Relationship Between the Face Scale for Rating of Perceived Exertion and Physiological Parameters in Older Adults and Patients with Atrial Fibrillation

Satoshi Nashimoto (nathy740818@gmail.com)
  Niigata medical center  https://orcid.org/0000-0002-5620-8543

Shinichiro Morishita
  Niigata Iryo Fukushi Daigaku

Kazuki Hotta
  Niigata Iryo Fukushi Daigaku

Susumu Iida
  Niigata Medical Center

Atsuhiro Tsubaki
  Niigata Iryo Fukushi Daigaku

Research article

Keywords: Face scale, Elderly, Atrial fibrillation, Cardiopulmonary exercise test, Heart rate, Oxygen uptake, Aerobic threshold, Cut off

DOI: https://doi.org/10.21203/rs.3.rs-35481/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
  Read Full License
Abstract

Background: The Borg scale is used to determine exercise intensity in rehabilitation but can be difficult for older adults to understand. By contrast, face scale that are used to evaluate pain are much easier to understand thanks to the inclusion of illustrations. On the other hand, the prevalence of atrial fibrillation (AF) increases with age. We aimed to investigate the correlation between face scale for rating of perceived exertion (RPE) and various physiological parameters during cardiopulmonary exercise testing in older adults and AF patients. We also investigated the relationship between Face Scale and anaerobic threshold (AT).

Methods: Patients were asked to perform a ramp cardiopulmonary exercise test with an incremental increase in work rate (WR) of 10 watts/min, using a stationary bicycle until maximum fatigue. We recorded participant responses using a face scale for RPE compared with WR, heart rate (HR), oxygen uptake (VO₂), and minute ventilation (VE) every minute during the exercise test. We determined the AT by the V-slope method.

Results: We enrolled 90 sinus rhythm (SR) patients (74 men 16 women) and 22 AF patients. For SR men, SR women and AF, there were significant positive correlations between the face scale RPE and HR, VO₂, WR, and VE. There was no statistically significant differences difference in correlation coefficient between age and SR or AF. The cutoff value for AT of the Face Scale was “4” and it showed high sensitivity and specificity.

Conclusions: These results suggest that the face scale can be used to determine the intensity of physical exercise equivalent to AT unaffected by age, gender, SR or AF.

Background

Studies have shown that total daily physical activity levels are associated with cardiovascular death [1-3], with regular exercise known to be effective for the secondary prevention after myocardial infarction [4-8]. Physical activity is also an independent factor for the prognosis of patients with heart failure [9]. Therefore, it is important that patients with heart disease continue to exercise regularly.

Exercise intensity is typically rated using either the heart rate (HR) or the rating of perceived exertion (RPE) [10]. However, each method has problems when implemented with older adults. For example, HR can be unreliable in the presence of certain medications [11] or arrhythmias [12]. The most widely used RPE tool is the Borg scale, which has been shown to correlate with the HR and maximum oxygen uptake [13-15]. Although it is usually reliable, the Borg scale can be difficult for children and older adults to understand [16-18]. Many scales have been developed for use by children [16,19-21], yet there are few for older adults, especially those with morbidities. We therefore adapted a face scale that could be used to evaluate exercise levels [17].
Face scale are often used in the evaluation of pain [22]. A notable example is the Wong-Baker FACES Pain Rating Scale, which consists of a set of six faces that express different levels of distress. This scale is easy to understand because it is expressed as illustrations, making it useful for children or older adults with communication or cognitive issues[23-26]. We previously validated a modified version of the FACES scale for use as an exercise intensity evaluation index. Our findings indicated that there was a significant correlation between the modified FACES scale, HR, exercise load, and oxygen uptake (VO$_2$) in healthy college students [17]. However, we did not determine whether it was suitable for use with older adults or patients suffering from morbidity.

In contrast, the prevalence of atrial fibrillation (AF) increases with age. Research has shown that the prevalence of AF is 2.3%–4.0% among those aged 65–70 years and 7.3%–15.4% in those aged ≥80 years [27-31]. Considering population aging, the number of patients is expected to increase [30]. A case report has been published on PRE in AF cases [12] but few studies. The effect of exercise is also expected in AF cases [32,33], and the RPE for exercise prescription is important.

In this study, we aimed to investigate the correlation between our face scale for RPE and various physiological parameters during cardiopulmonary exercise testing in older adults and patients with AF. In addition, we aimed to investigate the relationship with the anaerobic threshold (AT).

**Methods**

**Study design**

This was a prospective observational study of patients with AF who were referred to Niigata Medical Center from June 2018 to March 2019.

We identified 184 patients with AF during the study period; of these, we enrolled 92 men and 20 women in sinus rhythm (SR). Patients were excluded if they used beta-blockers; if they had cardiac pacemakers or received dialysis; or if they were diagnosed with COPD25 or mental disease. In addition, electrocardiographic changes appeared during the exercise test in five patients [SR to paroxysmal atrial fibrillation (n = 1), SR to paroxysmal atrial flutter and to paroxysmal atrial tachycardia (n = 1), AF to SR (n = 1)]. It was difficult to measure the AT in one patient, and measurement failed in eight patients. Thus, 90 patients with sinus rhythm (SR, paroxysmal atrial fibrillation, 74 men and 16 women) and 22 patients with AF (22 men) were analyzed (Figure 1).

The study was approved by the Ethics Committee of Niigata Medical Center (Approval No.2018-04) and the Ethics Committee of Niigata University Health and Welfare Graduate School of Medicine (Approval No.17956-180313). Written informed consent to participate in the study was obtained from all patients.

**Clinical variables**
Peripheral blood samples were collected for the measurement of C-reactive protein level, hemoglobin (Hb) level, brain natriuretic peptide (BNP) level, estimated glomerular filtration rate (eGFR), and glycosylated hemoglobin (HbA1c) level, in addition to evaluating the left ventricular ejection fraction (LVEF) in the echocardiography. We investigated the complications of diabetes, hypertension, and smoking.

**Face scale**

A modified version of the FACES scale was used [17,22], as shown in Figure 2. This presents a set of six faces that express various levels of distress in a format that is easy to understand. The scale score ranges from 0 to 10 and includes numbers, face illustrations, and verbal expressions. Participants were asked to choose what best described their feelings at a given assessment point. At 1 min intervals during the exercise tests, participants were asked “How hard do you feel you are working?” and to rate their RPE on the face scale by pointing.

**Cardiopulmonary exercise tests (CPX)**

We measured HR, VO\(_2\), intensity of exercise (WR), and ventilation (VE) by CPX, using stationary bicycles (Wellbike BE-260; FUKUDA DENSNI, Tokyo, Japan). Participants began exercise tests with a 3 min rest in a sitting position before the warm-up phase of 3 min cycling at 10 W. They then cycled under a 10 W/min ramp load test until maximum fatigue was achieved. All subjects were instructed to maintain a cadence of 50 rotations per minute (rpm) throughout the CPX until they reached exhaustion. If a subject could not maintain at least 50 rpm, the CPX was discontinued. After test completion, a 3 min cool-down period of cycling at 10 W was completed by each participant.

During the CPX, HR was recorded by a 12-lead surface electrocardiogram (Stress Test System ML-6500; FUKUDA DENSNI, Tokyo, Japan). VO\(_2\), VE, and carbon dioxide emissions were measured by an exhaled gas analyzer (Cpex-1; Inter Reha, Tokyo, Japan). Each parameter was recorded every minute when the patients were asked to rate their RPE on the face scale. Additionally, we determined the anaerobic thresholds by the V-slope method during the CPX. And we calculated R(VCO\(_2\)/VO\(_2\)) at maximum load, VE/VCO\(_2\), PeakVO\(_2\)/HR and VO\(_2\)/WR.

**Statistical analysis**

All data analyses were performed in R (version 2.6.1) and a p-value of <0.05 was considered statistically significant. Correlation analyses were then performed based on gender group, the individual, and age, and are reported with 95% CI.

First, the patient characteristics and clinical variance were examined using the Shapiro–Wilk test and Levene's test, respectively. Two-sample t-test was used to analyze the data with normal distribution and equal variance. The Welch test was used to analyze the data with normal distribution and without equal
variance, and the Mann–Whitney U test was used to analyze the data without normal distribution. We compared the variables between men and women, between those aged ≥65 years and those aged <65 years, and between the SR and AF.

Second, Spearman's rank correlation coefficients (\(\rho\)) were calculated to evaluate the correlation between the face scale RPE and the HR, VO\(_2\), WR, and VE each minute during the exercise test, and comparing the correlation coefficient with less than 65 years of age or older, 65-year-old by gender and cardiac rhythm. Correlations between parameters were assessed using bivariate simple correlation analysis, with Spearman's rank correlation coefficient for non-parametric values.

Third, Spearman's rank correlation coefficients (\(\rho\)) were calculated to evaluate the correlation between the face scale RPE and the HR, VO\(_2\), WR, and VE each minute during the exercise test for individuals.

Fourth, receiver operating characteristic curve analysis was performed to determine the cut off value of the Face Scale for AT prediction. We determined the cutoff value, sensitivity, specificity, and area under the curve (AUC) of the Face scale.

**Results**

Additional file 1 shows the participant characteristics and clinical variables; Additional file 2 shows the CPX results. There were 37 men aged ≥65 years and 37 aged <65 years old. There were 10 women aged ≥65 years and 6 aged <65 years. Moreover, there were 22 patients with AF.

In men aged >65 years, the Hb, WR at AT, maximum VO\(_2\) and WR, peak VO\(_2\)/HR, and VO\(_2\)/WR were significantly lower, whereas BNP, R, and VE/VCO\(_2\) were significantly greater than those in men aged <65 years. In women, smoking rates, and maximum VO\(_2\) were significantly lower in those aged ≥65 years. In AF, Hb, BNP, HR of rest, AT and maximum, Maximum Face scale were significantly greater than SR of men. Peak VO\(_2\)/HR was significantly lower than SR of men.

There were significant positive correlations by gender between the face scale for RPE and the exercise test parameters. The correlation coefficient tended to decrease with increasing age, but there was no difference in the correlation coefficient between over the age of 65 years and older group and under the age of 65 years old group. There were no statistically significant differences between SR men (n=74) and AF men (n=22) (Additional file 3).

In addition, all correlation coefficients were significant for individuals (\(p < 0.05\)), and many cases showed a strong correlation of ≥0.8 at this level (Table 1).
Table 1
Correlation Analyses at an individual Level

|                  | Sinus Rhythm | Sinus Rhythm | Atrial Fibrillation |
|------------------|--------------|--------------|---------------------|
|                  | Men          | Women        |                     |
| ≥65 years old    | n = 37       | n = 37       | n = 10              |
| <65 years old    | n = 37       | n = 37       | n = 6               |
| HR               | 0.94         | 0.93         | 0.92                |
|                  | 0.88–0.97    | 0.91–0.96    | 0.88–0.95           |
| VO₂              | 0.93         | 0.93         | 0.92                |
|                  | 0.85–0.97    | 0.89–0.96    | 0.87–0.95           |
| WR               | 0.96         | 0.96         | 0.93                |
|                  | 0.88–0.97    | 0.92–0.97    | 0.90–0.96           |
| VE               | 0.94         | 0.93         | 0.92                |
|                  | 0.85–0.97    | 0.90–0.96    | 0.85–0.94           |

HR, heart rate; VO₂, oxygen uptake; WR, Work rate; VE, ventilation.

Results are shown as median (25%-75% value).

Correlation coefficients for all individuals were significant ($p < 0.05$).

On the Face Scale, the number of records below AT were 314 and the number of records above AT were 194 in men aged ≥65 years, men aged ≤65 years 337 and 222, women aged ≥65 years 67 and 29, women aged ≤65 years 39 and 24, AF 209 and 139.

In men aged ≥65 years, the cutoff value for the Face Scale score was 4; the sensitivity of the scale was 86.6% (95%CI: 81.1%–90.7%), the specificity was 79.6% (95%CI: 74.8%–83.7%), and the AUC was 0.90 ($p < 0.01$). In men aged <65 years, the cutoff value for the Face Scale was 4; the sensitivity of the scale was 90.0% (95%CI: 85.5%–93.3%), the specificity was 82.5% (95%CI: 78.1%–86.2%), and the AUC was 0.93 ($p < 0.01$). In women aged ≥65 years, the cutoff value for the Face Scale was 4, the sensitivity was 82.8% (95%CI: 65.5%–92.4%), the specificity was 80.6% (95%CI: 69.6%–88.3%), and the AUC was 0.87 ($p < 0.01$). In women aged <65 years, the cutoff value for the Face Scale was 4, the sensitivity was 87.5% (95%CI: 69.0%–95.7%), the specificity was 87.2% (95%CI: 73.3%–94.4%), and the AUC was 0.91 ($p < 0.01$). In those with AF, the cutoff value of the Face Scale was 4, the sensitivity was 96.4% (95%CI: 91.9%–98.5%), the specificity was 80.9% (95%CI: 75.0%–85.6%), and the AUC was 0.96 ($p < 0.01$) (Figure 3).
Discussion

There is a need for a valid and easy to use scale that can accurately measure exercise intensity in older adults and AF patients. In this study, we showed that our previously modified face scale for RPE correlated significantly with HR, VO\textsubscript{2}, WR, and VE in older adults and AF patients. The most important finding was that based on AT, the cutoff value for the Face scale was 4, its sensitivity was 82.8%–96.4%, and specificity was 79.6%–87.2% in patients with AF. The Face scale is simple, and easy to understand for setting of exercise intensity for elderly and AF patients.

With respect to the blood test data, although Hb tended to be low in the elderly subjects and BNP tended to be higher in elderly and AF patients, there were no outliers [34,35], no cases of anemia, and no patients with heart failure symptoms. In few patients, there was decline in the LVEF and ventilation capacity (VE/VO\textsubscript{2}). Based on the results of CPX, the average R was 1.3–1.4, and the maximum intensity could be applied.

To date, the most widely used assessment tool for measuring RPE has been the Borg scale (Riebe et al., 2017), the validity of which has been evidenced by its high correlation with relevant physiological parameters. For example, the Borg scale has been shown to have a moderately high positive correlation between RPE and physiological variables such as HR, VO\textsubscript{2}, and VE [36,37]. A meta-analysis [38] further supported this correlation, reporting mean validity coefficients for the Borg scale with the HR, VO\textsubscript{2}, and VE of 0.62 (n = 3708), 0.63 (n = 332), and 0.61 (n = 357), respectively. Moreover, a recent cohort study stated that the correlation between HR and the Borg scale was 0.74 among 2560 large population [39].

The correlation coefficients between the face scale for RPE and the physiological parameters were positive in the present study among both men (0.58 for HR, 0.76 for VO\textsubscript{2}, 0.81 for WR, 0.72 for VE) and women (0.45 for HR, 0.63 for VO\textsubscript{2} and 0.75 for WR, 0.74 for VE). It was also noteworthy that we found no difference in the correlation coefficient when grouping by age older or younger than 65 years and SR or AF. In earlier research, we showed correlations between the face scale and these physiological measures of ≥0.8 in healthy college students [17]. Although the correlation coefficients among older adults were lower in this study especially in relation to HR. We consider that the influence of age on the HR response accompanying exercise was large [40]. In the grouping of this study, compared with previous studies targeting students, there is a range of ages of the subjects, the variance of the maximum HR was large, and the correlation coefficient was small. Moreover, no details about exercise habits were collected in this study. Training reportedly affects the HR response [41], and it is possible that exercise habits affected the HR response. Group-wise comparison of elderly patients showed that paying attention to the variation may be necessary. In AF patients, the HR response accompanying exercise is faster and higher due to a lower stroke volume [41]. In the AF-only group, the correlation between HR and Face Scale score remained unchanged.

Many reports have examined the correlations between physiological parameters and various scales for RPE at a group level [16,17,19-21,42-44]. However, when using this approach, there is a risk that the correlation coefficient will be lowered because individual affects the maximum value of the evaluation. In
a meta-analysis [38] of the relationship between RPE and physiological parameters, the authors reported that there was a negative correlation between the number of subjects and the resulting correlation coefficient. Methods for examining correlation in individuals were reported in one study for eight patients with Alzheimer's disease [45], and despite the sparsity of supporting reports, the method seems effective when dealing with the data of patients with various backgrounds. Therefore, to supplement the analysis at the group level, we examined the correlation coefficient at the individual level. This revealed higher correlations of HR, VO\textsubscript{2}, WR, and VE with the face scale (≥0.8 in most cases for both men and women). At least for individual, the face scale for RPE benefits from being illustrated and easy to understand, and we anticipate that its use will be unaffected by gender and age, SR of AF.

Our results showed that the cutoff value for the Face Scale was 4 “Somewhat Strong,” the sensitivity was 82.8%–96.4%, and the specificity was 79.6%–87.2%. If the Face Scale score during exercise is ≥4 (for example, 6, 8, or 10), it is highly possible that the exercise intensity exceeded the AT. A Borg scale score of 13 indicated “Somewhat Hard” and was considered the AT [39,46]; in the Face Scale, the same expression was the AT point. The AT point is important in exercise prescription because it suppresses the rise in lactic acid and catecholamine levels and can maintain exercise and the response of cardiac function with the exercise [47,48]. The Face Scale score can be used to prescribe an exercise intensity equivalent to the AT, irrespective of patient age and sex and presence of SR or AF.

**Limitations**

There are several limitations of this study. First, only AF cases were targeted, and the number of cases was small, especially in women. In the future, it is necessary to consider other heart diseases such as heart failure and ischemic heart disease. Second, in this study, there were many cases with relatively good cardiac function. Examination is necessary in cases of low cardiac function. Finally, the difference with the Borg scale cannot be clearly shown. In the ROF report developed as a fatigue scale in the previous research [49], it is said that the scales are easy to understand because of the descriptors and diagrams. In the future, we would like to examine the difference between Face Scale and Borg scale for more age groups.

**Conclusion**

In conclusion, we showed that there was a significant positive correlation between the face scale for RPE and the HR, VO\textsubscript{2}, WR, and VE during cardiopulmonary exercise test in older adults with AF for groups, especially individuals. For AT, the cutoff value of Face scale was “4” and its sensitivities were from 82.8% to 96.4% and specificities 79.6% to 87.2%. These results suggest that the face scale can be used to determine the intensity of physical exercise unaffected by gender and age, SR of AF.

**List Of Abbreviations**
Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Niigata Medical Center (Approval No.2018-04) and the Ethics Committee of Niigata University Health and Welfare Graduate School of Medicine (Approval No.17956-180313). Written informed consent to participate in the study was obtained from all patients.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

SN: The primary author oversaw writing the main parts of the manuscript, recruitment of participants, conducting the study, data collection and statistics. SN and SM designed the research question. SN and SI conducted the testing and data collections. SN, SM and KH analyzed the data. SM, KH, AT contributed to critical review of draft manuscripts and approved the final manuscript. All authors read and approved the final manuscript.
Acknowledgements

The authors would like to thank Cardiologists of Niigata medical center. Especially, we greatly appreciate all staff members of the Department of Rehabilitation, and Clinical Laboratory, Niigata Medical Center.

Authors' information (optional)

References

1. Paolillo S, Agostoni P, De Martino F, Ferrazzano F, Marsico F, Gargiulo P, et al. Heart rate during exercise: mechanisms, behavior, and therapeutic and prognostic implications in heart failure patients with reduced ejection fraction. Heart Fail Rev. 2018; 23(4): 537-545.

2. Brubaker PH, Kitzman DW. Chronotropic incompetence: causes, consequences, and management. Circulation. 2011; 123(9): 1010-1020.

3. Scherr J, Wolfarth B, Christie JW, Pressler A, Wagenpfeil S, Halle M. Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. Eur J Appl Physiol. 2013; 113(1): 147-155.

4. Chen MJ, Fan X, Moe ST. Criterion-related validity of the Borg ratings of perceived exertion scale in healthy individuals: a meta-analysis. J Sports Sci. 2002; 20(11): 873-899.

5. Swain DP, Leutholtz BC, King ME, Haas LA, Branch JD. Relationship between % heart rate reserve and % VO\textsubscript{2} reserve in treadmill exercise. Med Sci Sports Exerc. 1998; 30(2): 318-321.

6. Dorn JP, Cerny FJ, Epstein LH, Naughton J, Vena JE, Winkelstein W Jr, et al. Work and leisure time physical activity and mortality in men and women from a general population sample. Ann Epidemiol. 1999; 9(6): 366-373.

7. Noda H, Iso H, Toyoshima H, Date C, Yamamoto A, Kikuchi S, et al. Walking and sports participation and mortality from coronary heart disease and stroke. J Am Coll Cardiol. 2005; 46(9): 1761-1767.

8. Inoue M, Iso H, Yamamoto S, Kurahashi N, Iwasaki M, Sasazuki S, et al. Daily total physical activity level and premature death in men and women: results from a large-scale population-based cohort study in Japan (JPHC study). Ann Epidemiol. 2008; 18(7): 522-530.

9. Taylor RS, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. Am J Med. 2004; 116(10): 682-692.

10. Clark AM, Hartling L, Vandermeer B, McAlister FA. Meta-analysis: secondary prevention programs for patients with coronary artery disease. Ann Intern Med. 2005; 143(9): 659-672.

11. Leon AS, Franklin BA, Costa F, Balady GJ, Berra KA, Stewart KJ, et al. Cardiac rehabilitation and secondary prevention of coronary heart disease: an American Heart Association scientific statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on
12. Janssen I, Jolliffe CJ. Influence of physical activity on mortality in elderly with coronary artery disease. Med Sci Sports Exerc. 2006; 38(3): 418-423.

13. Bäck M, Cider A, Gillström J, Herlitz J. Physical activity in relation to cardiac risk markers in secondary prevention of coronary artery disease. Int J Cardiol. 2013; 168(1): 478-483.

14. Izawa KP, Watanabe S, Oka K, Hiraki K, Morio Y, Kasahara Y, et al. Usefulness of step counts to predict mortality in Japanese patients with heart failure. Am J Cardiol. 2013; 111(12): 1767-1771.

15. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982; 14(5): 377-381.

16. Eston R, Connolly D. The use of ratings of perceived exertion for exercise prescription in patients receiving beta-blocker therapy. Sports Med. 1996; 21(3): 176-190.

17. Borg G, Dahlstöm H. A case study of perceived exertion during a work test. Acta Soc Med Ups. 1962; 67:91-93.

18. Borg G. Borg’s perceived exertion and pain scales. Champaign, IL: Human Kinetics; 1998. p.29-54

19. D Riebe, JK Ehrman, G Liguori, M Magal. ACSM’s Guidelines for Exercise Testing and Prescription 10th ed. Philadelphia: Wolters Kluwer; 2017. p.82-84

20. Mihevic PM. Sensory cues for perceived exertion: a review. Med Sci Sports Exerc. 1981; 13(3): 150-163.

21. Chen YL, Chiou WK, Tzeng YT, Lu CY, Chen SC. A rating of perceived exertion scale using facial expressions for conveying exercise intensity for children and young adults. J Sci Med Sport. 2017; 20(1): 66-69.

22. Morishita S, Tsubaki A, Nashimoto S, Fu JB, Onishi H. Face scale rating of perceived exertion during cardiopulmonary exercise test. BMJ Open Sport Exerc Med. 2018; 17; 4(1).

23. Morishita S, Tsubaki A, Nakamura M, Nashimoto S, Fu JB, Onishi H. Rating of perceived exertion on resistance training in elderly subjects. Expert Rev Cardiovasc Ther. 2019; 17(2): 135-142.

24. Roemmich JN, Barkley JE, Epstein LH, Lobarinas CL, White TM, Foster JH. Validity of PCERT and OMNI walk/run ratings of perceived exertion. Med Sci Sports Exerc. 2006; 38(5): 1014-1019.

25. Gros slambert A, Hintzy F, Hoffman MD, Dugué B, Rouillon JD. Validation of a rating scale of perceived exertion in young children. Int J Sports Med. 2001; 22(2): 116-119.

26. Quinart S, Gros slambert A, Ecarnot F, Simon-Rigaud ML, Nicolet-Guénat M, Nègre V, et al. Validation of a new scale to measure perceived exertion in obese adolescents: the Childhood Obesity Perceived Exertion (Cope-10) Scale. J Sports Med Phys Fitness. 2016; 56(9): 1013-1020.

27. Marilyn J Hockenberry, David Wilson, Marilyn Link Winkelstein, Nancy E Kline. Nursing care of infants and children. 7th Edition. St. Louis, Mo: Mosby/Elsevier; 2002. p. 1050-1052

28. Herr KA, Mobily PR, Kohout FJ, Wagenaar D. Evaluation of the Faces Pain Scale for use with the elderly. Clin J Pain. 1998; 14(1): 29-38.
29. Wong DL, Baker CM. Pain in children: comparison of assessment scales. Okla Nurse. 1988; 33(1): 9-17.

30. Lewko A, Bidgood PL, Garrod R. Evaluation of psychological and physiological predictors of fatigue in patients with COPD. BMC Pulm Med. 2009; 21;9:47.

31. Bieri D, Reeve RA, Champion GD, Addicoat L, Ziegler JB. The Faces Pain Scale for the self-assessment of the severity of pain experienced by children: development, initial validation, and preliminary investigation for ratio scale properties. Pain. 1990; 41(2): 139-150.

32. Wolf PA, Abbott RD, Kannel WB. Atrial fibrillation as an independent risk factor for stroke: the Framingham Study. Stroke. 1991; 22(8): 983-988.

33. Furberg CD, Psaty BM, Manolio TA, Gardin JM, Smith VE, Rautaharju PM. Prevalence of atrial fibrillation in elderly subjects (the Cardiovascular Health Study). Am J Cardiol. 1994; 74(3): 236-241.

34. Majeed A, Moser K, Carroll K. Trends in the prevalence and management of atrial fibrillation in general practice in England and Wales, 1994-1998: analysis of data from the general practice research database. Heart. 2001; 86: 284-288.

35. Go AS, Hylek EM, Phillips KA, Chang Y, Henault LE, Selby JV, et al. Prevalence of diagnosed atrial fibrillation in adults: national implications for rhythm management and stroke prevention: the AnTicoagulation and Risk Factors in Atrial Fibrillation (ATRIA) Study. JAMA. 2001; 285(18): 2370-2375.

36. Heeringa J, van der Kuip DA, Hofman A, Kors JA, van Herpen G, Stricker BH, et al. Prevalence, incidence and lifetime risk of atrial fibrillation: the Rotterdam study. Eur Heart J. 2006; 27(8): 949-953.

37. Mertens DJ, Kavanagh T. Exercise training for patients with chronic atrial fibrillation. J Cardiopulm Rehabil. 1996; 16(3): 193-196.

38. Hegbom F, Sire S, Heldal M, Orning OM, Stavem K, Gjesdal K. Short-term exercise training in patients with chronic atrial fibrillation: effects on exercise capacity, AV conduction, and quality of life. J Cardiopulm Rehabil. 2006; 26(1): 24-29.

39. Januzzi JL Jr, Camargo CA, Anwaruddin S, Baggish AL, Chen AA, Krauser DG, et al. The N-terminal Pro-BNP investigation of dyspnea in the emergency department (PRIDE) study. Am J Cardiol. 2005; 95(8): 948-954.

40. Richards M, Di Somma S, Mueller C, Nowak R, Peacock WF, Ponikowski P, et al. Atrial fibrillation impairs the diagnostic performance of cardiac natriuretic peptides in dyspneic patients: results from the BACH Study (Biomarkers in ACute Heart Failure). JACC Heart Fail. 2013; 1(3): 192-199.

41. Pandolf KB. Advances in the study and application of perceived exertion. Exerc Sport Sci Rev. 1983; 11: 118-158.

42. Morishita S, Wakasugi T, Tanaka T, Harada T, Kaida K, Ikegame K, Ogawa H, et al. Changes in Borg scale for resistance training and test of exercise tolerance in patients undergoing allogeneic hematopoietic stem cell transplantation. Support Care Cancer. 2018; 26(9): 3217-3223.

43. Cleland BT, Ingraham BA, Pitluck MC, Woo D, Ng AV. Reliability and Validity of Ratings of Perceived Exertion in Persons with Multiple Sclerosis. Arch Phys Med Rehabil. 2016; 97(6): 974-982.
44. Penko AL, Barkley JE, Koop MM, Alberts JL. Borg scale is valid for ratings of perceived exertion for individuals with Parkinson's disease. Int J Exerc Sci. 2017; 10(1): 76-86.

45. Yu F, Demorest SL, Vock DM. Testing a modified perceived exertion scale for Alzheimer's disease. Psych J. 2015; 4(1): 38-46.

46. Purvis JW, Cureton KJ. Ratings of perceived exertion at the anaerobic threshold. Ergonomics. 1981; 24(4): 295-300.

47. Katch V, Weltman A, Sady S, Freedson P. Validity of the relative percent concept for equating training intensity. Eur J Appl Physiol Occup Physiol. 1978; 39(4): 219-227.

48. Kindermann W, Simon G, Keul, J. The significance of the aerobic-anaerobic transition for the determination of work load intensities during endurance training. Eur J Appl Physiol Occup Physiol.1979; 42(1): 25-34.

49. Micklewright D, St Clair Gibson A, Gladwell V, Al Salman A. Development and Validity of the Rating-of-Fatigue Scale. Sports Med. 2017; 47(11): 2375-2393.

Figures

Figure 1
Flowchart of the patient recruitment process

Figure 2

The face scale for rating of perceived exertion

Figure 3

Receiver operating characteristic curve analysis to determine the cut off value of the Face Scale for it to predict anaerobic threshold a, men over the age of 65 years and older group b, men under the age of 65
years old group c, women over the age of 65 years and older group d, women under the age of 65 years old group e, AF group

**Supplementary Files**

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile2.docx
- Additionalfile1.docx
- Additionalfile3.docx