor BF500 (Hoofddorp, Netherlands).

The CPET was performed using current guidelines.[8] A Metamax II (Cortex, Leipzig, Germany) was used for the ergospirometry measurements, and ECG was recorded simultaneously with a Cardiovit CS-200 (Schiller, Baar, Switzerland). The participants were instructed to avoid coffee, food and cigarette smoking at least 2 h before the CPET and heavy exercise the day before. After a 10-min warm-up, work load was added either by increasing the incline by 2–3% every minute or increasing speed by 0.5–1 km/h. The test was terminated when the participants experienced exhaustion or symptoms.[8]

RPE is recommended for exercise prescription in patients with CAD[8] medicated with beta-blockers,[14] and it is widely used in cardiac rehabilitation. The Borg 6–20 scale[10] was introduced to the participants when they started the rehabilitation program. The standard procedure (usual care) was followed with an explanation of the scale and instruction for how to use it. During all HIT sessions, the instruction from the physiotherapist was to exercise at RPE 17 during the bouts. After each bout, the participants reported RPE. The reported values were averaged for the first to fourth intervals (description of progression) and for all exercise sessions.

Polar HR RS 400 monitors (Polar Electro, Finland) were used to collect HR data during all exercise sessions. Monitors, treadmills and stationary bikes were masked for HR during the RPE sessions. All of the participants were individually instructed in their target HR after the CPET and how to operate the monitors. No further information was provided to the participants about the achievement of target HR during or after the exercise sessions. The exercise intensity was calculated as an average from the last two minutes during each bout, as one to two minutes is required to reach target