

WHAT IS YOUR RATING OF PERCEIVED PUMP? A NOVEL, SUBJECTIVE ROCK CLIMBING TRAINING TOOL

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Abstract

Introduction. Accurately assessing forearm-finger fatigue during rock climbing training may help optimize daily and yearlong training sessions. **Purpose.** To beta test the usefulness of a forearm-finger specific, novel rating of perceived pump (RPP) scale. **Methods.** Twelve (n=12, female=5) experienced climbers participated and underwent three lab visits: (1) habituation to a 45-degree overhanging, 3 m high, indoor wall; (2) 5-min bouldering warm-up, then maximal, continuous timed test to max fatigue (TMF) set to a metronome at 37 hand touches per min; and (3) 5-min bouldering warm-up, then three timed, continuous, randomized, submaximal climbs with speed standardized, and 20-min rest in between bouts of 25% TMF, 50% TMF, and 75% TMF. Rate of force production (RFP) in the right fingers, right forearm hand volume (mL), heart rate (HR), and RPP were assessed post WU and post intensity condition. **Results.** A near significant (p=0.065), positive correlation between RPP and HR was observed with a concurrent significant (p<0.05) increase in RFP at 25% TMF vs 100% TMF. Also, when comparing 25% and 50% RPP to 100% RPP, a significant (p<0.05) difference was observed. **Conclusion.** Declining grip power seemed to explain, in part, the subjective feeling of forearm-finger “pump” from submax to maximal efforts.

Keywords: rating of perceived exertion, heart rate, forearm volume, rate of force production

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Abstrait

Introduction. L'évaluation précise de la fatigue des doigts de l'avant-bras pendant l'entraînement d'escalade peut aider à optimiser les séances d'entraînement quotidiennes et d'une année. **Objectif.** Pour tester en bêta l'utilité d'une nouvelle évaluation de l'échelle de pompe perçue (RPP) spécifique à l'avant-bras. **Méthodes.** Douze alpinistes expérimentés ($n = 12$, femmes = 5) ont participé à trois visites de laboratoire: (1) accoutumance à un mur intérieur en surplomb de 3 m de haut et à 45 degrés; (2) échauffement au bloc de 5 min, puis essai chronométrique continu maximal jusqu'à la fatigue maximale (FAT) réglé sur un métronome à 37 coups de main par minute; et (3) un échauffement de bloc de 5 minutes, puis trois montées temporisées, continues, randomisées et sous-maximales avec une vitesse normalisée, et un repos de 20 minutes entre des périodes de TMF de 25%, 50% de TMF et 75% de TMF. La vitesse de production de la force (DP) dans les doigts droits, le volume de la main de l'avant-bras droit (mL), la fréquence cardiaque (FC) et le RPP ont été évalués après l'UT et après l'intensité. **Résultats.** Une corrélation positive presque significative ($p = 0,065$) entre RPP et HR a été observée avec une augmentation significative simultanée ($p < 0,05$) de la RFP à 25% de TMF par rapport à 100% de TMF. De plus, en comparant 25% et 50% de RPP à 100% de RPP, une différence significative ($p < 0,05$) a été observée. **Conclusion.** La diminution de la puissance d'adhérence semblait expliquer, en partie, le sentiment subjectif d'une «pompe» de l'avant-bras, de la submaxation aux efforts maximaux.

Mots clés: évaluation de l'effort perçu, fréquence cardiaque, volume de l'avant-bras, taux de production de la force

INTRODUCTION

The French phrase rock climbers use to describe what their forearms feel like after a tough climb is *avoir les bouteilles*, which translates to *have bottles for arms*. Rock climbing is an unusual physical activity in that it presents a local anaerobic-endurance challenge, meaning fatigue is often localized in the small muscles of the forearm and fingers rather than being more central or limited by the cardiovascular system (Watts, 2004). This occurs from the natural compression of blood vessels when statically gripping rock holds, thereby squeezing vessels shut under maintained pressure and interrupting the neutralizing supply of oxygen and other nutrients to the working tissue. Gravity also negates blood flow to working muscle due to the outstretched and frequent overhead placement of the hands and forearms during rock climbing. However, compared to non-climbers, trained climbers tend to have an augmented forearm vasodilator capacity and therefore may have better oxygenation and recovery abilities in between hard muscle contraction sets (Watts, 2004).

Competitive rock climbing will debut on the Olympic stage in Tokyo 2020. With the progression of this competitive sport, proper training is crucial for best performance outcomes; however, sport specific and appropriate training intensities are challenging to pinpoint due to localized arm fatigue and the highly variable nature of rock climbing routes. Heart rate (HR) is the most common general measure of intensity (ACSM, 2017), yet it does not always equate to segmental (e.g., arms, legs) or localized exertion when assessing rock climbers. Notably, most climbers are limited by their forearm “pump” or severe perception of localized muscle fatigue due to lack of blood in their distal, often overhead extremities. We believe this max perception of “pump” may equate to a climber’s maximum effort, but to our knowledge this relationship has not been examined. We aim to develop a new rating of perceived pump (RPP) scale based off the rating of perceived exertion (RPE) tool developed by Borg (Borg, 1982, 1998). Assessing RPP may help distinguish varying levels of climbing intensity to improve/enhance/inform proper training and recovery for athletes in this sport.

Purpose

Therefore, the primary purpose of our research was to assess the practicality of utilizing the forearm-finger specific RPP scale by relating it to the objective intensity measure of heart rate (HR) throughout four intensities of climbing.

METHODS

Testing

We assessed the usefulness of the RPP scale (Figure 1), used to describe the level of discomfort related to forearm-finger “pump” at baseline (i.e., immediately after a 5-min, gentle climbing specific warm up) and immediately after varying levels of timed (sec) intensity (i.e., (a) time to maximal effort or complete failure (TMF), (b) 25% TMF, (c) 50% TMF, (d) 75% TMF), on a High Intensity Interval Training (HIIT) indoor climbing wall (i.e., 45-degree overhanging/angled bouldering wall about 3 meters high with positive holds). The first lab visit was a habituation day with regard to climbers learning how to continuously ascend and descend, in a standardized fashion at 37 beats or hand placements per minute, set to a metronome, on the HIIT wall. The second lab visit, at least a day later, habituated

RATING OF PERCEIVED PUMP RPP Scale	
<i>Use this 0-10 scale to describe the pump or feeling of discomfort in your forearms along with grip strength fatigue:</i>	
0	no pump
1	very light pump
2	light pump
3	somewhat moderate pump
4	moderate pump
5	somewhat hard pump
6	hard pump
7	very hard pump
8	beyond hard pump
9	way beyond hard pump
10	maximum – eminent failure
Figure 1. Rating of Perceived Pump (RPP) Scale	

climbers were timed to maximal fatigue (i.e., TMF, falling off the HIIT wall) at the set speed of 37 hand placements per minute. TMF was recorded and 25%, 50%, and 75% of TMF were calculated for each participant ($n = 12$, female = 5). Note, a 5-min, gentle bouldering warm up occurred prior to TMF, whereby primary variables (discussed below) were assessed before and after the warm up and immediately after TMF. On the third and final lab visit, separated by at least one rest day, the three submaximal bouts of 25%, 50%, and 75% of TMF were completed in randomized order and separated by 20-min of rest. Prior to the initial submaximal climb, a 5-min gentle bouldering warm up was employed. Immediately before and after the warm up, primary variables were assessed. Also, immediately after each submaximal climb, primary variables were measured. Percent change for each variable was based on data observed immediately after the warm up (i.e., considered baseline) and immediately after each climb (i.e., max time to fatigue, 25% TMF, 50% TMF, and 75% TMF).

Participants

Twelve ($n = 12$, female = 5), experienced rock climbers volunteered for this study, approved by Northern Michigan University's Institutional Review Board (IRB #: HS17-914). Climber age, height, weight, ape index, skinfold measures, and IRCRA climber ratings are described in Table 1.

Table 1. Participant Characteristics.

	age (yr)	height (cm)	weight (kg)	Ape Index (cm)	Skinfold chest/tri (mm)	skinfold ab/suprail (mm)	skinfold thigh (mm)	Top Rope Rating (IRCRA)	Sport Lead Rating (IRCRA)
Mean	29.2	172.4	69.1	172.5	11.4	14.5	15.8	13.2 (5.10d YDS)	11.9 (5.10b-c YDS)
SD	15.0	7.2	9.0	9.2	6.3	4.0	7.4	3.6	4.6

Variables

Throughout the study protocol, described beforehand, primary variables observed were: (1) rate of force production (sec) based on the right hand via a finger force apparatus (Watts et al., 2008), (2) right forearm volume (mL) via a graduated cylinder filled with water (Watts, Joubert, Lish, Mast, & Wilkins, 2003), (3) heart rate (bpm) via a Polar chest strap and wrist receiver (Lake Success, NY), and (4) RPP via a new exertion scale (Figure 1).

Data Analysis

Excel (Microsoft Office Professional Plus 2016) was utilized to analyze data. Regression analysis was used to determine the correlation between RPP and HR over the four intensity categories (i.e., 25% TMF, 50% TMF, 75% TMF, and 100% TMF). Paired, 2-tailed, t-tests were conducted to determine differences between submax and max for each measure. Significance was set at $p < 0.05$.

Results: In general, RFP, forearm volume, HR, and forearm RPP slightly or greatly changed from 25% TMF to TMF. Figure 2 showcases percent change for each primary variable. Particularly, RFP at 25% TMF, and forearm RPP at 25% and 50% TMF were significantly ($p < 0.05$) different vs TMF.

A nearly significant ($p = 0.065$) correlation ($r(45) = 0.272$, $R^2 = 0.074$) between HR and RPP was observed from pooling all data points (i.e., 25% TMF – 100% TMF). Figure 3 depicts the relationship between RPP and HR.

Discussion

Our primary aim was to beta test the usefulness of a new Rating of Perceived Pump (RPP) scale specific to forearm + finger discomfort, from 25% TMF to 100% TMF, in experienced rock climbers. Notably, many years

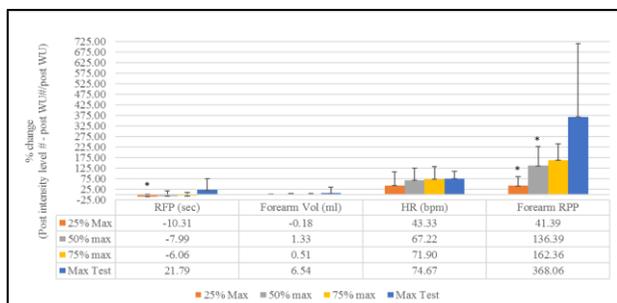


Figure 2. Percent change between post warm-up (baseline) to immediate post climb at four intensity levels. RFP = rate of force production; HR = heart rate; RPP = rating of perceived pump. * $p < 0.05$ vs Max Test (TMF).



Figure 3. Regression analysis between Rating of Perceived Pump (RPP) and heart rate (HR). Note, data points represent 25% max effort – 100% max effort (TMF).

ago, Borg (1982) developed the well-known and widely used rating of perceived exertion (RPE) scale, a tool he manipulated as part of the RPP scale. In conjunction with RPE (or RPP), HR, although not always well correlated, is none-the-less a useful, objective measure commonly utilized to gauge exercise intensity in healthy, recreationally active persons (ACSM, 2017). With this in mind, we showed a nearly significant correlation ($R = .272$, $p = 0.065$) between our new RPP scale and HR. Borg (1982) stated, “In my opinion perceived exertion is the single best indicator of the degree of physical strain”. Further, Borg (1982, 1998) underscored the high inter-individual variation between ratings of perceived exertion vs heart rates during submaximal to maximal exercise intensities. We observed the same fluctuations between climbers and their relative perception of pump in their forearms from 25% TMF to 100% TMF. Thus, in using the RPP scale alone, be mindful of individual, subjective differences when attempting to gauge climbing intensity and/or workout progression. Finally, because we saw a significant increase in RFP (in sec) at 100% TMF vs 25% TMF, and a significant increase in RPP at 100% TMF vs 25% and 50% TMF, declining grip power seemed to explain, in part, the subjective feeling of forearm “pump”. A major limitation of this study is that we did not calculate the inter- and intra-climber reliability of the RPP scale. Lastly, the numerical RPP rating scale must be clearly explained and understood by the climber.

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