

**Self-selected vs programed load adjustment methods in strength and body composition: a pilot study****Métodos de ajuste de carga auto-selecionado vs programado na força e composição corporal: um estudo piloto**

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**ABSTRACT**

The aim of this study was to compare the effect of two different methods of resistance training (RT) load adjustment (self-selected vs. programmed) in strength and body composition outcomes. Fourteen resistance-trained college-level students (5 females and 9 males), (age:  $21.4 \pm 2.23$  years; height:  $1.71 \pm 0.08$  m and body mass:  $77.6 \pm 11.9$  kg) were randomly assigned to one of the following experimental groups: Self-selected load adjustment (SSLA), where loads were arbitrarily/subjectively increased by each participant; Programmed load adjustment (PLA), where an absolute load increment was implemented according to the number of repetitions performed in the last set of each exercise. Four weekly sessions were performed during a 7-week intervention. Maximal dynamic strength and muscular endurance were assessed through one repetition maximum (1RM) and 60% 1RM tests for both upper and lower limbs in bench press and unilateral leg press exercises, respectively. A moderate ES was observed for both groups in 1RM<sub>LEG PRESS</sub> (SSLA:  $d = 0.96$ ; PLA:  $d = 1.13$ ) and 60% 1RM<sub>BENCH PRESS</sub> (SSLA = 0.88; PLA = 1.00). Trivial ( $d = 0.19$ ) and small ( $d = 0.24$ ) ES in 1RM<sub>BENCH PRESS</sub> were observed for SSLA and PLA groups, respectively. The only variable that presented large ES was 60% 1RM<sub>LEG PRESS</sub> for SSLA ( $d = 1.29$ ). The sum of skinfolds presented moderate ES for PLA ( $d=0.68$ ) and small for SSLA ( $d = 0.39$ ). In conclusion, different methods of RT load adjustments induce similar effects in strength and body composition in recreationally trained individuals.

**Keywords:** Training; Low intensity; Neuromuscular; Adaptations; Loading.

**RESUMO**

O objetivo deste estudo foi comparar o efeito de dois métodos diferentes de ajuste da carga do treinamento resistido (TR) (auto-selecionado vs. programado) nos resultados de força e composição corporal. Quatorze estudantes de nível universitário treinados em resistência (5 mulheres e 9 homens), (idade:  $21,4 \pm 2,23$  anos; altura:  $1,71 \pm 0,08$ m e massa corporal:  $77,6 \pm 11,9$  kg) foram aleatoriamente designados para um dos seguintes grupos experimentais: Ajuste de carga auto-selecionado (SSLA), onde as cargas foram arbitrária / subjetivamente aumentadas por cada participante; Ajuste de carga programado (PLA), onde um incremento absoluto de carga foi implementado de acordo com o número de repetições realizadas no último conjunto de cada exercício. Quatro sessões semanais foram realizadas durante uma intervenção de 7 semanas. A força dinâmica máxima e a resistência muscular foram avaliadas através dos testes de uma repetição máxima (1RM) e 60% de 1RM para membros superiores e inferiores nos exercícios supino reto e leg press unilateral, respectivamente. Um ES moderado foi observado para ambos os grupos em 1RM<sub>LEG PRESS</sub> (SSLA:  $d = 0,96$ ; PLA:  $d = 1,13$ ) e 60% 1RM<sub>BENCH PRESS</sub> (SSLA = 0,88; PLA = 1,00). ES trivial ( $d = 0,19$ ) e pequeno ( $d = 0,24$ ) no 1RM<sub>BENCH PRESS</sub> foram observados nos grupos SSLA e PLA, respectivamente. A única variável que apresentou ES elevado foi 60% de 1RM<sub>LEG PRESS</sub> para SSLA ( $d = 1,29$ ). A soma das dobras cutâneas apresentou ES moderada para o PLA ( $d = 0,68$ ) e pequena para o SSLA ( $d = 0,39$ ). Em conclusão, diferentes métodos de ajuste da carga de TR induzem efeitos semelhantes na força e na composição corporal em indivíduos treinados em recreação.

**Palavras-chave:** Treinamento; Intensidade baixa; Neuromuscular; Adaptações; Carregando.

## 1 INTRODUCTION

The adjustment of resistance training (RT) loads is of great relevance in the promotion of improvements in training adaptive responses. However, RT coaches frequently fail to adopt an optimal strategy in order to appropriately adjust such loads and implement a higher progressive overload stimulus during a training period. Delorme and Watkins (1948) were pioneer in describing the relevance of training with progressive loads for increasing strength and skeletal muscle hypertrophy.

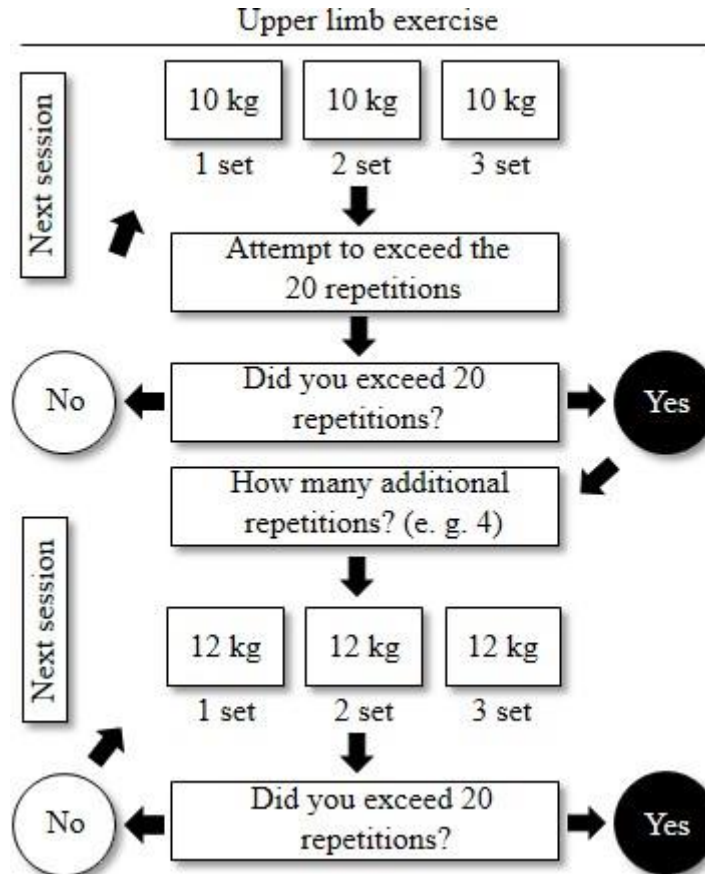
Training intensity is a relevant RT variable, and its proper manipulation can induce significant neuromuscular and morphological responses (CAMPOS et al., 2002). On the other hand, RT practitioner's self-selection of load and/or the absence of an experient training coach, might reduce the magnitude of the outcomes induced by a training program (FOCHT, 2007; FOCHT et al., 2015; LIMA-SILVA et al., 2007). However, literature is still scarce regarding chronic effects of different load adjustment approaches in previously trained individuals. Therefore, the purpose of this study was to compare the effect of 2 different methods of RT load adjustment (self-selected vs. programmed) in maximal strength, muscular endurance and body composition outcomes. The initial hypothesis of the study was that both load adjustment protocols would promote improvements in the dependent variables assessed, but with larger increases for subjects submitted to a programmed load adjustment.

## 2 MATERIALS AND METHODS

### 2.1 EXPERIMENTAL APPROACH TO THE PROBLEM

The present study followed a randomized-longitudinal design. Participants were initially submitted to a period of 8 familiarization sessions performing the exercises that would be adopted during the intervention. Three sets of 15-20 maximum repetitions were performed. After the familiarization sessions, participants were then allocated in one of the following experimental groups according to baseline maximal strength values: Self-selected load adjustment (SSLA) and Programmed load adjustment (PLA). Participants from both groups were instructed to perform 15-20RM for 3 sets in each exercise. For PLA, in case of exceeding 20 repetitions in the last set, the initial load adopted in the next training session would be the number of exceeded repetitions multiplied by 0.5kg (upper limbs) or 1.0 kg (lower limbs) (RODRIGUES, 2001) (figure 1). For SSLA, participants were able to maintain or increase the training load of each exercise in arbitrary/subjective fashion.

Figure 1. Load adjustment routine for the group with Programmed Load Adjustment.



## 2.2 PARTICIPANTS

Fourteen recreationally trained college-level students (5 females and 9 males), (age:  $21.4 \pm 2.23$  years [range:18-27], height:  $1.71 \pm 0.08$  m and body mass:  $77.6 \pm 11.9$  kg) participated the study. To be able to participate in the study, participants should present a minimal RT experience of 6 months, be free from any existing musculoskeletal disorders, present no history of injury with residual symptoms in the trunk, upper and lower limbs within the last year, state that they had not taken anabolic steroids or nutritional supplements for a minimum period of 6 months and have not being performing any type of RT for 30 days previously to the intervention. Additionally, participants were instructed to maintain their usual food intake and daily activities during the training period. This study was approved by the University's research ethics committee (Protocol No. 39/13) and was conducted in accordance with the Declaration of Helsinki; all subjects read and signed an informed consent document.

*-Resistance training protocol.* Two different split-training routines consisting of 9 exercises each were performed during the 7-week intervention period by both groups. Training routine A (Monday and Thursday): bench press, incline bench press, incline dumbbell press, dumbbell hammer curl, biceps curl, dumbbell preacher curl, leg extension, leg press 45°, unilateral horizontal leg

machine. Training routine B (Tuesday and Friday): lat pull-down (pronated-grip), lat pull-down (supinated-grip), seated row, cable triceps press-down, “nosebreaker”, rope triceps press-down, leg curl machine, standing leg curl and lunge. A passive rest of 60 seconds between sets and exercises was adopted (DE SALLES et al., 2009). All sessions, exercises, and load adjustments were monitored by the same researchers.

*-Body Composition Assessments.* Assessments of body mass, height and the sum of 9 skinfolds (pectoral, middle axillary, subscapular, triceps, biceps, suprailiac, abdominal, thigh and medial calf) were performed in the pre and post-intervention moments (GUEDES, 1985).

*-Maximal dynamic strength.* Upper- and lower-body maximum strength was assessed by 1RM testing in the bench press ( $1RM_{\text{BENCH PRESS}}$ ) and unilateral leg press ( $1RM_{\text{LEG PRESS}}$ ) exercises. Participants attended to the laboratory having refrained from any exercise other than activities of daily living for at least 48 hours before baseline assessments and after the last training session of the intervention period. Maximum strength testing was consistent with recognized guidelines, as established by the NSCA (BAECHLE and EARLE, 2008).

*-Muscle endurance.* Ten minutes after 1RM tests, participants performed as many repetitions as possible until muscle failure at 60% of 1RM load on both the bench press ( $60\% 1RM_{\text{BENCH PRESS}}$ ) and unilateral leg press ( $60\% 1RM_{\text{LEG PRESS}}$ ) exercises (CAMPOS et al., 2002).

### 2.3 STATISTICAL ANALYSIS

For the comparisons between 2 means, the effect size (ES) was calculated by Cohen's d. For the ES in the time factor (pre vs. post) the formula  $d = (\text{mean 1} - \text{Mean of 2}) / \text{standard deviation combined (combined DP)}$  was used. The combined DP was calculated by the formula  $\sqrt{((DP^2 \text{ of variable 1} + DP^2 \text{ of variable 2}) / 2)}$  (LAKENS, 2013). For comparison of the moments between groups, the assumptions discussed in Dankel et al. (2017), using the formula  $d = (\text{mean of the absolute changes of group 1} - \text{mean of the absolute changes of group 2}) / \text{combined standard deviation (combined DP)}$  were adopted. Values of  $d < 0.2$ , 0.2-0.6, 0.6-1.2, 1.2-2.0, 2.0-4.0 and 4.0 were considered to be trivial, small, moderate, large, very large and extremely large, respectively (HOPKINS et al., 2009). The 90% confidence interval (CI90%) of the ES differences was calculated. When CI90% exceeded trivial ES ( $d < 0.2$ ), the difference was considered "unclear". The percentage delta between the differences ( $\Delta\%$ ) was calculated by the formula  $\Delta\% = [(value 1 - value 2 / value 2) * 100]$  (DANKEL et al., 2017). The minimum detectable difference (MDD) of the dependent variables was also calculated using the formula  $MDD = \text{standard deviation of post - pre - differences} \times 0.5$  (HOPKINS et al., 2009). We defined an individual as “responding” to training with a response

greater than 1MDD from zero for increases in dependent-variables; if not, he was considered as a “nonresponder”.

### 3 RESULTS

Table 1 presents values of maximal strength, muscular endurance and body composition for pre- and post-intervention moments. A moderate ES was observed for both groups in  $1RM_{LEG PRESS}$  (SSLA = 0.96, CI90% = 0.50 to 1.42; PLA = 1.13, CI90% = 0.72 to 1.44) and 60%  $1RM_{BENCH PRESS}$  (SSLA = 0.88, CI90% = 0.54 to 1.12; PLA = 1.00, CI90% = 0.53 to 1.47). Trivial ( $d = 0.19$ , CI90% = -0.30 to 0.68) and small ( $d = 0.24$ , CI90% = -0.22 to 0.70) ES in  $1RM_{BENCH PRESS}$  were observed for SSLA and PLA groups, respectively. The only variable that presented large ES was 60%  $1RM_{LEG PRESS}$  for SSLA ( $d = 1.29$ , CI90% = 0.72 to 1.57). The sum of skinfolds presented moderate ES for PLA (0.68, CI90% = 0.12 to 1.04) and small for SSLA ( $d = 0.39$ , CI90% = -0.02 to 0.80).

All differences calculated between the SSLA vs. PLA groups were small or trivial and considered unclear, since the CI90% did not exceed the trivial zone. The values found were: sum of skinfolds (ES = 0.27, CI90% 0.07 to 0.47), 60%  $1RM_{LEG PRESS}$  (ES = 0.38, CI90% 0.08 to 0.68), 60%  $1RM_{BENCH PRESS}$  (ES = 0.25, CI90% 0.09 to 0.40),  $1RM_{LEG PRESS}$  (ES = -0.31, -0.51 to -0.11),  $1RM_{BENCH PRESS}$  (ES = -0.18, CI90% -0.48 to 0.12).

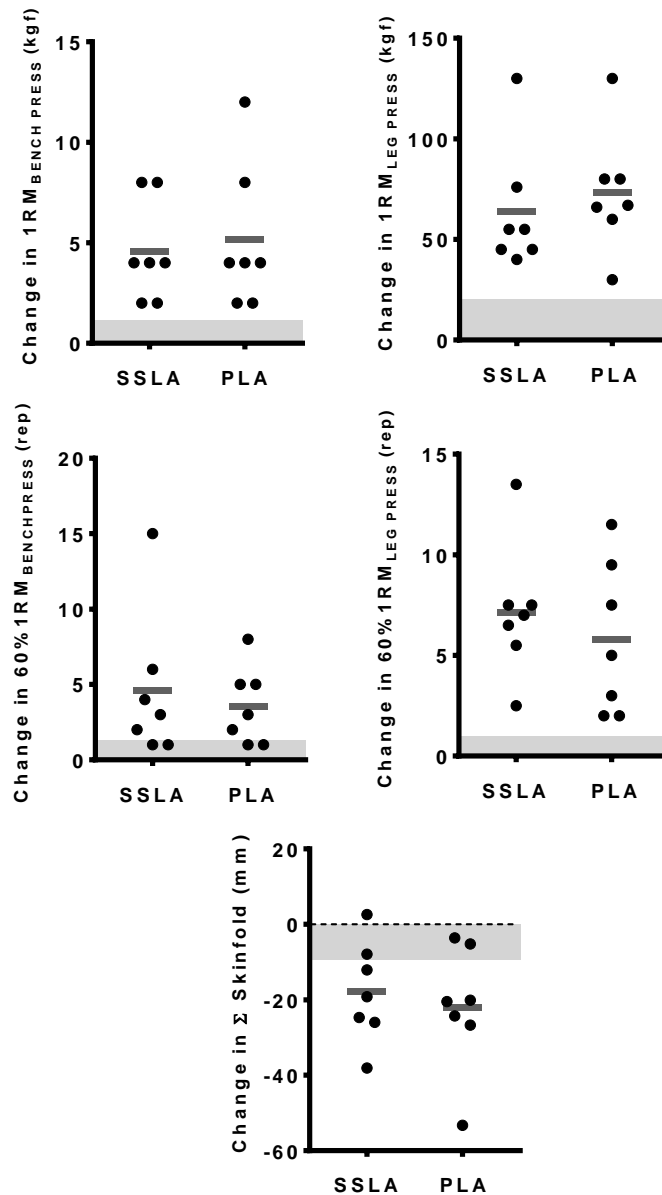
Figure 2 presents the analysis of individual responsiveness (> MDD) in the intervention period. The calculated values of MDD were:  $1RM_{BENCH PRESS} = 1.5$  kgf,  $1RM_{LEG PRESS} = 15.1$  kgf, 60%  $1RM_{BENCH PRESS} = 2$  replicates, 60%  $1RM_{LEG PRESS} = 2$  replicates and  $\Sigma$  skinfolds = 8 millimeters. Except for 60%  $1RM_{BENCH PRESS}$  and  $\Sigma$  skinfold variables (2 nonresponsive subjects per group), all volunteers presented increases above MDD areas for all the dependent variables assessed.

**Table 1.** Values of maximal strength, muscle endurance and body composition during the pre- and post-intervention moments.

Variables	Pre	Post	$\Delta\%$	MD [95%CI]	ES
<b>1RM<sub>BENCH PRESS</sub> (kgf)</b>					
SSLA	52 ± 24	56 ± 24	8.8	4 [3.2 to 5.8]	0.19
PLA	64 ± 21	69 ± 21	8.1	5 [3.5 to 6.5]	0.24
<b>1RM<sub>LEG PRESS</sub> (kgf)</b>					
SSLA	234 ± 66	298 ± 67	27.2	64 [41 to 87]	0.96
PLA	300 ± 21	374 ± 66	24.4	74 [70 to 88]	1.13
<b>60% 1RM<sub>BENCH PRESS</sub> (rep)</b>					
SSLA	19.9 ± 4.2	24.4 ± 6.1	23.0	4.5 [1.2 to 7.8]	0.88
PLA	23.1 ± 3.2	26.7 ± 3.9	15.4	3.6 [2.2 to 5.0]	1.00
<b>60% 1RM<sub>LEG PRESS</sub> (rep)</b>					
SSLA	23.7 ± 6.1	30.9 ± 4.9	30.1	7.2 [3.2 to 11.2]	1.29*
PLA	31.8 ± 6.9	37.6 ± 6.6	18.2	5.8 [2.2 to 9.4]	0.86
<b><math>\Sigma</math> Skinfolds (mm)</b>					
SSLA	189 ± 41	171 ± 49	-9.5	-18 [-24 to -12]	0.39
PLA	206 ± 37	184 ± 27	-10.7	-22 [-17 to -27]	0.68

SSLA = self-selected load adjustment group; PLA = programmed load adjustment; 1RM = one maximum repetition; ES = effect size; rep = repetitions;  $\Sigma$  = sum; MD [95% CI] = mean difference with 95% confidence interval. \* Large ES.

**Figure 2.** Scatterplots graphs with the mean (dark gray line) of the absolute difference of the post-dependent variables with pre-intervention. Black circle represent participants. The gray area represents the minimal detectable difference (see methods). SSLA = s.



#### 4 DISCUSSION

The main finding of the present study is that an auto-regulated RT load adjustment method is as effective as a programmed one to induce improvements in maximal strength, muscular endurance and a reduction in the sum of skinfolds in recreationally-trained individuals. The initial hypothesis (larger improvements for the PLA group) was not confirmed, since no differences were observed in between groups analysis for any assessments, since both ES and/or CI 90% crossed the trivial area for each dependent variable (unclear differences).



For  $1RM_{\text{BENCH PRESS}}$ , trivial ( $d=0.19$ ) and small ( $d=0.24$ ) ES were observed for SSLA and PLA groups, respectively. A moderate ES was observed for both groups in  $1RM_{\text{LEG PRESS}}$  ( $d=0.96$  and  $d=1.13$  for SSLA and PLA, respectively) and  $60\% 1RM_{\text{BENCH PRESS}}$  ( $d=0.88$  and  $d=1.0$  for SSLA and PLA, respectively). For  $60\% 1RM_{\text{LEG PRESS}}$ , large ( $d=1.29$ ) and moderate ( $0.86$ ) ES were observed for SSLA and PLA, respectively. For the sum of skinfolds, small ( $d=0.39$ ) and moderate ( $0.68$ ) ES were observed for SSLA and PLA, respectively.

Although speculative, the absence of differences between the methods of load adjustment adopted in the present study might be justified by an eventual equal total training volume (TTV) performed between both experimental groups during the 7 training weeks. Such variable has been shown to strongly influence muscle strength and mass increases induced by a RT program (SOONESTE et al., 2013). Additionally, independently of the manipulation of training variables, RT protocols equalized for TTV result in the same magnitude of strength and morphological adaptations (AHTIAINEN et al., 2003). Future studies with a specific control of the accumulated TTV induced by these distinct methods must be performed in order to confirm or refute the findings of the present study. The similar results observed between groups may also be explained by the fact that all participants, independently of the load adjustment method adopted, performed all sets to the point of concentric muscular failure, which has been shown to be an important factor when strength increments are desired, specifically when lighter training loads are adopted during a RT program (LASEVICIUS et al., 2019).

Given the large variability usually observed between individuals submitted to a RT protocol, an analysis of each participant's responsiveness is of great relevance to better understand the effects of the intervention and draw evidence-based inferences. Although a low-intensity protocol was adopted in the present study, all participants from both groups presented increments above MDD in 1RM tests. Previous studies have reported that low-intensity RT schedules can induce significant increases in muscle strength, although in a smaller magnitude compared to high-intensity ones (SCHOENFELD et al., 2015; LASEVICIUS et al., 2018; RODRIGUES et al., 2019). Future investigations adopting higher intensities are encouraged in order to clarify if the effects of distinct load adjustments would be different from those reported from our data. For muscle endurance, even though 28% of the participants did not present increases above the MDD for  $60\% 1RM_{\text{BENCH PRESS}}$ , all the participants responded above MDD for  $60\% 1RM_{\text{LEG PRESS}}$ . Additionally, the higher percentual increases in  $60\% 1RM$  compared to 1RM tests confirm that neuromuscular adaptations might follow a continuum order, where low and high intensities induce larger increments in muscle endurance and maximal strength, respectively (CAMPOS et al., 2002).

The present study is not without limitations. First, the design (longitudinal pilot study) and the small sample size adopted limited statistical inferences through the adoption of proper hypothesis tests. Second, the 7-week duration of training protocol might not have been long enough to detect possible large differences between load adjustments methods on the variables assessed. Third, the assessment of possible local morphological adaptations adopting valid/refined instrumentations (e.g, ultrasound, magnetic resonance) may represent a greater understanding about eventual differences between distinct load regulation methods. Additionally, even though participants were instructed to maintain their usual dietary habits, no specific assessment (24-hour food recall) of daily nutrient intake was adopted. Then, possible influences of nutritional variables in the results must not be ignored. The authors of the present study strongly encourage longer interventions, with a larger sample size and more accurate morphological assessments in order to draw evidence-based conclusions regarding possible differences in muscle adaptations induced by distinct RT load adjustment methods.

## 5 CONCLUSION

In conclusion, distinct methods of load adjustments during a RT program induce similar neuromuscular and body composition outcomes in resistance-trained individuals.

Individuals with previous experience in RT may present strength and body composition improvements adopting an auto regulated or a programmed load adjustment method. From a practical standpoint, personal preferences and the presence (or absence) of a RT coach must influence which method should be adopted during a training program.

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