Validation of the OMNI-Cycle Scale of Perceived Exertion in the Elderly

Laura Guidetti, Antonio Sgadari, Cosme F. Buzzachera, Marianna Broccatelli, Alan C. Utter, Fredric L. Goss, and Carlo Baldari

This study examined the concurrent and construct validity of the OMNI-Cycle Rating of Perceived Exertion (RPE) Scale, using elderly men and women. Seventy-six participants performed a load-incremented cycle-ergometer exercise test. Concurrent validity was determined by correlating OMNI-RPE responses with oxygen uptake, relative peak oxygen uptake, pulmonary ventilation, heart rate, respiratory rate, and respiratory-exchange ratio during a load-incremented cycle-ergometer protocol. Construct validity was established by correlating RPE derived from the OMNI-Cycle Scale with RPE from the Borg (6–20) Scale. Multilevel, mixed linear-regression models indicated that OMNI-RPE distributed as a significant \( p < .05 \) positive linear function \( (r = .81–.92) \) for all physiological measures. OMNI-RPE was positively \( p < .01 \) and linearly related to Borg-RPE in elderly men \( (r = .97) \) and women \( (r = .96) \). This study demonstrates both concurrent and construct validity of the OMNI-Cycle RPE Scale. These findings support the use of this scaling metric with elderly men and women to estimate RPE during cycle-ergometer exercise.

**Keywords:** RPE, concurrent and construct validity, Borg Scale, OMNI Scale, oxygen consumption, heart rate

Perceived exertion is defined as the ability to detect and respond to sensations that arise from the body during exercise (Noble & Robertson, 1996). The cognitive awareness of these sensations is considered a form of feedback in which central, peripheral, and metabolic changes occurring during exercise are integrated (Pfeiffer, Pivarnik, Womack, Reeves, & Malina, 2002). In a pioneering work, Borg (1962) developed and validated a psychophysical scale to quantify exertional perceptions associated with a wide range of exercise intensities, and, thereafter, the Borg Rating of Perceived Exertion (RPE) Scale (Borg-RPE, 6–20) has been widely used in clinical settings around the world.
The OMNI-Cycle Scale for Elderly Adults (Robertson, Goss, & Metz, 1998). The Borg-RPE Scale is routinely used to quantify subjective feelings of fatigue and exercise tolerance during submaximal (Noble & Robertson, 1996) and maximal exercise (Doherty, Smith, Hughes, & Collins, 2001) and to prescribe exercise intensity for the maintenance of cardiovascular fitness in both healthy (Dishman, 1994; Dunbar & Kalinski, 2004) and diseased populations (Gutmann, Squires, & Pollock, 1981; Morrison et al., 2008).

The Borg Scale has been used to measure exertional perceptions in pediatric populations (Lamb, 1995; Lamb & Eston, 1997; Pfeiffer et al., 2002). However, the use of an adult-formatted scale in this population raised a series of methodological and semantic issues (Robertson & Noble, 1997). Some children could not consistently assign numbers to words or phrases that describe exercise-related feelings, and many younger children have difficulty interpreting certain scale descriptors (Williams, Eston, & Stretch, 1991). To solve this problem, Robertson, Goss, et al. (2000) developed a scale of perceived exertion that contains both mode-specific pictorials and verbal descriptors positioned along a numerical range from 0 to 10, so that the “exertional meaning of each pictorial descriptor is consonant with its verbal descriptor” (p. 452). This scale was called the OMNI Scale of Perceived Exertion (OMNI-RPE), and, to date, it is considered more reliable and valid than the Borg-RPE scale for use in pediatric populations (Pfeiffer et al., 2002; Robertson, Goss, et al., 2000; Utter, Robertson, Nieman, & Kang, 2002).

Recent studies have demonstrated that the OMNI-RPE Scale is also valid for use in adult populations in different modes of exercise (Robertson et al., 2004; Robertson et al., 2003; Robertson, Moyna, et al., 2000; Utter et al., 2004). However, all of those studies were conducted exclusively in young-adult populations (18–32 years). Thus, the question arises whether the OMNI-RPE Scale can be used with elderly individuals. The perception of exertion can be considered a cognitive function that reflects the progressive aging process. The cognitive decline with aging (Spirduso, 1995) could decrease the ability to consistently assign numbers to words or even pictures that describe exercise-related feelings (Dunbar & Kalinski, 2004; Grosolambert & Mahon, 2006; Shigematsu, Ueno, Nakagaichi, Nho, & Tanaka, 2004). Therefore, the purpose of this investigation was to examine concurrent and construct validity of the OMNI-RPE Scale (Robertson et al., 2004) during cycle-ergometer exercise in elderly subjects (>60 years). Because gender may affect the way physical exertion is perceived (O’Connor, Poudevigne, & Pasley, 2002; Robertson et al., 1998), validation of the OMNI Scale was carried out separately for men and women.

**Methods**

**Participants**

Seventy-six elderly men (n = 34) and women (n = 42) volunteered as subjects. Their characteristics are presented in Table 1. Subjects underwent a preliminary physical examination conducted by a senior physician and did not present any contraindications to maximal-exercise testing. Informed, written consent was obtained from each subject. The experimental protocol was designed
Experimental Design

This study used a cross-sectional, perceptual estimation paradigm administered during a single, maximal graded-exercise test performed on a cycle ergometer. Each subject underwent one orientation and one estimation trial. All were tested in a 3-hr postprandial state and were asked not to consume alcohol or participate in physical activity during the 24 hr preceding each trial.

Both concurrent and construct paradigms were used to determine validity of the OMNI-RPE Scale. A concurrent validation paradigm employs a two-variable scheme: a criterion (i.e., stimulus) variable and a concurrent (i.e., response) variable. Oxygen uptake (VO₂), relative maximal oxygen uptake (%VO₂peak), pulmonary ventilation (VE), respiratory rate, respiratory-exchange ratio, and heart rate (HR) responses to a load-incremented cycle-ergometer protocol served as criterion variables, whereas the OMNI-RPE Scale for the overall body was the concurrent variable. Evidence of concurrent validity was a significant positive correlation greater than .50 (Cohen, 1988) between criterion and concurrent variables when examined over the entire perceptual-physiological range.

Construct validity was determined by correlating the OMNI Scale with the 6–20 Borg Scale (Borg, 1982). An Italian version of each scale was employed. In this paradigm, RPE was the construct variable. Given that the 6–20 Borg Scale has been considered the most common and valid perceptual scaling metric during exercise for many populations, regardless of age, this scale was the criterion metric. The OMNI Scale was the conditional metric. A significant positive correlation (i.e., \( r > .50 \); Cohen, 1988) demonstrates that the conditional metric measures the same perceptual construct as the criterion metric.

Table 1  Characteristics of Elderly Men and Women and Selected Physiological Responses to Maximal Exercise, \( M \pm SD \)

<table>
<thead>
<tr>
<th></th>
<th>Men (n = 34)</th>
<th>Women (n = 42)</th>
</tr>
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<tbody>
<tr>
<td>Age (years)</td>
<td>69.8 ± 5.6</td>
<td>68.6 ± 5.9</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>78.4 ± 12.0</td>
<td>68.2 ± 13.6*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.1 ± 7.1</td>
<td>159.3 ± 5.9*</td>
</tr>
<tr>
<td>Body-mass index (kg/m²)</td>
<td>27.0 ± 3.4</td>
<td>26.8 ± 4.9</td>
</tr>
<tr>
<td>Oxygen uptake (ml/min)</td>
<td>1,990.6 ± 509.7</td>
<td>1,448.9 ± 335.2*</td>
</tr>
<tr>
<td>Carbon dioxide production (ml/min)</td>
<td>2,199.4 ± 531.9</td>
<td>1,580.4 ± 340.0*</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>142.5 ± 16.0</td>
<td>147.3 ± 12.2</td>
</tr>
<tr>
<td>Pulmonary ventilation (L/min)</td>
<td>79.1 ± 16.6</td>
<td>57.9 ± 11.0*</td>
</tr>
<tr>
<td>Respiratory rate (breaths/min)</td>
<td>39.8 ± 7.4</td>
<td>37.5 ± 7.6</td>
</tr>
<tr>
<td>Respiratory-exchange ratio</td>
<td>1.12 ± 0.16</td>
<td>1.10 ± 0.09</td>
</tr>
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</table>

*\( p < .01 \) between genders.
Anthropometric Measures

Weight (nearest 0.01 kg.) and height (nearest 0.1 cm.) were measured according to the techniques described by Gordon, Chumlea, and Roche (1988). Body-mass index (kg/m) was calculated as weight/height².

Orientation Trial

During the orientation trial, subjects were familiarized with cycle-ergometer exercise testing and both of the RPE scales. The familiarization exercise test was conducted according to the protocol proposed by Wassermann, Sue, and Hansen (2004), which consisted of a 3-min warm-up stage with unloaded pedaling followed by a 1-min stage with a 20-W load. Subsequent increases in power output were made every minute. The magnitude of these increases in power output depended on subject age, gender, height, and weight and ranged from 5 to 20 W (Wassermann et al., 2004). The familiarization test was conducted until volitional fatigue was reached. Thereafter, a 5-min recovery stage with a 20-W load was carried out. Subjects were instructed regarding the use of both RPE scales immediately before the familiarization exercise test and practiced estimating overall-body RPE during the final 15 s of each stage (a more complete explanation is presented in the “RPE” section).

Estimation Trial

During the estimation trial, subjects performed a progressive incremental test on a cycle ergometer (Sensormedics, Italy) using the previously described protocol (Wassermann et al., 2004). The incremental test was terminated when the participant volitionally stopped exercise because of fatigue or shortness of breath or could not maintain the designated pedal rate for 10 consecutive seconds. A pedal rate of 60 rpm signaled by an electronic metronome was used for all stages of the exercise testing. The power output was set by an investigator at the beginning of each stage, and the subjects were masked to the actual power output. RPE derived from both scales and cardiorespiratory responses were measured throughout the exercise test (a more complete explanation is presented in the “RPE” and “Cardiorespiratory and Aerobic Metabolic Measures” sections). Although this exercise protocol involves stages that are not long enough to achieve a physiological steady state, thus reflecting perceptual responses from a transitional period, it allows measures to be obtained across the entire psychophysiological range. Moreover, because the participants in this study were elderly men and women, larger workload increments or longer test duration may have reduced the safety, as well as quality, of the maximal-exercise test (Huggett, Connelly, & Overend, 2005).

Cardiorespiratory and Aerobic Metabolic Measures

HR (beats/min) was recorded throughout both familiarization and progressively incremented exercise tests using a standard 12-lead ECG (Quark T12, Cosmed, Italy). $V_E$ (L/min), $VO_2$ (ml/min), $VCO_2$ (ml/min), respiratory rate (breaths/min), and respiratory-exchange ratio were measured breath by breath throughout the progressively incremented exercise test. Participants breathed through a low-resistance transducer (K4b², Cosmed, Italy), which had a dead space of 60 ml,
and gas-exchange parameters were calculated and displayed breath by breath after accounting for the delay between the volume and concentration signals. The volume transducer was calibrated before each test with a 3-L calibration syringe according to the manufacturer’s instructions. The gas analyzers were calibrated using room air (21% oxygen, 0.03% carbon dioxide) and a certified gas mixture (16% oxygen, 5% carbon dioxide; Scott Medical Products, Plumsteadville, PA, USA) before each test. Data collected on a breath-by-breath basis were transferred to a PC for further analysis. Occasional errant breaths caused by swallowing, coughing, sighing, and so forth, which were considered not to be reflective of the underlying physiological response, were excluded. Average cardiorespiratory and aerobic metabolic responses during the final 15 s of each stage of the progressively incremented exercise test were used in the analyses.

**RPE**

An undifferentiated RPE was estimated for the overall body using both the 1982 version of the 6–20 Borg-RPE Scale and the OMNI-Cycle RPE Scale (Robertson et al., 2004). A standard definition of perceived exertion (i.e., subjective intensity of effort, strain, discomfort, and fatigue felt during exercise; Noble & Robertson, 1996) and separate instructional sets for the Borg and OMNI scales were read to the subjects immediately before the orientation and estimation trials. The instructional set for the 15-category Borg scale has been published previously (Robertson, Moyna, et al., 2000). The instructions for the OMNI Scale were as follows:

> We would like you to ride on a bicycle ergometer. Please use the numbers on this scale to tell us how your body feels when bicycling. Look at the person at the bottom of the hill who is just starting to ride a bicycle. If you feel like this person when you are riding, the exertion will be Extremely Easy. In this case, your rating should be a zero. Now look at the person who is barely able to ride a bicycle to the top of the hill. If you feel like this person when riding, the exertion will be Extremely Hard. In this case, your rating should be a number 10. If you feel somewhere between Extremely Easy (0) and Extremely Hard (10) then give a number between 0 and 10. We will ask you to point to a number that tells how your whole body feels. Remember, there are no right or wrong numbers. Use both the pictures and words to help you select a number. Use any of the numbers to tell how you feel when riding the bicycle. (Robertson et al., 2004, p. 104)

The Borg-RPE and OMNI-RPE scales were viewed separately by the subject when their respective instructional set was read.

Subjects were anchored to both scales using a combination of exercise (Robertson, Moyna, et al., 2000) and memory (Robertson, Goss, et al., 2000) procedures during the orientation trial. The OMNI procedure requires a subject to cognitively establish a perceived intensity of exertion that is consonant with that depicted visually by the figure cycling at the bottom (i.e., low anchor, rating 0) and top (i.e., high anchor, rating 10) of the hill as presented in the OMNI-Scale illustrations. During the estimation trial, the Borg and OMNI scales were in full view of the subjects at all times of the progressively incremented exercise test. In a counterbalanced manner, subjects were asked to point to the number on either the Borg or the OMNI...
scale during the final 15 s of each stage of the test that corresponded to their overall feeling of exertion. After the first RPE was obtained from either scale, within 10 s the subjects were asked to rate their perceived exertion from the alternate scale.

**Statistical Analysis**

Descriptive data for the perceptual, cardiorespiratory, and aerobic metabolic variables were expressed as $M \pm SD$. Independent $t$ tests were employed to examine gender differences in anthropometric variables and maximal cardiorespiratory and aerobic metabolic responses. Significance was set at $p < .05$. All descriptive data were analyzed using SPSS 17.0 for Windows (SPSS, Inc., Chicago, IL, USA). Evidence for both concurrent and construct validity was determined using multilevel, linear, mixed-model analysis (MLwiN 2.19, University of Bristol, Bristol, UK), with stage and subject at Levels 1 and 2, respectively. The mixed-model analysis fits a linear trend line for each subject and does not require data for each stage, maximizing the use of the available data, so data from all stages performed by each subject were included in the analyses. When testing concurrent validity, the analysis separately regressed cardiorespiratory and aerobic metabolic variables against OMNI-RPE and Borg-RPE scales. When testing construct validity, the analysis regressed OMNI-RPE against Borg-RPE. All regression analyses were carried out separately for the men and the women.

**Results**

**Descriptive Responses**

Listed in Table 1 are the means and standard deviations for selected maximal cardiorespiratory and aerobic metabolic responses, in addition to subject descriptive characteristics. Weight, height, VO$_2$, VCO$_2$, and $V_E$ differed between genders ($p < .01$).

**Concurrent Validity: OMNI-Cycle RPE Scale**

Multilevel, mixed-model analysis showed that for both elderly men and women, the RPEs from the Borg and OMNI scales distributed as significant ($p < .05$) positive linear functions of HR, VO$_2$, %VO$_2$peak, $V_E$, respiratory rate, and respiratory-exchange ratio (Table 2).

**Construct Validity: OMNI-RPE Versus Borg-RPE Scale**

Multilevel, mixed-model analysis indicated that the RPEs from the OMNI Scale were positively related ($p < .01$) to the RPEs from the Borg Scale in both men and women (Figure 1).

**Discussion**

The pictorial format of the OMNI-Cycle RPE Scale was validated using both a concurrent and a construct paradigm for elderly men and women. Validation criteria stipulated that during the progressively incremented exercise test, (a) RPE derived...
<table>
<thead>
<tr>
<th></th>
<th>Intercept</th>
<th>Slope</th>
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<tr>
<td></td>
<td>Borg</td>
<td>OMNI</td>
<td>Borg</td>
<td>OMNI</td>
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<td>OMNI</td>
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<tr>
<td><strong>Men</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>$-5.563 (0.959)$</td>
<td>$-9.643 (0.785)$</td>
<td>$0.174 (0.008)$</td>
<td>$0.135 (0.007)$</td>
<td>$.92$</td>
<td>$.91$</td>
</tr>
<tr>
<td>VO₂</td>
<td>$2.780 (0.601)$</td>
<td>$-3.183 (0.411)$</td>
<td>$0.008 (0.001)$</td>
<td>$0.006 (0.000)$</td>
<td>$.90$</td>
<td>$.89$</td>
</tr>
<tr>
<td>%VO₂peak</td>
<td>$2.598 (0.628)$</td>
<td>$-3.313 (0.433)$</td>
<td>$0.154 (0.006)$</td>
<td>$0.122 (0.005)$</td>
<td>$.93$</td>
<td>$.92$</td>
</tr>
<tr>
<td>VE</td>
<td>$5.941 (0.486)$</td>
<td>$-0.621 (0.323)$</td>
<td>$0.173 (0.009)$</td>
<td>$0.135 (0.007)$</td>
<td>$.90$</td>
<td>$.89$</td>
</tr>
<tr>
<td>RR</td>
<td>$2.261 (0.772)$</td>
<td>$-3.443 (0.597)$</td>
<td>$0.437 (0.026)$</td>
<td>$0.337 (0.020)$</td>
<td>$.83$</td>
<td>$.82$</td>
</tr>
<tr>
<td>RER</td>
<td>$-11.133 (1.203)$</td>
<td>$-14.358 (1.040)$</td>
<td>$26.472 (1.422)$</td>
<td>$21.170 (1.282)$</td>
<td>$.86$</td>
<td>$.85$</td>
</tr>
<tr>
<td><strong>Women</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>$-8.911 (1.262)$</td>
<td>$-11.293 (0.933)$</td>
<td>$0.190 (0.009)$</td>
<td>$0.142 (0.007)$</td>
<td>$.91$</td>
<td>$.91$</td>
</tr>
<tr>
<td>VO₂</td>
<td>$1.957 (0.662)$</td>
<td>$-3.272 (0.551)$</td>
<td>$0.011 (0.001)$</td>
<td>$0.009 (0.000)$</td>
<td>$.90$</td>
<td>$.89$</td>
</tr>
<tr>
<td>%VO₂peak</td>
<td>$1.387 (0.734)$</td>
<td>$-3.655 (0.598)$</td>
<td>$0.171 (0.007)$</td>
<td>$0.128 (0.006)$</td>
<td>$.91$</td>
<td>$.90$</td>
</tr>
<tr>
<td>VE</td>
<td>$6.183 (0.489)$</td>
<td>$-0.086 (0.425)$</td>
<td>$0.229 (0.009)$</td>
<td>$0.170 (0.007)$</td>
<td>$.91$</td>
<td>$.91$</td>
</tr>
<tr>
<td>RR</td>
<td>$1.432 (0.803)$</td>
<td>$-3.727 (0.696)$</td>
<td>$0.487 (0.028)$</td>
<td>$0.365 (0.022)$</td>
<td>$.82$</td>
<td>$.81$</td>
</tr>
<tr>
<td>RER</td>
<td>$-12.679 (1.225)$</td>
<td>$-14.443 (1.083)$</td>
<td>$28.048 (1.173)$</td>
<td>$21.285 (1.101)$</td>
<td>$.89$</td>
<td>$.87$</td>
</tr>
</tbody>
</table>

*Note.* HR = heart rate; VO₂ = oxygen uptake; %VO₂peak = relative peak oxygen uptake; VE = ventilation; RR = respiratory rate; RER = respiratory-exchange ratio. Parameter estimate (standard error of the estimate). $p < .05$ for all variables.
from the OMNI Scale would distribute as a strong \((r > .50)\) positive linear function of selected cardiorespiratory and aerobic metabolic responses for both elderly men and women and (b) RPEs derived from the OMNI and Borg scales would be strongly \((r > .50)\) related.

**Concurrent Validity**

In a pioneering investigation, Borg (1962) employed a concurrent psychophysiological paradigm to validate a 21-category numerical-verbal scale to measure RPE. Since this initial investigation, concurrent paradigms employing selected cardiorespiratory variables as criterion measures have been accepted as a standard procedure when validating RPE category scales (Noble & Robertson, 1996; Robertson et al., 2004). In this study, RPE derived from the OMNI Scale distributed as a positive linear function of all selected cardiorespiratory variables during cycle-ergometer exercise. Validity coefficients derived from the various regression models ranged from \(r = .81\) to \(r = .92\).

These findings of a strong positive relation between the OMNI-RPE Scale and selected cardiorespiratory variables are in agreement with the results of previous studies that used a concurrent psychophysiological paradigm to validate the OMNI-Cycle RPE Scale in both youth (Robertson, Goss, et al., 2000) and adults (Robertson et al., 2004). Indeed, in a recent investigation conducted by Robertson et al. (2004) to establish concurrent validity of the adult format of the OMNI-Cycle RPE Scale, a strong and linear relation was found between RPE and VO\(_2\) and HR \((r = .88\) and .83, respectively, \(p < .01\)). A strong positive linear relation between RPE measured by the OMNI pictorial system and cardiorespiratory variables was not only observed during submaximal cycle-ergometer exercise but also found during different weight-bearing (Utter et al., 2004; Utter et al., 2002) and non-weight-bearing (Robertson et al., 2005; Robertson et al., 2003) exercise modes in different populations.
It should be noted that this positive linear relation observed in the current study between the OMNI-RPE Scale and selected cardiorespiratory variables is consistent with Borg’s effort continua model (Borg, 1962, 1982), which states that as exercise intensity increases there is a linear increase in perceptual (i.e., RPE) and physiological (i.e., VO₂, HR, Vₑ, and respiratory rate) measures of intensity. This finding is in agreement with previous studies (Robertson, Goss, et al., 2000; Robertson et al., 2003; Utter et al., 2004; Utter et al., 2002) and indicates that the OMNI pictorial system is consistent with the assumptions of the Borg effort continua model not only for children, adolescents, and adults but also for elderly men and women.

**Construct Validity**

Construct validity of the OMNI-Cycle RPE Scale was established using the 6–20 version of the Borg-RPE Scale as the criterion metric. It was hypothesized that RPE derived from the OMNI Scale would be strongly and positively correlated with the Borg Scale when perceptual estimates from both metrics were obtained during the same incremental exercise test. The findings of the current investigation supported this hypothesis, establishing construct validity of the OMNI-RPE Scale for both genders. Validity coefficients between perceptual responses obtained from the two category scales were \( r = .97 \) among elderly men and \( r = .96 \) among elderly women. These results are consistent with those of the adult version of the OMNI-Cycle Scale, in which the validity coefficients ranged from \( r = .85 \) to \( r = .92 \) for RPE overall, RPE legs, and RPE chest (Robertson et al., 2004).

The comparatively high level of construct validity noted currently indicates that the OMNI-Cycle Scale measures the same exertional perceptual properties in elderly subjects as the Borg Scale during incremental exercise tests. In this manner, it might be suggested that elderly individuals may use the OMNI and Borg scales interchangeably to regulate and prescribe cycle-ergometer exercise. Moreover, the OMNI Scale is considered easier to use by subjects because the verbal descriptors are placed in juxtaposition with the pictorial descriptors, establishing a verbal-visual correspondence in exertion (Robertson et al., 2004).

In conclusion, the findings of this study provide both concurrent and construct evidence supporting the use of the OMNI Scale with elderly men and women to estimate RPE during an incremental cycle-ergometer exercise test. Concurrent validity demonstrated that the RPE measured by the OMNI Scale increased in a concurrent manner with the selected cardiorespiratory and aerobic metabolic responses during the graded exercise test in elderly subjects, which is consistent with Borg’s effort continua model. In addition, construct validity indicated that the OMNI-Cycle Scale measured the same perceptual construct (i.e., RPE) as a previously validated criterion scale (6–20 Borg-RPE Scale). This validity evidence broadens the scope of application of the OMNI-RPE pictorial system; that is, the use of the OMNI-Cycle Scale is possible not only among youth and adults, but it may also be extended to elderly subjects. Specifically, this is important because the elderly (a) may have a decreased ability to consistently assign numbers to words that describe exercise-related feelings, (b) are the fastest growing segment of the population in Western societies, (c) over the last decades have been increasingly engaging in regular physical activities, and (d) given the higher prevalence of chronic
conditions, often receive, or at least should receive, the prescription to exercise at a definite exercise intensity.

Acknowledgments

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References


