Comparison of the Peak Exercise Response Measured by the Ramp and 1-min Step Cycle Exercise Protocols in Patients With Exertional Dyspnea*

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Study objectives: To compare the peak exercise response and determine the limits of agreement between the ramp and the 1-min step cycle protocols in a representative population of patients with exertional breathlessness attending a respiratory outpatient clinic.

Design: Crossover with the test order double blinded and randomized.

Setting: Outpatient exercise physiology laboratory.

Patients: Twenty-two patients (12 men; mean [SD] age, 59 [8] years; FEV1, 71% [21%]) with lung disease and/or exertional breathlessness.

Intervention: Symptom-limited, maximum cycle exercise tests using a ramp and a 1-min step work rate (WR) protocols. The two protocols were assigned to subjects in a randomized manner.

Measurements and results: Oxygen uptake (V˙O₂), minute ventilation (V˙E), heart rate (HR), WR, exercise time, and Borg scores were compared at symptom-limited peak exercise. The mean (SD) peak values for the ramp and the step protocols, respectively, were as follows: peak V˙O₂, 1.51 (0.44) L/min and 1.49 (0.43) L/min; peak V˙E, 50.8 (12.9) L/min and 49.9 (14.5) L/min; and peak HR, 133 (24) beats/min and 131 (22) beats/min (p > 0.05). There were no significant differences between breathlessness and perceived exertion at peak exercise. Peak WR (WRpeak) and exercise time were significantly higher using the ramp protocol: 110.5 (37.1) W vs 105.6 (35.6) W, and 8.2 (2.0) min vs 7.6 (1.9) min, respectively.

Conclusions: The ramp protocol leads to a higher WRpeak, and this may have implications for exercise prescription. However, there were no significant differences between the two protocols for the peak physiologic responses. The choice of protocol for the measurement of maximal exercise capacity remains one of laboratory preference.

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Key words: cycle ergometer; 1-min step exercise protocol; ramp exercise protocol

Abbreviations: AT = anaerobic threshold; HR = heart rate; HRpeak = peak heart rate; V˙E = minute ventilation; V˙Epeak = peak minute ventilation; V˙O₂ = oxygen uptake; V˙O₂peak = peak oxygen uptake; WR = work rate; WRpeak = peak work rate

The American Thoracic Society Laboratory Manual1 suggests a number of standardized protocols that are suitable for maximum exercise tests. The European guidelines2 recommend either a 1-min step protocol or a ramp cycle protocol for clinical exercise tests in pulmonary disease. Whipp et al3 first described the ramp protocol for the cycle ergometer in 1981, and since that time there have been improvements in ergometers to achieve a continuously changing, or ramped, profile in work rate (WR). Several studies have compared the ramp protocol to more established protocols for both the treadmill4–6 and the cycle ergometer.4,7–9 The treadmill studies involved patients with cardiac disease4,5 and obese women,6 while the cycle ergometer comparisons have been on patients with cardiac disease,4 normal men,7 young adults,8 and elderly, sedentary men.9 To our knowledge, there are no reports of a comparison of the ramp protocol and the 1-min step cycle protocol in patients with respiratory disease.

A previous study has shown that short tests with large WR increments underestimate maximum exercise capacity,10 while ramp protocols are superior for optimizing the relationship between oxygen uptake (V˙O₂) and WR and for predicting maximal V˙O₂.4 The majority of patients referred for investigative respi-
ratory exercise tests are not cyclists and are often sedentary, factors that should be considered when choosing an exercise protocol, in addition to the degree of impaired lung function and clinical status. A step WR protocol is more likely to demand abrupt changes in muscular effort compared to the constant and gradual change of the ramp protocol. For this reason, the ramp protocol may be less intimidating and more readily tolerated by this patient group, thereby leading to a higher peak response compared to the step protocol. The purpose of this study, therefore, was to compare the ramp and 1-min step cycle protocols to determine if there were systematic differences in the peak physiologic response in patients with exertional breathlessness.

**Materials and Methods**

**Patients**

The aim was to recruit a study population similar to the population most usually referred for investigative respiratory exercise tests from the outpatient respiratory clinics. Thus, patients who had reported a reduced exercise tolerance and breathlessness on exertion during routine clinical examination were approached to take part in the study. Patients who would not be referred normally on a routine basis for a full, investigative respiratory exercise test were excluded. These included patients with the following conditions: exercise-induced bronchoconstriction, asthma (usually referred for exercise-induced bronchoconstriction test), cystic fibrosis (except for monitoring prior to transplantation), skeletal abnormality, sleep apnea syndrome, acute exacerbation, recent chest infection, infectious disease, or other contraindication to exercise. All patients willing to take part in the study were approached to take part in the study. Patients who would not be referred normally on a routine basis for a full, investigative respiratory exercise test were excluded. These included patients with the following conditions: exercise-induced bronchoconstriction, asthma (usually referred for exercise-induced bronchoconstriction test), cystic fibrosis (except for monitoring prior to transplant), skeletal abnormality, sleep apnea syndrome, acute exacerbation, recent chest infection, infectious disease, or other contraindication to exercise. All patients willing to take part in the study gave informed written consent, and the study protocol received approval from the district ethics committee.

**Study Design**

Twenty-three patients were recruited (13 men and 10 women). Each patient attended on two separate occasions, at the same time of day, and > 1 day and < 10 days apart. All patients were advised to avoid eating for 2 h prior to their appointment time and to avoid exercise, other than routine activities, for 24 h. The order of the ramp and the step protocols was randomized with both the patients and the main test operator (K.E.B.) blinded to the order. To gain an overall impression of an individual's level of fitness, the number of hours of exercise per week and any restrictions of routine daily activities were recorded at the first visit. Height and weight were measured. At both visits, FEV\(_1\) and FVC were measured. For safety considerations, a 12-lead ECG was recorded at the first visit at rest, at peak exercise, and twice during the recovery phase. At all other times, a single-lead ECG was displayed on a monitor. Patients were instructed to continue cycling until too tired or breathless to continue. The same test operator (K.E.B.) gave standardized encouragement during the exercise. The end of the test was indicated by an inability to maintain the correct pedaling rate or a hand signal from the patient.

**WR Protocols**

The size of the WR increment for each patient was calculated according to the equation of Wasserman et al.\(^1\)\(^1\) (see Appendix). The formula provides a minute increment in WR aiming to reach a symptom-limited maximum within approximately 10 min. For the step protocol, the increment was applied at the start of each minute and remained constant for the remainder of the minute. The minimum increment available on the cycle ergometer (ER 900; E. Jaeger, Ltd; Warwa, UK) in our laboratory was 1 W/s; therefore, we divided 60 by the calculated increment in order to establish the rate of change for the ramp protocol. For example, if the calculated 1-min increment size was 15 W, then the change in wattage during the ramp protocol was 1 W per 4 s. Thus, the overall increment per minute was the same regardless of protocol. At the start of the test, both protocols incorporated 3 min of unloaded pedaling in order to provide a reference phase, a warm-up, and to familiarize patients with the recommended pedaling rate of 40 to 45 revolutions per minute.

**Measurements**

Expired gas and ventilation were measured using a breath-by-breath computerized exercise system (OxyconBeta; E. Jaeger Ltd). Heart rate (HR) was recorded from a single lead ECG (Graseby Medical, Harts, UK). The peak values for VO\(_2\), minute ventilation (VE), and HR were taken as the mean of the final 20-s sampling period prior to the end of loaded exercise. The exercise system has internal temperature and barometric pressure measurement for correction of gas volumes. The system barometric pressure was checked against an aneroid barometer at every test. The gas analyzers were calibrated prior to every test by invoking the automatic two-point gas calibration procedure, which uses air for the high oxygen/zero carbon dioxide points and cylinder gas containing 5% carbon dioxide in nitrogen for the high carbon dioxide and zero oxygen points. The volume calibration was also performed prior to every test using a 3-L syringe.

At the first visit patients were familiarized with the Borg scales\(^1^2\) and received a standardized explanation of their use. The explanation was modified slightly from the one published by Belman et al.\(^1^3\) (see Appendix). At the end (final 15 s) of every alternate minute of the exercise test and at peak exercise, breathlessness and perceived exertion were rated by asking the patient to point to the statement or number that best corresponded to the relevant symptoms. Breathlessness was scored first, followed immediately by perceived exertion. The patient symptoms and reason for exercise termination were noted for every test.

**Manual Calculations**

The gas exchange anaerobic threshold (AT) was measured according to the modified V-slope method described by Sue et al.\(^1^4\) The person measuring the AT was blinded to the cycle protocol. The ratio of increase in VO\(_2\) to the increase in WR (VO\(_2\)/WR) was calculated according to the equation given by Hansen et al.\(^1^5\) The rate of change of Borg scores (Borg score per minute) was calculated from the equation (Borg peak − Borg base)/time, where Borg peak is the score at peak exercise, Borg base is the score at the end of the unloaded cycling period, and time is the duration of loaded cycling in minutes.

**Statistical Analysis**

Results are presented as mean and SD unless otherwise stated. Paired data were compared using the Student's t test or the Wilcoxon signed rank test for the Borg scores. A p < 0.05 was considered significant throughout. The mean difference between methods and the limits of agreement (difference ± 2 SD) for peak VO\(_2\) (VO\(_2\)peak), peak VE (VEpeak), and peak HR (HRpeak)
were calculated according to the method of Bland and Altman. Previous studies have already determined that the between-day variability of repeat cycle exercise measurements of VO\textsubscript{2peak}, V\textsubscript{Epeak}, and HR\textsubscript{peak} is < 10% for patients with chronic obstructive lung disease\textsuperscript{17,18} and for patients with restrictive type lung disease.\textsuperscript{19} Thus for the purposes of this study we chose a value of > 10% difference between the peak physiologic variables to indicate a systematic difference between the two methods (ie, between the ramp and 1-min step protocols).

RESULTS

Thirty patients were approached for recruitment, and 23 patients agreed to take part in the study. The reasons for refusal were social or work commitments. Twenty-two patients (12 men and 10 women) completed the study, and 1 patient failed to attend for a second test because of work commitments. The demographic data, baseline lung function, and Borg breathlessness rating at rest are shown in Table 1. There were no significant differences between visits for the lung function measurements at rest (p > 0.05). The patient population studied included four patients with bronchiectasis, six patients with COPD/emphysema, five patients with sarcoidosis, three patients with cryptogenic fibrosing alveolitis, one patient with extrinsic allergic alveolitis (pigeon fancier), one patient with bleomycin alveolitis, and two patients with breathlessness of unknown cause.

The mean (SD) values for each protocol for VO\textsubscript{2peak}, V\textsubscript{Epeak}, HR\textsubscript{peak}, breathlessness, and perceived exertion were similar (Table 2). Although there was a tendency for the peak values from the ramp protocol to be slightly higher than the 1-min step protocol, the differences were small and did not reach significance except for the WR\textsubscript{peak} and exercise time (Table 2). The scatter of the individual differences between protocols (ramp - step) for the peak physiologic variables were illustrated with Bland and Altman graphs (Fig 1). The graphs demonstrated that the differences between tests were spread evenly above and below zero, indicating an absence of bias toward either protocol (Fig 1).

The mean percentage differences and limits of agreement (difference [± 2 SD]) were +1.3% (−20.6%, +23.2%) for VO\textsubscript{2peak}, +2.8% (−25.6%, +31.2%) for V\textsubscript{Epeak}, and +0.84 (−12.4%, +14.1%) for HR\textsubscript{peak}. There were eight patients for whom the difference between values of VO\textsubscript{2peak} > 150 mL (ie, > 10% of the group mean VO\textsubscript{2peak} value) [ramp values greater than step values in four patients]; in five of these patients, it was > 200 mL (ramp values greater than step values in three patients).

Although there were no significant differences between the peak values for breathlessness and perceived exertion, there were significant differences between the unit rate of change in the Borg scores (Table 3). The type of symptom and number of patients reporting it as the primary symptom for stopping exercise at the end of each protocol were leg fatigue (8 ramp, 12 step), breathlessness (7 ramp, 6 step), breathlessness and leg fatigue (3 ramp, 0 step), and general fatigue (4 ramp, 4 step).

The female patients achieved significantly higher ramp WRs and exercise times (mean [SD] of 89.4 [22.8] W and 8.7 [2.1] min) compared to 1-min step (83.5 [23.6] W and 7.8 [2.2] min); mean difference (± 2 SD) was 5.9 W (± 7.3 W, +19.1 W) and 0.9 min (+0.02 min, +1.8 min), respectively. For the male patients, the ramp WR\textsubscript{peak} was slightly higher, 128 (38) W vs 124 (34) W, but the differences did not reach significance (p = 0.22). The individual WRs achieved for male and female patients are shown in Figure 2. The higher ramp WR in women was supported by a slightly greater mean VO\textsubscript{2peak}, 1.21 (0.27) L/min vs 1.16 (0.28) L/min; however, the difference was not significant (p = 0.20). The male patients achieved a small but significantly longer ramp time, 7.8 (1.9) min vs 7.3 (1.6) min, with insignificant differences in VO\textsubscript{2peak}, 1.76 (0.40) L/min vs 1.77 (0.31) L/min, respectively.

The gas exchange AT was measured by the V-slope method\textsuperscript{14} from the graphical printouts of VO\textsubscript{2} vs carbon dioxide output recorded during every exercise test. Using this method, an AT was detected in 17 patients from both the ramp and the step protocols, in 3 patients from the step protocol only, and in 2 patients from the ramp protocol only. Thus, neither protocol was superior for the detection of the

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**Table 1—Baseline Demographics, Lung Function, and Borg Breathlessness Score at Rest**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Whole Group (n = 22)</th>
<th>Women (n = 10)</th>
<th>Men (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>59 (7.7)</td>
<td>61 (8.1)</td>
<td>58 (7.4)</td>
</tr>
<tr>
<td>Height, m</td>
<td>1.68 (0.09)</td>
<td>1.62 (0.07)</td>
<td>1.72 (0.08)</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>74.2 (15.4)</td>
<td>63.2 (12.2)</td>
<td>83.3 (11.4)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>26.2 (3.9)</td>
<td>23.8 (3.4)</td>
<td>28.2 (3.1)</td>
</tr>
<tr>
<td>FEV\textsubscript{1}, L</td>
<td>2.06 (0.79)</td>
<td>1.66 (0.64)</td>
<td>2.40 (0.76)</td>
</tr>
<tr>
<td>FEV\textsubscript{1}, % predicted</td>
<td>71 (21)</td>
<td>63 (22)</td>
<td>77 (19)</td>
</tr>
<tr>
<td>FVC, L</td>
<td>3.07 (0.76)</td>
<td>2.62 (0.58)</td>
<td>3.45 (0.69)</td>
</tr>
<tr>
<td>FVC, % predicted</td>
<td>86 (14)</td>
<td>83 (9.1)</td>
<td>88 (17)</td>
</tr>
<tr>
<td>Borg BS at rest</td>
<td>1.0 (1.1)</td>
<td>1.1 (1.2)</td>
<td>0.9 (1.2)</td>
</tr>
</tbody>
</table>

*Data are presented as mean (SD) range. BS = breathlessness score.
AT using the V-slope method. The mean values for the $\dot{V}O_2$ at AT were 1.06 (0.25) L for the ramp protocol and 1.05 (0.22) L for the step protocol ($p > 0.05$). The rate of $\dot{V}O_2$ per watt of work achieved was 10.06 (1.37) mL/min/W for the ramp protocol and 10.79 (1.77) mL/min/W for the step protocol ($p < 0.05$).

**Discussion**

This study has compared the ramp and the 1-min step cycle protocols in patients with exertional breathlessness and determined the limits of agreement between the peak values of $\dot{V}O_2$, $\dot{V}E$, and HR. The group mean differences between protocols for the peak physiologic variables were small (<10%) and nonsignificant, indicating that there was no systematic variance between protocols. The group did not consistently achieve higher values on any one protocol; however, for a number of individuals, the agreement between values of $\dot{V}O_2$ peak was poor ($>200$ mL [13%] for five patients), and greater than published values of between-day variability for patients with COPD and restrictive lung disease. Thus, for individual patients, the two types of protocol are not interchangeable.

Our findings are consistent with other studies that compared peak physiologic responses between ramp and step cycle protocols in a range of subject groups and found no major differences. Myers et al recorded significantly lower $\dot{V}O_2$ peak values during a 25-W, 2-min stepped protocol compared to a ramp protocol and a 50-W step protocol (17.7 mL/min/kg vs 18.5 mL/min/kg vs 18.1 mL/min/kg, respectively) in a mixed group of normal subjects and patients with heart disease. HRpeak and $\dot{V}E$ peak were not significantly different between cycle protocols. The authors concluded that the differences were not major, but the ramp protocols (for both cycle and treadmill) were superior for predicting $\dot{V}O_2$ from WR. Matthys et al recorded no significant differences between the ramp and the step-wise James protocol for $\dot{V}O_2$ peak (2.62 L/min vs 2.64 L/min), $\dot{V}E$ peak (88 L/min vs 87 L/min), and HRpeak (181 beats/min vs 179 beats/min) in 20 young adults. In the most recent study, a ramp protocol was compared to four high-intensity, constant WR tests in 10 sedentary, elderly males (>60 years old). The size of difference between the mean values of $\dot{V}O_2$ peak from each of the five protocols was small and nonsignificant and, though not calculated, the difference appears similar to the mean difference of 20 mL detected in the current study.

There was a significant difference in the WRpeak and exercise time achieved by the female patients. Matthys et al also found higher peak power when comparing the ramp protocol with the James step protocol in young people. The higher WRpeaks achieved with the ramp protocol were likely to be the result of some patients being able to achieve intermediate WRs but unable to cycle at the next incremented WR of the step protocol. This would also explain the significantly higher ramp times. The longer exercise times also influenced the calculation of the rate of change in exercise Borg scores. There were no differences in the peak Borg values, confirming that patients exercised to the same level of subjective stress. However, the slower rate of symptom development during the ramp exercise suggests that the small and continuous increase in external work modified the perception of exercise. The achievement of higher ramp WRpeaks may have implications for the prescription of exercise training, where the training is based on a percentage of the maximum WR achieved. Additionally the slower rate of change in perceived symptoms with the ramp may make an exercise test more acceptable for the individual. Further studies investigating the use of the ramp protocol to advise in the prescription of exercise may be warranted.

Some patients did not manage to exercise for >8 min. The optimum time scale to achieve the highest

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ramp Protocol</th>
<th>Step Protocol</th>
<th>Mean Difference ($\pm 2$ SD)</th>
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</thead>
<tbody>
<tr>
<td>$\dot{V}O_2$peak, L/min</td>
<td>1.51 (0.44)</td>
<td>1.49 (0.43)</td>
<td>0.02 (± 0.29, + 0.33)</td>
</tr>
<tr>
<td>$\dot{V}E$peak, L/min</td>
<td>50.8 (12.9)</td>
<td>49.9 (14.5)</td>
<td>0.9 (± 12.1, + 14.0)</td>
</tr>
<tr>
<td>HRpeak, beats/min</td>
<td>133 (24)</td>
<td>131 (22)</td>
<td>1.4 (± 14.8, + 17.6)</td>
</tr>
<tr>
<td>WR, W</td>
<td>110.5 (37.1)</td>
<td>105.6 (35.6)</td>
<td>4.91 (± 13.3, + 23.1)</td>
</tr>
<tr>
<td>Time, min</td>
<td>8.2 (2.0)</td>
<td>7.6 (1.9)</td>
<td>0.71 (± 0.5, + 1.9)</td>
</tr>
<tr>
<td>Borg BS</td>
<td>7 (2)</td>
<td>7 (2)</td>
<td>0.1 (± 3.38, + 3.58)</td>
</tr>
<tr>
<td>Borg PE</td>
<td>16 (2)</td>
<td>17 (2)</td>
<td>0 (± 3.38, + 3.38)</td>
</tr>
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</table>

*Data are presented as mean (SD) unless otherwise indicated. PE = perceived exertion. See Table 1 for expansion of other abbreviation. *$p < 0.05.$
VO₂ has been found to be 8 to 17 min.¹⁰ Tests shorter or longer than this period can lead to a 5 to 10% reduction in the VO₂peak measurement.¹⁰ In the current study, the WR increment was calculated for each individual and allowances were made for habitual activity and reduced lung function. A WR increment of 10 W was used for 9 of the 10 female patients; 15-W and 20-W increments were used for the male patients (9 patients and 3 patients, respectively). Choosing an appropriate WR increment is always difficult, although a previous study²⁰ attempted to derive a prediction equation using baseline respiratory function data using the prediction equation. Pretto et al²⁰ reported a reduction in the number of tests of inadequate duration (< 8 min) compared to using a fixed WR increment of 15 W for all patients. The reduced exercise times in some patients lead us to suggest that more use is made of lower WR increments, eg, 5 W/min, 7.5 W/min, and 12.5 W/min, etc, and that a fixed WR increment for all should be avoided.

In early work, the oxygen cost of aerobic cycle exercise was reported to be approximately 10.0 to 10.5 mL/min/W.²¹ More recent studies have demonstrated that the size of the WR increment influences the oxygen cost of cycle exercise but that the pattern of the increment does not have a major effect as long as the overall WR is the same.⁷ Hansen et al²² reported values of 11.2 mL/min/W, 10.2 mL/min/W, and 8.8 mL/min/W for WR increments of 15 W/min, 30 W/min, and 60 W/min, respectively. The authors postulate that there was a greater anaerobic component in the shorter 60-W/min test. Testing a group of eight sedentary male patients, Zhang et al⁷ reported values of 9.77, 10.36, 9.88, and 9.80 mL/min/W, respectively, for ramp, 1-min, 2-min, and 3-min step protocols. In the current study, the values for the 1-min step protocol were slightly, although significantly, higher compared to the ramp protocol (10.79 mL/min/W vs 10.06 mL/min/W). We can only speculate that the difference may be related to differences in the VO₂ kinetics with the two patterns of WR increments, but this issue can only be resolved with further investigation.

In conclusion, there were no significant differences between the mean peak physiologic values of VO₂, VE, and HR. The mean differences were < 10%, indicating there was no systematic variance between the protocols. However, the agreement was

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ramp Protocol</th>
<th>Step Protocol</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΔBS/min</td>
<td>0.69 (0.31)</td>
<td>0.80 (0.28)</td>
<td>0.022</td>
</tr>
<tr>
<td>ΔPE/min</td>
<td>0.95 (0.39)</td>
<td>1.16 (0.36)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*Data are presented as mean (SD) unit change in Borg scores from unloaded pedaling to the peak score for breathlessness and perceived exertion; see Tables 1, 2 for expansion of abbreviations.
poor for a number of individual patients, indicating that the protocols are not interchangeable. The comparison of the exercise protocols was in an elderly patient group with a range of symptomatic respiratory disorders, which to our knowledge has not been investigated previously. The findings from this study therefore add to the knowledge concerning the use of the cycle ramp protocol in a range of subject groups, which includes young adults, normal adults, male patients with cardiac disease, and sedentary, elderly men. The slightly longer ramp exercise times and slower rates of change in breathlessness and perceived exertion suggest that the continuous changing WR profile of the ramp protocol is perceived to be less demanding and might be more readily tolerated by this patient group. The higher ramp WRpeak may be important for exercise prescription, where a percentage of the maximum achieved is prescribed as part of a training program. In terms of peak physiologic capacity, our findings support the European guidelines that state either a ramp protocol or a 1-min step protocol can be used for the respiratory exercise test, and the final choice of protocol remains one of laboratory preference.

APPENDIX
1. Equation to calculate WR increments (from Wasserman et al11).
   (a) Estimate $V_{O_2}$ unloaded in milliliters per minute: $150 + (6 \times \text{body weight in kilograms})$
   (b) Estimate maximum $V_{O_2}$ in milliliters per minute: (height in centimeters – age in years) $\times$ 20 for sedentary men and $\times$ 14 for sedentary women
   (c) The WR watt increment per minute: (maximum $V_{O_2} - V_{O_2}$ unloaded)/100
2. Standardized explanation of Borg scales (from Belman et al13). Modifications from the original are shown in italics.
   The Borg score is an indicator of the severity of your breathlessness. The scale ranges from 0 to 10 where the value of 0 represents nothing at all or no discomfort with your breathing and a score of 10 means that the intensity of the breathlessness is maximal. Imagine a situation or past experience that has caused the worst breathlessness for you—an equivalent sensation would represent a score of 10 on this scale. You will be asked at rest and every 2 min of the exercise test to point with your finger to a Borg rating between 0 and 10 which should represent your level of breathlessness at that moment.

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