

Translation and Validation of the Modified Borg Scale (CR-10) in Hindi Language in Healthy Indian Adults

Riddhi R Shah, Raziya Nagarwala¹, Seemi Retharekar², Rachana Dabadghav³, Ashok Shyam⁴, Parag Sancheti⁵

MPT Cardiovascular and Respiratory Sciences, ¹HOD and Professor, Cardiovascular and Respiratory Department, ²Associate Professor, Cardiovascular and Respiratory Department, ³Research Co-ordinator, ⁴Orthopaedic Surgeon, ⁵Orthopaedic Surgeon, Sancheti Institute College of Physiotherapy, Pune, Maharashtra, India

Abstract

Objective: The present study was conducted to translate the original English version of Modified Borg Scale (CR-10) in Hindi language and validate Hindi translated version of the scale for its use in healthy Indian adult population. **Subjects and Methods:** An observational analytical study was conducted on 50 healthy Indian subjects (24 males, 26 females) who were recruited from a tertiary healthcare setup. The study was conducted in two parts: 1st part included translation of English version of Modified Borg Scale (CR-10) in Hindi language by cross-cultural adaptation process. 2nd part included validation of Hindi translated version of Borg CR-10 scale by correlating subjective values of rating of perceived exertion (RPE) with the objective parameters of heart rate (HR) and maximal oxygen consumption (VO_2 max) during a Bruce treadmill protocol. **Results:** Spearman correlation coefficient was computed between subjective and objective measures. The results of the study showed that there was a high positive correlation between RPE and HR with $r = 0.822$, $P < 0.01$ and $r = 0.97$, $P < 0.05$ by using two different methods of statistical analysis. There was a moderate correlation between RPE and VO_2 max with $r = 0.587$, $P < 0.01$ by using method 1 and a high correlation with $r = 0.98$, $P < 0.05$ by using method 2. **Conclusion:** The Hindi version of Borg CR-10 Scale is a valid tool to measure perceived exertion during Bruce protocol on a motorized treadmill in a healthy Indian adult population.

Keywords: Borg CR-10, Hindi, rating of perceived exertion, translation, validation text

INTRODUCTION

There is a wide increase in a number of multicultural research projects with the need for translation, validation and generalization of health care instruments for its use in other than the source language.^[1,2] Cross-cultural adaptation is a process aiming in translation of an instrument and its adaptation for a sample of population different from the original population where it is applied. This process is faster, economical, and reliable in comparison with the processes involved in creating a new instrument hence, it is frequently been used.^[3] Physiological work or exercise intensity is typically assessed using objective and subjective methods.^[4]

Maximal oxygen consumption (VO_2 max) by definition is the ability to consume, transport, and utilize oxygen during exhausted work and is considered Gold standard for objectifying exercise intensity.^[5,6] Heart rate (HR) because of its linear relationship with % VO_2 max is in turn considered as a silver standard to measure exercise intensity.^[7] Distinct from these objective methods, the rating of perceived exertion (RPE)

scale integrate signals from various sources such as peripheral working muscles and joints, cardiovascular, respiratory, and central nervous system giving a subjective perception to quantify exercise intensity.^[8] Gunnar Borg started his studies on RPE in 1970 and published a widely known scale for its measurement in 1982.^[4] Borg proposed a number of RPE scales (Borg, 1961, 1962, 1998), most well-known being RPE 6-20 scale and CR-10 scale.^[1,9] Borg CR-10 is a category scale with ratio properties that presents with a range of numbers from which the subject is instructed to express verbally a numerical value for his perceived exertion with the help of text descriptors located along the scale. Scale ranges from 0 to 10, 0 corresponding to nothing

Address for correspondence: Dr. Raziya Nagarwala, 11/12 Thube Park, Sancheti College of Physiotherapy, Shivaji Nagar, Pune 411005, Maharashtra, India. E-mail: sancheticop@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Shah RR, Nagarwala R, Retharekar S, Dabadghav R, Shyam A, Sancheti P. Translation and validation of the modified Borg scale (CR-10) in Hindi language in healthy Indian adults. *Indian J Respir Care* 2022;11:24-9.

Received: 22-06-2021

Revised: 28-10-2021

Accepted: 23-12-2021

Published: 04-01-2022

Access this article online

Quick Response Code:



Website:
www.ijrc.in

DOI:
10.4103/ijrc.ijrc_78_21

at all and 10 corresponding to maximal exertion. In addition, decimals (e.g., 0.5) are also permitted. The Borg 6-20 and CR10 scales have shown validity and reliability in healthy, clinical, and athletic adult populations.^[10] Data obtained from either scale can be freely transformed to another if comparisons are desired and thus both the scales can be used interchangeably.^[9] CR-10 scale is more conveniently used by the patients as it is easy to perceive 0 (on CR-10) as no/minimum exertion than 6 (on RPE 6-20). The RPE scale is widely used for monitoring exercise intensity in exercise prescription and rehabilitation.

In addition, it is free from technical measurements as in other exercise monitoring methods (e.g., HR, VO_2 max). Therefore, RPE can be used in conjunction with objective measures of exercise tolerance to give a subjective measure of physical effort.^[7] The American College of Sports Medicine (ACSM) has recommended RPE since 1986 for both fitness and Cardiac rehabilitation purposes.^[11] As the RPE scale denotes the subjective perception of physical effort, it should be in a language easily understood by its user. For this reason, efforts to translate the scale into different languages have been made recently. Researchers mainly reported a strong positive linear relation between subjective (RPE) and objective (HR, VO_2 max, and power output) measures of exercise intensity with moderate to high correlations when the English RPE scale was translated into Japanese,^[12] Cantonese^[13] and Chinese.^[14] From this relationship, different RPE scales have been validated in different languages; yet not in any Indian language. Hindi is one of the most widely spoken languages in India and is recognized and understood throughout the country. Thus, the present study aims at translating the Borg CR-10 Scale in Hindi language and validating it for the healthy Indian population for better understanding and clear interpretation by Indians.

SUBJECTS AND METHODS

The present study was submitted and approved by the Institutional Ethical Committee. An observational analytical study was conducted on 50 healthy Indian subjects (24 males, 26 females) who were recruited from a tertiary healthcare setup. Subjects were between 18 and 45 years of age (mean 28.66 ± 5 years) and all of them were able to read and understand Hindi Language properly. Subjects who were unable to walk on treadmill due to any Musculoskeletal, Neurological, and Cardiovascular, Pulmonary and/or Visual impairments were excluded from the study. The study was conducted in two parts: 1st part included translation of English version of Modified Borg Scale (CR-10) in Hindi language by cross-cultural adaptation process. 2nd part included validation of Hindi translated version of Borg CR-10 scale by comparing the subjective value of RPE with the objective parameters of HR and VO_2 max during a Bruce treadmill protocol.

After explaining the study procedure, an informed written consent was taken from each participant. 1st part: Translation Process: 1, 2 following steps were undertaken for cross-cultural adaptation of the scale. Step 1: Forward translation: Two independent translators

whose mother tongue was the desired target language of the instrument, i.e., Hindi forward translated the instrument from the source language (English) to target language (Hindi). Both the translators were bilingual (fluent in both English and Hindi). First translator had knowledge about medical terminologies and the content of the instrument, i.e., CR-10 scale thus he became the “informed” translator. Second or the “uninformed” translator neither had any medical or clinical background nor had any knowledge about the construct or use of CR-10 scale. This approach generated two translated versions that covered both medical and layman terms with its cultural nuances. Step 2: Synthesis of the translation: Working from the original scale as well as the first translator’s and the second translator’s versions, a synthesis of these translations were conducted producing one common translation. Step 3: Back translation: Two translators who were totally blind to the original version, then translated the scale back into the original language, i.e., English. Their mother tongue was the source language (English). The first translator had knowledge about health care terminology but had no clue of the instrument being back translated. The second translator neither had knowledge regarding any medical terminology nor the construct or use of the CR-10 scale. This was done to avoid information bias and to elicit unexpected meanings of words in the translated version. Step 4: Expert Committee: It comprised of 1 healthcare professional, 1 language professional, and the all translators (two forward and two back translators) involved in the translation process. The expert committee consolidated all the versions of the scale, resolved discrepancies, and developed a pre-final version of the scale for pilot testing.

Step 5: Pilot testing: Pilot testing was done to use the pre-final version of the Hindi translated version of the Borg CR10 scale in subjects from the target setting. A sample of 10 healthy controls who gave consent to participate were selected from the target population. Each participant was asked to use a binary scale (clear or unclear) to rate the items of the scale. 2nd part: Validation of the Hindi translated version of Borg CR-10 Scale in healthy Indian adults Pre-test requirements: (1) Participants were asked to refrain from ingesting food, alcohol, caffeine, or using tobacco products 3 h before testing. (2) They were advised to avoid significant exertion or exercise on the day of testing. (3) They were advised clothing that would permit freedom of movement and include walking or running shoes. Procedure: Prior to the start of procedure, all the participants were asked to complete the Physical Activity Readiness Questionnaire (PAR-Q and YOU) for their health screening.^[15]

Demographic data of the participants including age, height, weight, and body mass index (BMI) were noted. Testing criterion was explained in brief. The participants were then introduced to the Hindi translated version of CR10 scale (Appendix 1). and standard instructions for the use of the scale and verbal explanation regarding how the scale should be interpreted in numerical form was given.^[11] Preexercise resting HR, blood pressure (BP), respiratory rate (RR), and RPE of each participant were recorded to establish baseline data. The Hindi version of CR-10 scale was posted in front of the participant. Each participant underwent graded

exercise testing (GXT) using Bruce’s protocol¹⁶ on a motorized treadmill (Aerofit AF 131) and were asked to rate their perceived exertion using the Hindi-translated version of CR-10 scale. The Bruce’s treadmill exercise test is a continuous, incremental test which involves 7 stages, each stage of 3 min duration with an increase in speed and inclination of treadmill at every stage.^{16,17} Each participant was instructed to rate their perceived exertion during the last 15 s of each stage. They were instructed just to point at the numerical value on the scale and not actually speak. Simultaneously, HR was recorded using Polar FT2 HR monitor for that stage. Subjects were refrained to view HR monitor during the entire course of the test [Figure 1] VO₂ max was indirectly calculated using a regression equation: VO₂ max (ml/kg/min) = 58.443– (0.215*age)– (0.632*BMI)– (68.639*grade) + (1.579*time) 6 (Where grade is taken in decimal value [e.g., 10% = 0.1]) test was terminated when the participant reported maximum RPE of 10. At the end of test, the total time of exercise was recorded. Data of participants who were unable to complete at least three stages of the test were excluded. Each participant was monitored until their vital parameters, i.e., HR, BP, RR, and RPE returned to baseline. All RPE, HR, VO₂ max data were recorded by the same investigator on an identical form.

RESULTS

All the statistical procedures were conducted using IBM SPSS version 16.0 software. Shapiro Wilk test was done to test the normal distribution of the data [Table 1]. As the data were not normally distributed, the Concurrent Validity of the Hindi version of Borg CR-10 Scale was established using Spearman’s correlation coefficient (rho) by using two statistical methods: Method 1 and Method 2. Table 2 shows demographic characteristics of the participants. Range of RPE values of all the subjects at different stages of Bruce Protocol are shown in Table 3. HR over 5 stages of Bruce Protocol ranged from 122.1 beats/min to 180 beats/min for all the subjects (for males: 121.58 beats/min–178.09 beats/min, for females: 122.1 beats/min–180 beats/min) [Table 4]. Oxygen consumption over 5 stages of

Bruce Protocol ranged from 34.26 ml/kg/min to 47.08 ml/kg/min with a range of 34.27 ml/kg/min–47.02 ml/kg/min specific to males and a range of 34.26 ml/kg/min–47.08 ml/kg/min specific to females [Table 5]. The *P* value was significant at 0.01 for Method 1 and at 0.05 for Method 2. The results of the study showed that there was an overall high positive linear correlation between RPE and HR with *r* = 0.822, *P* = 0.01 and *r* = 0.97, *P* < 0.05 using method 1 and method 2, respectively. There was a moderate correlation between RPE and VO₂ max with *r* = 0.587, *P* < 0.01 using method 1 and a high correlation with *r* = 0.98, *P* < 0.05 using method 2 [Table 6 and Graphs 1-6].

DISCUSSION

During the process of translating the original English version of Modified Borg Scale (CR-10) into Hindi language, the

Table 1: Test for normality

Shapiro-Wilk test	df	Significant
HR	205	0.005*
RPE	205	0.000*
VO ₂ max	205	0.672*

**P*<0.05. df: Degrees of freedom, HR: Heart rate, RPE: Rating of perceived exertion, VO₂ max: Maximal oxygen consumption

Table 2: Demographic characteristics of the participants

Gender	No. of participants	Mean ± SD		
		Age (years)	Weight (kg)	BMI (kg/m ²)
Males	24	29.06±5.96	61.79±10.75	23.61±4.39
Females	26	28.66±5.72	61.45±10.98	23.77±4.41
Overall	50	28.66±5.72	61.45±10.98	23.77±4.41

SD: Standard deviation, BMI: Body mass index

Table 3: Rating of perceived exertion values at different stages of Bruce protocol

Bruce stage	Mean ± SD		
	Males	Females	Overall
1	0.53±0.69	0.58±0.68	0.58±0.68
2	2.22±1.6	2.28±1.59	2.28±1.59
3	5.62±2.62	5.6±2.6	5.6±2.6
4	8.91±1.92	8.97±1.89	8.97±1.89
5	10±0	10±0	10±0

SD: Standard deviation

Table 4: Heart rate (beats/min) values at different stages of Bruce protocol

Bruce stage	Mean ± SD		
	Males	Females	Overall
1	121.58±12.58	122.1±12.24	122.1±12.24
2	142.48±13.32	142.94±13.12	142.94±13.12
3	163.48±12.37	163.4±12.11	163.4±12.11
4	179.1±15.01	179.74±14.47	179.68±14.47
5	178.09±25.37	180±25.08	180±25.08

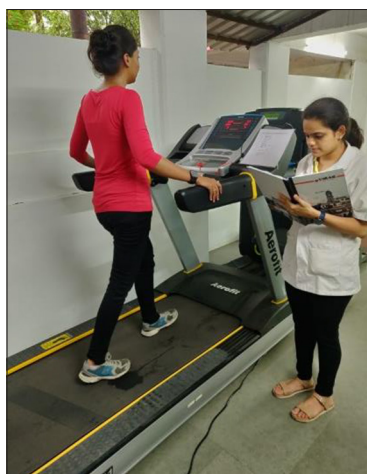
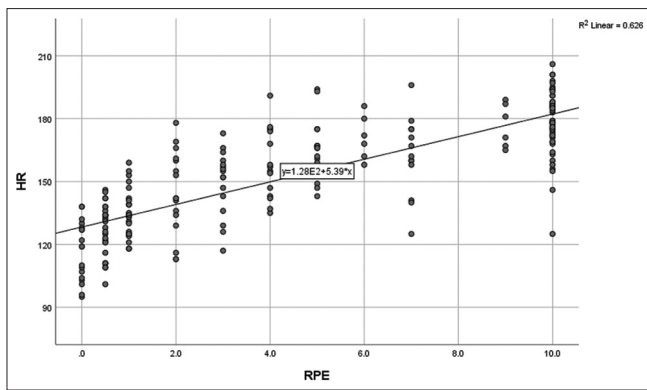
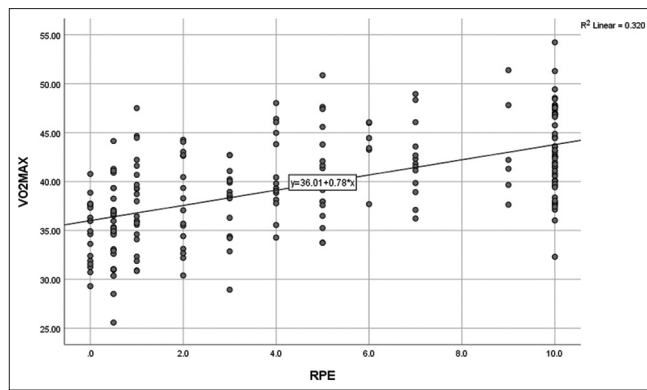


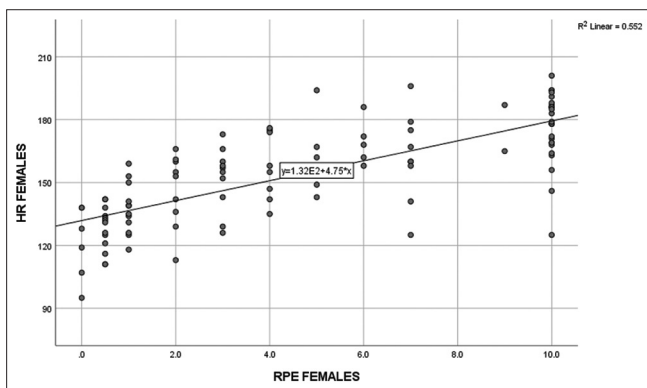
Figure 1: Subject performing Bruce treadmill protocol using Hindi translated version of Borg CR-10 scale



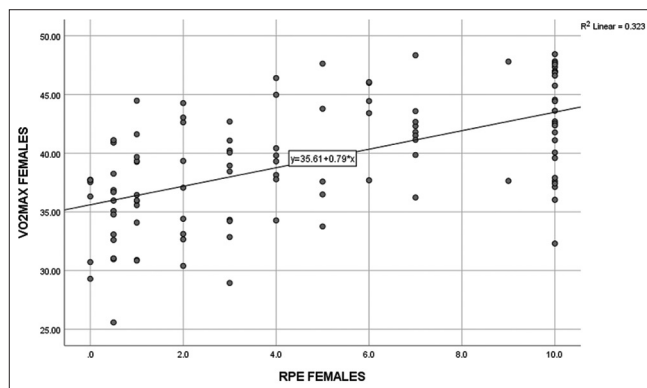
Graph 1: Positive linear correlation between rating of perceived exertion and heart rate using method 1



Graph 2: Positive linear correlation between rating of perceived exertion and maximal oxygen consumption using method 1



Graph 3: Positive linear correlation between rating of perceived exertion and heart rate in females using method 1



Graph 4: Positive linear correlation between rating of perceived exertion and maximal oxygen consumption in females using method 1

meaning of all the items was retained in the back translation and an integrated version from all the translated versions were formed. All the subjects involved in the pilot testing reported no difficulty in the clarity of language and ease of understanding of all the items. Once the scale has been translated in the source language, it is necessary to establish its validation.

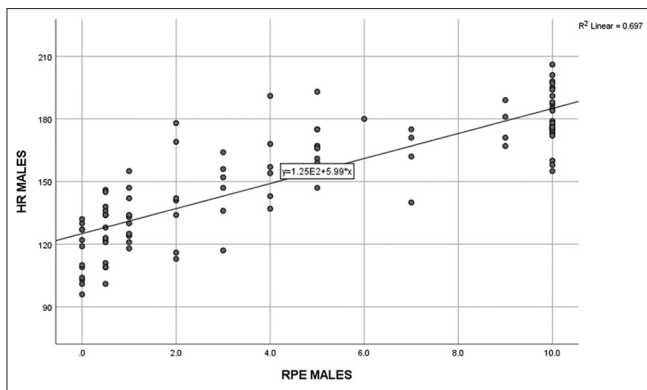
A systematic review of cross-cultural adaptation and validation of Borg's RPE scale utilized concurrent validity as the only method of validation for Borg's scale (6–20). This type of validity is most frequently found in correlations related with ratings of perceived exertion, probably due to the ease of relating the scale with physiological measures of HR, oxygen consumption, rate of ventilation, etc., that have already been validated for evaluating the intensity of exercise.^[3] Thus, in the present study, the concurrent validation of Borg CR-10 scale was established using two gold-standard measures, i.e., HR and oxygen consumption Borg 6–20 RPE Scale was originally validated against HR between 60 and 200 beats/min ($r = 0.80–0.90$), and since then it has been researched extensively.^[5,12] Similarly, Borg CR-10 scale has been validated against objective measures of exercise intensity such as HR and VO_2 max^[11–15] and has become a standard method for evaluating perceived exertion in exercise testing, training, and rehabilitation particularly

Table 5: Oxygen consumption (ml/kg/min) values at different stages of Bruce protocol

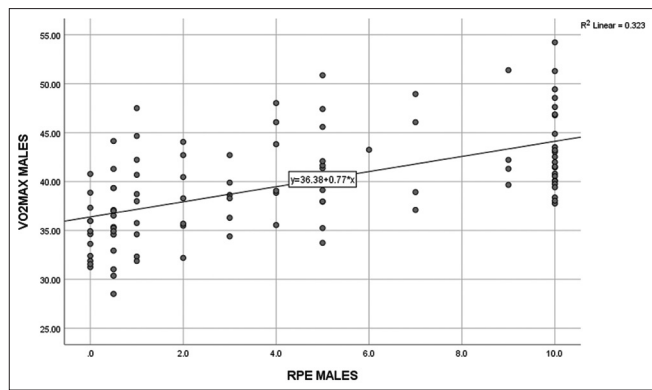
Bruce stage	Males	Females	Overall
1	34.27±3.32	34.26±3.27	34.26±3.27
2	37.63±3.32	37.62±3.27	37.62±3.27
3	41±3.31	40.99±3.27	40.99±3.27
4	44.17±3.61	44.03±3.57	44.03±3.57
5	47.02±4.33	47.08±4.14	47.08±4.14

SD: Standard deviation

because of its easy usability by the lay person, its response format, its construction as a numeric ratio scale with a true zero point, as well as categorical verbal descriptors of each numeric point.^[10] In accordance to previous studies, this study found moderate-to-high positive correlations between subjective (RPE) and objective (HR and VO_2 max) measures of exercise intensity while performing Bruce protocol on a motorized treadmill using a Hindi translated version of the Borg CR-10 Scale in healthy Indian population. The validity of multiple translated versions of Borg RPE scale has been examined by several researchers.^[9,12–14] Significant correlations between subjective (RPE) and objective measures (HR, VO_2 max, power output, resistance exercises) of exercise intensity with Pearson's correlation coefficient (r) ranging from



Graph 5: Positive linear correlation between rating of perceived exertion and heart rate in males using method 1



Graph 6: Positive linear correlation between rating of perceived exertion and maximal oxygen consumption in males using method 1

0.5 and 0.99 were found in their studies. In the present study, as the data were not normally distributed, Spearman’s correlation coefficient was computed between RPE and HR and RPE and VO₂ max. In this study, validity was computed by using two statistical methods. Method 1 is based on simultaneously analyzing and concurrently computing the entire data all at once, giving a single overall correlation coefficient [Graph 1 and 2].

Method 2 involves individual computation of data of each participant to give individual correlation coefficient and then calculating the mean of these individual coefficients [Graphs 3-6]. It was found that, higher correlations were observed using Method 2 ($r = 0.97$ between RPE and HR, $r = 0.98$ between RPE and VO₂ max with $P < 0.05$) than method 1 ($r = 0.822$ between RPE and HR, $r = 0.587$ between RPE and VO₂ max with $P < 0.01$) [Table 6]. Similarly, Leung, *et al.* calculated Pearson’s correlation using both the methods in their study and found the correlations were lower when using single overall correlations.^[13] Given the fact that direct VO₂ max measurement requires expensive equipment, involve complicated testing procedures, and are difficult to administer or perform, indirect estimation using regression models in specific populations are more appropriate for predicting VO₂ max. Thus, this study used a regression-based equation obtained from a study by Koutlianos *et al.* to predict VO₂ max.^[7]

CONCLUSION

The Hindi version of the Modified Borg Scale (CR-10) is a valid tool to measure perceived exertion during Bruce protocol on a motorized treadmill in healthy Indian adult population. This study found a moderate-to-high positive linear correlation between subjective RPE measure when compared against objective measures of HR and oxygen consumption.

Acknowledgment

The authors would like to thank Dr. Ankit Srivastava, Miss Malvika, Dr. Agnes Robin and Mr. Vikki Nanda for translation of the scale and Dr. Mrs. Dhara Kapoor and Dr. Mrs. Rachana Dabadghav for statistical analysis.

Table 6: Spearman correlation coefficient values using two statistical methods

Group	Method 1		Method 2	
	Rho	P	Rho	P
Overall				
RPE and HR	0.822	0.0	0.97	0.02
RPE and VO ₂ max	0.587	0.0	0.98	0.013
Males				
RPE and HR	0.86	0.0	0.96	0.03
RPE and VO ₂ max	0.604	0.0	0.98	0.01
Females				
RPE and HR	0.773	0.0	0.97	0.02
RPE and VO ₂ max	0.576	0.0	0.98	0.013

HR: Heart rate, RPE: Rating of perceived exertion, VO₂ max: Maximal oxygen consumption

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Beaton DE, Bombardier C, Guillemin F, Ferraz MB. Guidelines for the process of crosscultural adaptation of self-report measures. *Spine* 2000;25:3186-91.
2. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross cultural health care research: A clear and user- friendly guideline. *J Eval Clin Pract* 2011;17:268-74.
3. Cabral LL, Lopes PB, Wolf R, Stefanello JM, Pereira G. A systematic review of crosscultural adaptation and validation of Borg’s rating of perceived exertion scale. *J Phys Educ* 2017;28:e2853.
4. Borg GV. *Perceived Exertion and Pain Scales*. Champaign, IL: Human Kinetics; 1998.
5. Ronghe RN, Gotmare NA, Deshpande MG. Correlation of ACSM’s walking equation and directly measured VO₂ max in Indian population: A pilot study. *Int J Clin Biomed Res* 2017;3:30-3.
6. Koutlianos N, Dimitros E, Metaxas T, Cansiz M, Deligiannis A, Kouidi E. Indirect estimation of VO₂ max in athletes by ACSM’s equation: Valid or not? *Hippokratia* 2013;17:136-40.
7. Karavatas SG, Tavakol K. Concurrent validity of Borg’s rating of perceived exertion in African American young adults, employing heart rate as the standard. *Internet J Allied Health Sci Pract* 2005;3:5.
8. Pereira G, Souza DM, Reichert FF, Smirmaul BP. Evolution of

- perceived exertion concepts and mechanisms: A literature review. *Rev Bras Cineantropometr Desempenho Humano* 2014;16:579-87.
9. Borg E, Kaijser LA. Comparison between three rating scales for perceived exertion and two different work tests. *Scand J Med Sci Sports* 2006;16:57-69.
 10. Van Leer E, van Mersbergen M. Using the Borg CR 10 physical exertion scale to measure patient-perceived vocal effort pre and post treatment. *J Voice* 2017;31:389-e19.
 11. Thompson WR, Gordon NF, Pescatello LS. *ACSM's Guidelines for Exercise Testing and Prescription*. 9th ed. Philadelphia, PA: Wolters Kluwer/Lippincott Williams and Wilkins; 2009.
 12. Miyashita M, Onodera K, Tabata I. How Borg's RPE-scale has been applied to Japanese. In: *The Perception of Exertion in Physical Work*. London: Palgrave Macmillan; 1986. p. 27-34.
 13. Leung RW, Leung ML, Chung PK. Validity and reliability of a Cantonese-translated rating of perceived exertion scale among Hong Kong adults. *Percept Mot Skills* 2004;98:725-35.
 14. Chung PK, Zhao Y, Liu JD, Quach B. A brief note on the validity and reliability of the rating of perceived exertion scale in monitoring exercise intensity among Chinese older adults in Hong Kong. *Percept Mot Skills* 2015;121:805-9.
 15. Thomas S, Reading J, Shephard RJ. Revision of the physical activity readiness questionnaire (PAR-Q). *Can J Sports Sci* 1992;17:338-45.
 16. Bruce RA, Kusumi F, Hosmer D. Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *Am Heart J* 1973;85:546-62.
 17. Zamunér AR, Moreno MA, Camargo TM, Graetz JP, Rebelo AC, Tamburús NY, da Silva E. Assessment of subjective perceived exertion at the anaerobic threshold with the Borg CR-10 scale. *J Sports Sci Med* 2011;10:130-6. eCollection 2011.

APPENDIX 1

HINDI-TRANSLATED VERSION OF MODIFIED BORG SCALE (CR-10)

०	कुछ भी नहीं
०.५	नहीं के बराबर
१	बहुत ज़रा सा
२	ज़रा सा
३	हल्का सा
४	थोड़ा ज्यादा / तेज़
५	ज्यादा / तेज़
६	
७	बहुत ज्यादा / तेज़
८	
९	लगभग असहनिय
१०	असहनिय