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ORIGINAL

RPE AND VELOCITY AS INTENSITY MARKERS FOR BENCH PRESS EXERCISES

RPE Y VELOCIDAD COMO MARCADORES DE INTENSIDAD EN EL PRESS DE BANCA

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ABSTRACT

The purpose of this study was to analyse the link between the evolution of the average velocity (Vel_{mean}) and the values of the OMNI-RES scale, in 3 intensities (beginning weight [CI], maximum potential [MP] and maximum repetition [RM]). 38 subjects were divided into two groups: Trained (G1, n = 19) and Untrained (G2, n = 19) underwent the bench press incremental protocol. In the Rating of Perceived Exertion (RPE) there were no significant differences noted between the groups. The analysis of the Vel_{mean} showed significant differences both in the MP as well as the RM. The OMNI-RES is a good method for quantifying the intensity of the bench press exercise, although it is recommendable to accompany this value with another intensity measurement like the Vel_{mean}. This way the true intensity can better be adjusted in different training sets.

KEY WORDS: execution velocity, perceived exertion, incremental protocol, resistance training, upper body

RESUMEN

El propósito de esta investigación fue analizar la relación entre la evolución de la velocidad media (Vel_{media}) y los valores de la escala OMNI-RES, en 3 intensidades (carga Inicial [CI], máxima potencia [MP] y repetición máxima [RM]). 38 sujetos divididos en dos grupos: Entrenados (G_1, n = 19) y No Entrenados (G_2, n = 19) realizaron un test incremental de cargas en el ejercicio del press de banca. En la percepción subjetiva del esfuerzo (RPE) no se encontraron diferencias significativas entre ambos grupos. El análisis de la Vel_{media} mostró diferencias significativas tanto en la MP como en la RM. La OMNI-RES es un buen método para cuantificar la intensidad en el ejercicio del press de banca, aunque sería aconsejable acompañar este valor con otra medida de intensidad como la Vel_{media}. De esta forma, se podría ajustar mejor la intensidad real realizada en las diferentes series de entrenamiento.

PALABRAS CLAVE: velocidad de ejecución, percepción subjetiva, protocolo incremental, entrenamiento de fuerza, tren superior

INTRODUCTION

In the training for any sport, the development of strength through external resistence is essential to better skills such as potential and/or velocity (Kawamori & Haff, 2004). In fact, high-speed power training is a method very frecuent in the context of sports performance (Ferrer, 2007). The total number of sets and repetitions, the percentage of the maximum repetition (RM), the breaks between sets, the order of the exercises and the execution velocity are the usual parameters used to cuantify the intensity of the exercises in strength training (Cormie, McGuigan, & Newton, 2011; Fleck, 1999; Pereira & Gomes, 2003). Different electronic devices were also used to measure variables such as strength, potential and velocity (Harris, Cronin, Taylor, Boris, & Sheppard, 2010). The linear shift devices (DDL), the accelerometers, the contact platforms and the strength platforms were the most used. However, the great economic and resource cost that these devices entail makes the perceived exertion scales very frequently used tools for controlling intensity (Lagally & Amorose, 2007; Marquez García & Fernandez- Gacía, 2012; Ozkan & Kin-Isler, 2007; Tiggemann et al., 2010). In this manner, apart from being able to cuantify and monitor training, very valuable information is obtained about the athlete's sensations that may help the trainer cuantify the intensity in different training sessions.

The control and monitorization of training based on external resistence has been one of the main objectives of percieved exertion scales such as the OMNI-RES, Borg's CR-10 scale or Borg's 15 category scale (Bellezza, Hall, Miller, & Bixby, 2009; Day, McGuigan, Brice, & Foster, 2003; Gearhart, Lagally, Riechman, Andrews, & Robertson, 2009; Naclerio et al., 2011; Robertson et al., 2008; Tiggemann et al., 2010). The validity of the OMNI-RES scale for intensity control, both in exercises that imply the upper body as well as the lower body, was proven in the study done by Robertson et al. (2003). In said study, the total weight lifted and the RPE of the bicep curl exercise and knee extension exercise were interlinked obtaining significant interlinked results, with r values over 0.79. Also, Day et al. (2003) concluded that the RPE is a reliable method for measuring intensity between training sessions. To do so, they used 5 exercises (sit-ups, bench press, bicep curl, lower neck press and triceps) and a total of 3 intensities (high, medium and low intensity), obtaining an elevated interlinking intercategory result of the RPE of 0.88 between sessions.

Recently, Tiggemann et al. (2010) analysed the RPE behavior in different weights during strength training done in three population categories (sedentary, active and trained adults), using Borg's 15 category scale to do so (6 – 20). The results showed a strong correlation between the RPE and the percentage of the RM in all three groups, in the bench press and leg press exercises (r range = 0.826 – 0.922) The authors concluded that the use of the Borg scale in gyms offers professionals an afforable and reliable way to measure intensity. Until now, when RPE and external resistence exercises have been researched, these studies were based on verifying the validity of the RPE to cuantify the intensity of the exercsies, using the total weight lifted, lactate and other scales as criteria variables (Lagally & Robertson, 2006; Robertson et al. 2003; Robertson et al. 2005). The execution velocity has been proposed as very effective criteria for measuring the intensity in strength training (González-Badillo & Sánchez-Medina, 2010; Kawamori & Newton, 2006; Pereira & Gomes, 2003). However, it is notable that in all previous studies mentioned on RPE and strength training, the fundamental criteria that is execution velocity was not taken into account. Specifically, González-Badillo & Sánchez-Medina (2010) analysed the average velocity of the propulsive phase during the bench press exercise and the correlation of the maximum weight lifted, resulting in an extremely hight correclation ($R^2 = 0.98$) between both variables. The authors reached the conclusion that it is possible to prescribe and monitor strength training based on this variable (execution velocity) instead of with a certain percentage of 1RM.

Keeping in mind the scarcity of studies found on the relationship between RPE and average execution velocity, as well as on the importance of both variables, it seems helpful to analyse the RPE and average execution velocity, using the latter as the criteria variable to cuantify the intensity of the excercises of external resistence. Therefore, the present research holds two fundamental goals: (1) to analyse the average rating of percieved exertion (RPE) through the OMNI-RES scale on the trained and untrained subjects under a weight increment protocol during the bench press; (2) to analyse the evolution of the average velocity (Vel_{mean}) and the OMNI-RES scale values of the trained and untrained subjects, in 3 intensities (initial weight [CI], maximun potential [MP] and maximum repetition [RM]) under a weight increment protocol during the bench press.

METHOD

Subjects

The sample consisted of 38 subjects, all of them students of the Faculty of Sport Sciences at the University of Granada (Spain). Table 1 summarizes the age, weight, height, RM, and RM/Body weight ratio (RM/BW) data of both groups and the total of the groups. The distinction between the groups was done via the RM/BW ratio as the criteria variable (Cormie, McGuigan, & Newton, 2010). The subjects whose RM/BW ratio was over 1, were included in G1 (Trained), while the subjects whose ratio was below 1 formed part of G2 (Untrained). Prior to the study, all the participants signed a consent form which informed them of the dangers and benefits of the study, which was approved by an ethics comittee at the University of Granada.

Table 1. Description of the sample expressed in averages (common variance).

	Group 1 (n = 19) Trained	Group 2 (n = 19) Untrained	TOTAL
Age (years)	22.61 (1.66)	22.82 (1.69)	22.71 (1.65)
Body Weight (kg)	70.28 (5.64)	74.01 (7.67)	72.09 (6.88)
Height (cm)	174.2 (2.37)	178.42 (6.95)	176.26 (6.08)
RM (kg)	77 (12)	59 (9)	68 (10.5)
RM/BW	1.1 (2.12)	0.67 (1.17)	0.89 (1.65)

Weight Increment Protocol

The experiment took place in the Performance Control Laboratory of the Faculty of Sport Sciences at the University of Granada. In the first session, the participants met in the lab to measure weight, height, and standard execution of the bench press exercise. To standardize the grip: (1) a 90º angle between the arm and forearm was used as reference, with the elbows and shoulders of the subject horizontal during the supine position. (2) The bar's projection over the chest ws standardized to stay 5 cm away from where the jugular veins and chest meet.

In the second session a weight increment protocol was done to evaluate the exercise of the Smith bench press machine. The initial weight in the protocol was that of 20 kg. Increments of 10 kg were done (for bar velocities over 0.5 m × s^{-1}) and increments of 5 kg (for bar velocities of less than 0.5 m × s-1). To avoid the effects of neural fatigue, 3 - 5 minute breaks were taken to regain strength and breath. The breaks were shorter (3 minutes) for the 10 kg increments while the longer breaks (5 minutes) were used for those with 5 kg increments. All subjects did a total of 4 - 2 sets, except with the maximum weight, where they could only do one set. The bar's movement was controlled through verbal instructions from the researchers to avoid a rebounding effect of the bar over the chest. Afterwards, a spontaneous auditive signal began to mark the start of the sets. Considering the importance of focusing on the speed of movement, subjects were encouraged to execute the movement at maximum speed before each lift (García, Moreno, Reina, & Menayo, 2011).

Devices

The bench press exercise was done on a Smith machine (Gervasport, Madrid, Spain) aptly prepared for evaluation. The total weight of the bar without discs was that of 20 kg. The bar was marked in milimeters to be able to note the individual grip of the participants. For the evaluation of the average execution velocity of each repetition of the incremental protocol a linear postition transducer (LPT) was used (T-Force System, Ergotech, Murcia, Spain). The system consists in a cable conected to the bar and the shift information is recorded, after passing through a data card in a personal computer. The LPT registers information at a frquency of 1.000 Hz.

OMNI-RES Scale

For the evaluation of the intensity exercised during the performance of each weight increment, the OMNI-RES scale was used. Directly after each subject finished a set, they were asked to judge the sensation of intensity felt, as well as being asked to point out the number on the rating of percieved exertion scale, following the process explained by Robertson et al. (2003).

Statistic analysis

All of the data is expressed in averages (variance). All the models passed the normality test (Kolmogorov – Smirnov) and the homogeniety test (Levene Test), both with a rating of $p > 0.05$. An analysis of variance (ANOVA) was done for each of the variables analysed (RPE, Vel_{mean} and weight lifted). When the sphericity supposal was not assumed, the Greenhouse-Geisser correction was applied. Bonferroni's Post Hoc was used to evaluate the significant differences of the comparisons. All the analyses were done using statistic analysis software (SPSS v.20, SPSS Inc., Chicago, Illinois, USA). The significant differences were established at a level of $p < 0.05$.

RESULTS

In Table 2 the descriptive data is summarized, expressed in averages (SD), for the variables RPE, Vel_{mean} and weight lifted (kg) in the 3 intensities analysed.

Table 2. Descriptive analysis, average (common variance) of the average velocity (Vel_{mean}), the rating of percieved exertion (RPE) and weight lifted (kg) in the three intensities analysed.

Intensity	Initial Load			Maximum Power Load			Repetitium Maximum		
Variables	Vel_{mean} ($m \times s^{-1}$)	RPE	Load (kg)	Vel_{mean} ($m \times s^{-1}$)	RPE	Load (kg)	Vel_{mean} ($m \times s^{-1}$)	RPE	Load (kg)
Group 1	1.20 (0.14)	0,42 (0.61)	20 (0)	0.67 (0.11)	4.53 (2.01)	45 (5)	0.20 (0.05)	9.58 (0.69)	77 (12)
Group 2	1.15 (0.14)	0,58 (1.12)	20 (0)	0.74 (0.07)	3.89 (1.48)	36,84 (4.7)	0,29 (0.09)	8,82 (1.07)	59 (9)

Rating of Perceived Exertion (RPE)

The ANOVA of the MR didn't show significant differences in the group variable ($F_{[2, 72]} = 2.363$; $\rho = 0.133$; $\eta 2 = 0.062$; $1–\beta = 0.322$) or in the correlation between *group x intensity* ($F_{[2, 72]} = 2.037$; $\rho = 0.138$; $\eta 2 = 0.054$; $1–\beta = 0.407$). Significant differences ($F_{[2, 72]}$; $= 503.26$; $\rho = 0.0001$; $\eta 2 = 0.93$; $1–\beta = 0.999$) were found in the *Intensity* factor. Bonferroni's Post Hoc showed significant differences ($\rho = 0.0001$, $\rho = 0.0001$ y $\rho = 0.0001$) in the comparisons in pairs between the three intensities (see Figure 1).

Average shift velocity

The ANOVA for the MR did not show significant differences in the *group* variable ($F_{[2, 72]}$ = 2.751; ρ = 0.106; η2 = 0.07; 1–β = 0.365). Significant differences were found in the *Intensity* factor ($F_{[2, 72]}$ = 784.15; ρ = 0.0001; η^2 = 0.956; 1–β = 0.999) and in the correlation between *Group x Intensity* ($F_{[2, 72]}$ = 4.869; ρ = 0.015; η^2 = 0.12; 1–β = 0.73). For the *Intensity* factor Bonferroni's Post Hoc showed significant differences (ρ = 0.0001; ρ = 0.0001 and ρ = 0.0001) during the comparison in pairs between the three intensities (CI, MP y RM, respectively). In the correlation between *Group x Intensity* Bonferroni's Post Hoc showed significant differences (ρ = 0.036 y ρ = 0.002) in the comparison of the intensities MP and RM, respectively no significant differences were found for CI (ρ = 0.282) (see Figure 1).

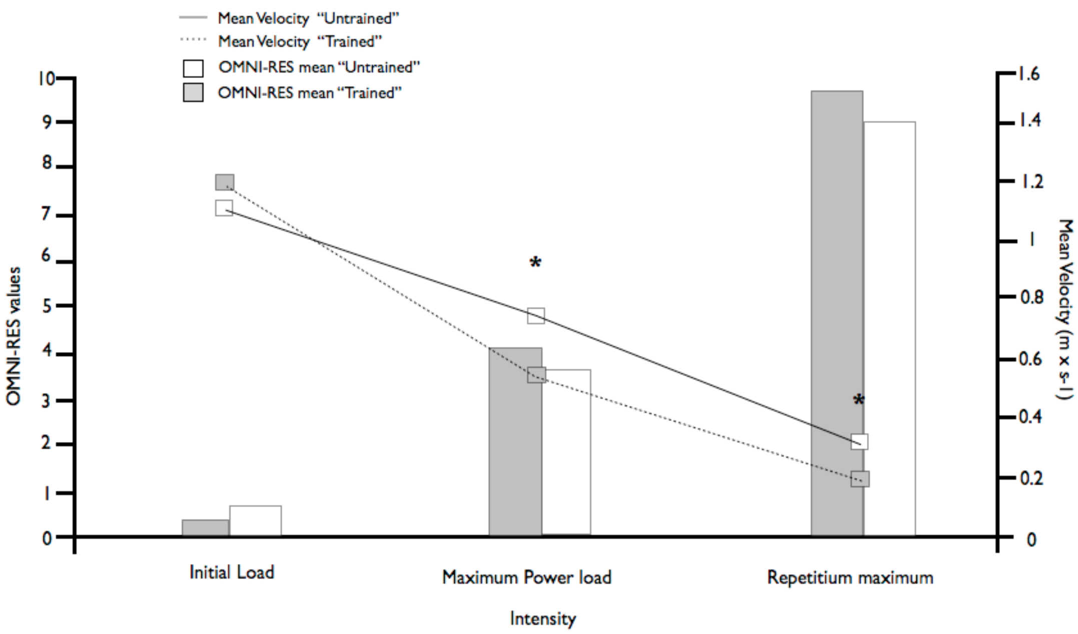

Figure 1. Evolution of the Average Velocity and Rating of Percieved Exertion in the three intensities analysed (initial weight, maximum potential and maximum repetition). * p < 0.05 in the Average Velocity variable.

Shifted weight

The ANOVA for the MR showed significant differences ($F_{[1, 36]}$ = 7.223; ρ = 0.011; η2 = 0.167; 1–β = 0.774) in the correlation between *Group x Intensity* in the weight shift variable. Bonferroni's Post Hoc showed significant diffferences (ρ = 0.0001 and ρ = 0.0001) in the comparisons of the MP and RM intensities respectively (see Figure 2). The average maximum weight shifted was higher in the Trained group, both in the MP intensity (45 ± 5 kg vs 37 ± 4.7 kg), as well as in the RM intensity (77 ± 12 kg vs 59 ± 9 kg). Due to the lack of variability of CI data, this variable was not included in the statistic analysis.

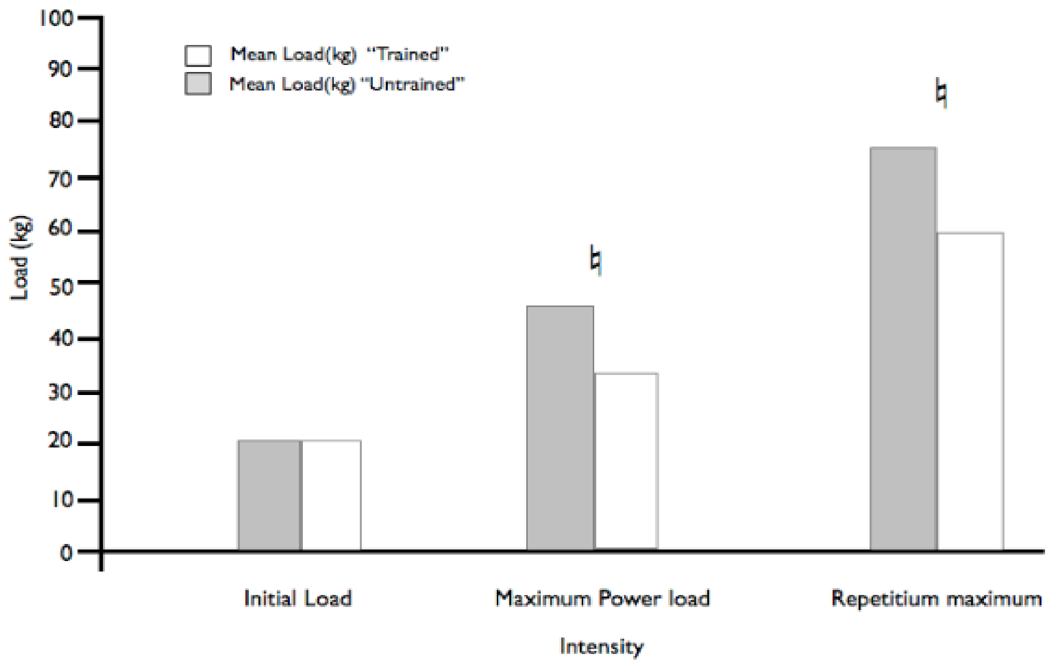

Figure 2. Weight (kg) ein the different intensities analysed (Initial Weight, Maximum Potential and Maximum Repetition). ♮ $p < 0.05$ in the weight shift variable.

DISCUSSION

In the present study, the evolution of the Vel_{mean} and RPE (measured with the OMNI- RES scale) was analysed under a weight increment protocol during the bench press exercise. On one hand, the Vel_{mean} was analysed in two gsubject groups (Trained and Untrained) using this variable as an intensity control factor. On the other hand, the RPE in both groups was compared in both the MP and RM intensities (the CI intensity was not analysed as it was the same for both groups).

In the RPE variable there were no significant differences when comparing the data between both groups, although the average RPE values in the MP intensity were higher in the Trained group. This is probably due to, in general, the Trained group shifted an average weight of 45 ± 5 kg, showing significant differences in the weight lifted, while in the Untrained group the average weight shifted in the MP intensity was that of 37 ± 4.7 kg, in other words, 20% less. But keeping in mind the relative weight data, both groups reached the average maximum potential of 62 ± 7.16 and 62 ± 9; 16% of the 1RM for the Trained and Untrained group respectively. Lagally, McCaw, Young, Medema, and Thomas (2004) compared the RPE and muscular activity of two subject groups (recreational and novice lifters) in two intensities (60 and 80% RM) in the bench press exercise. The results of this study do not show significant differences between both groups in the variables measured. Although they did find signigicant differences ($p < 0.01$) in the RM between both groups (31 ± 5.7 kg and 44 ± 11.2 kg, recreational and novice lifters, respectively) Unfortunately, the authors did not prove if significant differences were noted in the weight lifted in the 60 and 80% intensities of the 1 RM.

In the RPE variable, no significant differences between the groups were found in any of the analysed intensities (see Figure 1) although the average RPE was higher among the Trained group when compared to the Untrained group. To our knowledge, this is probably due to two interlinked factors. On one hand, the average weight lifted in both groups was that of 77 ± 12 and 59 ± 9 kg, in the Trained and Untrained group respectively. In percentages, the Trained group lifted 13% more weight creating significant differences (see Figure 2). Thus, the percieved effort of the Trained group was higher. On the other hand, the subjects belonging to the UNtrained group percieved the maximum shifted weight as a submaximum weight. Only 32% (n = 6) of the subjects pointed out the 10 value on the OMNI-RES scale. In the Trained group the porcentage of subjects that expressed a 10 value for their maximum weight was 68% (n = 10) of the total. This shows that the percieved effort of people not used to frequent training with external resistance tends to underestimate the reality of their possibilites. In the study by Sweet, Foster, McGuigan, and Brice (2004), they concluded that the RPE seems a reliable method to cuantify the intensity of the strength sessions, although the RPE the entire session seemed to be underestimated the RPE obtained directly after the different sets were carried out.

Tiggemann et al. (2010) analysed the evolution of the RPE in the bench press and leg press exercises, in three different subject groups (sedentary, active and trained adults). The main discovery in this study was that for the same RPE value there were significant differences in the percentage of weight lifted. The group of trained adults held a higher percentage of weight lifted in comparison with that of the other two groups, but the same RPE value. Analysing the data in Figure 1 of the present study, the same intensity can be seen having no significant differences between the groups. However, in the Vel_{mean} variable of both the bar shift and weight lifted, both the MP and RM intensities held significant differences. This shows us that the RPE in the intensity of the MP and the RM are greatly influenced by the Vel_{mean} din both the bar shift and the weight lifted.

In this same way, Shimano et al. (2006) measured the RPE in two groups (Trained and Untrained) in three different intensities (60, 80 and 90% of the 1RM). The results of this study did not show significant differences in the RPE of either group. The data presented in our study confirms the results obtained by Shimano et al. (2006). Of the three intensities analysed no significant differences were found in any case. Although we do keep in mind the analysis of the Vel_{mean} as a variable with which to cuantify the intensity of the exercise, significant differences were found both in the MP and Rm intensities. These results prove to us that, on one hand, measuring the effort perception to identify the intensity of the exercise can lead to an error, since the behavior of the Vel_{mean} showed significant differences in the MP and RM intensities between the Trained and Untrained groups. On the other hand, in the RPE variable no significant differences were found, unlike in the Vel_{mean} variable of the exercise's execution, since this was different in all pairings of two that compared the three intensities (see Figure 2).

Until now, none of the studies analysed the results with Vel_{mean} as the factor to cuantify the intensity of the exercise. The execution velocity of the different exercises has been proposed by different authors as another manner to control the intensity and adaptions produced in the muscles (González-Badillo & Sánchez-Medina, 2010; Kawamori & Newton, 2006; Pereira & Gomes, 2003). The importance of the execution velocity is related to potential training. To produce potential exercises, the best relationship between strength and velocity must be found. It is well-known that the greater the external weight the greater the force applied. But this relation diminishes the execution velocity. The percieved effort scales, such as OMNI-RES or Borg's CR-10 do not take into account that this factor is essential in potential training. As shown in different studies, (Naclerio et al. 2011; Robertson et al. 2008), the relation between weight and RPE is that of a positive lineal relation. The greater the weight percentage, the greater the RPE value.

The Vel_{mean} mvariable showed significant differences (see Figure 1) between both groups in the MP and RM intensities. These results show that the OMNI-REs scale is very useful to discriminate the exercise intensity with submaximum weights, both in trained subjects as well as untrained subjects, but on the other hand, the subjects that are not used to lifting maximums tend to underestimate the values percieved of the maximum weight. In this fashion, the complementary use od the Vel_{mean} to measure and adjust the actual intensity percieved would be recommendable.

Consequently, to conclude this study, we can point out that the RPE is a good method to monitor the intensity in strength exercises, although it should be pointed out that so that a greater control of the monitoring and adaptations in strength exercise would be convenient to use another complementary measurement such as the Vel_{mean} of the exercise execution. The control of this variable could help us to adjust and difenciate, with greater precision, the actual intensity of strength training.

PRACTICAL APPLICATIONS

The ONMI-RES scale is a good indicator od the intensity in strength exercises, especially with submaximum weights, but it is neccesary for this training to be able to adjust as best possible the sensation of intensity of the untrained subjects. Seeing these results, apart from using the OMNI-REs scale to evaluate the intensity of the exercises based on external resistence, another set of values such as the Vel_{mean} should be set in place to adjust the different training intensities more precisely. This way, an impact would be had over training based on stimulus quality and the search for maximum potential.

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