ACUTE EFFECT OF DIFFERENT LOADS ON MUSCLE PERFORMANCE AND PERCEIVED EXERTION IN YOUNG WOMEN

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EFEITO AGUDO DE DIFERENTES CARGAS NO DESEMPENHO MUSCULAR E ESFORÇO PERCEBIDO EM MULHERES JOVENS

EFECTO AGUDO DE DISTINTAS CARGAS SOBRE EL DESEMPEÑO MUSCULAR Y EL ESFUERZO PERCIBIDO EN MUJERES JÓVENES

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ABSTRACT

Introduction: Load reduction using the repetition maximum (RM) method may be necessary to promote higher numbers of repetitions, and consequently, higher total volume, time under tension, and perceived exertion ratings. Objective: To compare the effects of different leg press exercise loads on number of repetitions, total volume, time under tension, and perceived exertion. Methods: Eighteen women university students (23.9 ± 3.8 years) performed two experimental sessions with 90% and 100% of 10-12 RM in a balanced crossover design. Results: The number of repetitions of the second and third sets, the total volume, and time under tension at 90% of 10-12 RM was statistically higher than at 100% of 10-12 RM ($p < 0.05$). The perceived exertion of the first and second sets and the training load (perceived exertion x duration of sessions) were higher at 100% of the 10-12 RM session ($p < 0.05$). Conclusion: A small reduction in load results in a greater number of repetitions, total volume, and time under tension. The session with the higher load appeared to induce higher perceived exertion and training load. Thus, scientists and coaches might consider lower loads to maximize the number of repetitions, total volume, and time under tension, which may cause greater long-term muscular adaptations. ***Level of evidence II; Comparative prospective study.***

Keywords: Lower limb; Muscle fatigue; Muscle strength; Resistance training.

RESUMO

Introdução: A redução da carga pelo método das repetições máximas (RM) pode ser necessária para promover maior número de repetições e, consequentemente, maior volume total, tempo sob tensão e classificações do esforço percebido. Objetivo: Comparar os efeitos de diferentes cargas do exercício leg press no número de repetições, volume total, tempo sob tensão e percepção de esforço. Métodos: Dezoito universitárias (23,9 ± 3,8 anos) realizaram duas sessões experimentais com 90% e 100% de 10-12 RM em desenho transversal balanceado. Resultados: O número de repetições da segunda e terceira séries, volume total e tempo sob tensão a 90% de 10-12 RM foi estatisticamente maior do que a 100% de 10-12 RM ($p < 0,05$). A percepção do esforço da primeira e segunda séries e a carga de treinamento (percepção do esforço x duração das sessões) foram maiores na sessão realizada com 100% de 10-12 RM ($p < 0,05$). Conclusão: Uma pequena redução da carga resulta em maior número de repetições, volume total e tempo sob tensão. A sessão com maior carga induziu maior percepção do esforço e carga de treinamento. Assim, cientistas e treinadores podem considerar cargas menores para maximizar o número de repetições, o volume total e o tempo sob tensão, o que pode causar maiores adaptações musculares a longo prazo. ***Nível de evidência II; Estudo prospectivo comparativo.***

Descritores: *Membro inferior; Fadiga muscular; Força muscular; Treinamento de Força.*

RESUMEN

Introducción: La reducción de la carga por el método *de las repeticiones máximas (RM) puede ser necesaria para promover un mayor número de repeticiones y, consecuentemente, un mayor volumen total, tiempo bajo tensión y calificaciones del esfuerzo percibido. Objetivo: Comparar los efectos de diferentes cargas del ejercicio de prensa de piernas sobre el número de repeticiones, volumen, tiempo bajo tensión y esfuerzo percibido. Métodos: Dieciocho estudiantes universitarios (23,9 ± 3,8 años) realizaron dos sesiones experimentales con el 90% y el 100% de 10-12 RM en un diseño trasversal equilibrado. Resultados: El número de repeticiones de la segunda y tercera serie, el volumen total y el tiempo bajo tensión al 90% de 10-12 RM fue estadísticamente mayor que al 100% de 10-12 RM ($p < 0,05$). El esfuerzo percibido de la primera y segunda serie y la carga de entrenamiento (esfuerzo percibido x duración de las sesiones) fueron superiores en la sesión realizada al 100% de 10-12 RM ($p < 0,05$). Conclusión: Una pequeña reducción de la carga da lugar a un mayor número de repeticiones, volumen total y tiempo bajo tensión. La sesión con mayor carga indujo un mayor*

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esfuerzo percibido y carga de entrenamiento. Por lo tanto, los científicos y entrenadores pueden considerar cargas más bajas para maximizar el número de repeticiones, el volumen total y el tiempo bajo tensión, lo que puede causar mayores adaptaciones musculares a largo plazo. ***Nivel de evidencia II; Estudio prospectivo comparativo.***

Descriptores: *Miembro inferior; Fatiga muscular; Fuerza muscular; Entrenamiento de Fuerza.*

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INTRODUCTION

Resistance training programs are an excellent strategy to promote increases in strength and muscular hypertrophy.[1] In order to optimize muscular adaptations, several protocols may be designed by manipulating different variables, i.e., intensity, loads, volume, weekly frequency, contraction velocity, order of exercises and rest interval between sets and exercise.[1] According to American College of Sports Medicine,[1] the variations using such variables represent a specific stimulus, which may lead to alterations in different biological systems and achieve specific goal over time.

The load of resistance exercise may be determined by the repetition maximum (RM) method, which is characterized by concentric muscular fatigue in a range of repetitions.[1] When this method is applied in multiple sets, with initial absolute load, significant reductions in repetitions occur in subsequent sets.[2-4] In consequence, this reduction in the repetitions promotes lower total volume (∑ repetitions x load) and time under tension (duration of sets). Given that total volume and time under tension are important variables to provide an increase in myofibrillar protein synthesis and long-term muscular adaptations,[5-7] it is additional strategy is needed when RM method is used.

Several studies have demonstrated that a small load reduction using the RM method may be necessary to promote maintenance in the number of repetitions in subsequent sets and, consequently, a higher total volume and timer under tension in resistance exercise sessions.[8-13] In young women, a session performed with three sets at 90% of 10-12 RM promoted greater total volume (27.5%) compared to 100% of 10-12 RM in the elbow flexor muscles.[11] Notably, Calori et al.[13] showed that three sets at 90% of 15 RM in the leg press exercise resulted in higher total volume (22.5%) when compared to 100% of 15 RM in trained older people. Although these studies provide valuable information about manipulation of the load on number of repetitions, total volume, and time under tension, it seems that the magnitude of these responses may vary according to the load, exercise, and age of the sample. In this perspective, analyses of the effects of different loads in the leg press exercise on muscular performance may provide additional information in young women.

The ratings of perceived exertion (RPE) assessments may be another strategy for monitoring load during a resistance exercise session.[14-18] Moreover, some evidence has suggested that RPE is a reliable and valid method to provide a global rating regarding session training stimulus.[19-21] Some studies have shown that different loads prescribed according to the percentage of one maximal repetition (1 RM) promote distinct responses in RPE.[18,19,22] In this perspective, it is important to verify whether RPE scales are sensitive to identify small reductions in loads prescribed by the RM method. Thus, the purpose of this study was to examine the acute effects of resistance exercise sessions performed at 90% and 100% of 10-12 RM on number of repetitions, total volume, time under tension, and RPE in young women.

MATERIAL AND METHODS

Eighteen students from the local university (23.9 ± 3.8 years, 58.2 ± 5.1 kg, 162.8 ± 6.8 cm) participated in the study. The study included young women between 18 and 32 years, resistance-trained at least three times a week, for at least eight weeks prior to participation in this study, and absence of any contraindications involving the cardiovascular, neuromuscular, and skeletal systems. Participants were excluded if they did not complete all experimental sessions of the study. Information on the objectives and procedures of the study was provided to participants, who signed the appropriate informed consent. This study was approved by the local Ethics Committee (CAAE: 99340018.1.0000.5430), according to the Declaration of Helsinki.

A randomized and counterbalanced within-subject design was used to verify the effects of different loads on muscle performance and ratings of perceived exertion. Participants visited the laboratory six times, on nonconsecutive days. Two sessions were conducted to familiarize the participants with study procedures. In the two subsequent sessions, loads of 10-12 RM were tested and retested in the leg press exercise. On days five and six, the participants performed two experimental sessions at 90% of 10-12 RM (i.e., two sets of 12 repetitions and one final set until concentric muscle failure) and 100% of 10-12 RM (i.e., three sets to concentric muscle failure). In both sessions, the rest interval between sets was of 2-min. Total volume of each experimental session was registered (∑ repetitions x load). The duration of each set was recorded from the beginning of the first repetition to the end of the last repetition using a handheld stopwatch (Vollo®, Model VL-1809; Cotia, SP, Brazil). The time under tension was defined as the sum of the duration of the three sets (∑ duration of the three sets in seconds). The ratings of perceived exertion were measured immediately after each set and 30-min post-session. All participants performed the sessions at the same hour of the day and no vigorous exercise was performed 24 hours preceding testing.

The 10-12 RM was assessed using bilateral 45º leg press (Movement, São Paulo, SP, Brazil) and loads with a precision of 1.0 kg.[2] The adjustment of the equipment and feet position of the participants was recorded and used in all experimental sessions. Initially, all participants performed two warm-up set (eight repetitions at 30% of 10-12 RM and three repetitions at 80% of 10-12 RM, respectively). Two minutes after the warm-up, the individuals were instructed to execute the greatest number of repetitions until concentric muscle failure. Afterwards, the loads were adjusted according to maximum number of repetitions. A maximum of three trials per session were tested, with a 10-min rest interval between trials. The repetitions were performed in approximately three seconds in the concentric and eccentric phases. No pauses were allowed during the sets and only repetitions executed with full range of motion were recorded. Participants were motivated by strong verbal stimuli during all tests. All sessions were monitored by study researchers. The ICC for the 10-12 RM assessments was 0.79 (95% CI; 0.45 to 0.92) and the typical error of measurement was 0.89 repetitions.

The RPE was assessed after each set and 30-min post both experimental sessions using the Borg CR-10 category scale.[14] Participants were familiarized with the Borg CR-10 two weeks prior to the start of the experimental sessions. Training load of the experimental sessions was calculated by multiplying the RPE by session duration in minutes (training load = CR-10 * duration of the session).

The normal distribution of the data was assessed using the *Shapiro-Wilk* test. A paired Student-t test was used to compare total volume and time under tension between the different experimental sessions. The effects of different loads on number of repetitions and ratings of perceived exertion of each set were examined using a two-way analysis of variance (ANOVA), with repeated measures on the sets factor. The Scheffé post-hoc test for multiple comparisons was used whenever necessary. Intra-class correlation coefficient (ICC) and typical measurement error of the 10-12 RM assessments were calculated.[23] Data are expressed as mean and standard deviation values. The level of significance was set at $p < 0.05$. Statistical analysis was performed using Statistica™ program, version 7.0.

RESULTS

The number of repetitions in the different experimental sessions is shown in Figure 1. A significant decrease in the number of repetitions was observed from the first to the second and third sets in the session performed at 100% of 10-12 RM ($p < 0.05$). In the session performed at 90% of 10-12 RM, the number of repetitions was significantly increased for the third set, when compared to the first and second sets ($p < 0.05$). A higher number of repetitions in the second and third sets were observed in the session performed at 90% of 10-12 RM compared to 100% of 10-12 RM ($p < 0.05$).

Figure 2 shows the values of the total volume and time under tension of the different experimental sessions. The session performed at 90% of 10-12 RM demonstrated a higher total volume and time under tension than the session at 100% of 10-12 RM ($p < 0.05$).

The values of the RPE are shown in Figure 3. In both experimental sessions, there was a significant increase in the RPE in the second and third sets compared with the first set ($p < 0.05$). The 100% of 10-12 RM session resulted in a higher RPE in the first and second sets than the 90% of 10-12 RM session ($p < 0.05$). The session performed at 100% of 10-12 RM showed higher training load compared with 90% of 10-12 RM ($p < 0.05$).

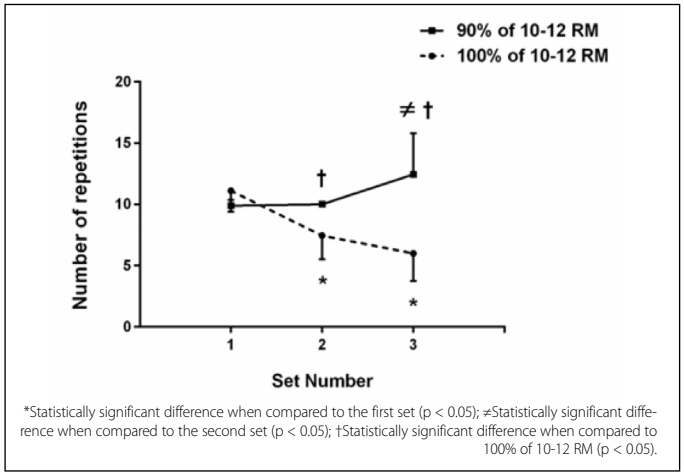

Figure 1. Number of repetitions performed at different loads in the leg press exercise in trained young women (n = 18). All values are presented as mean ± standard deviation.

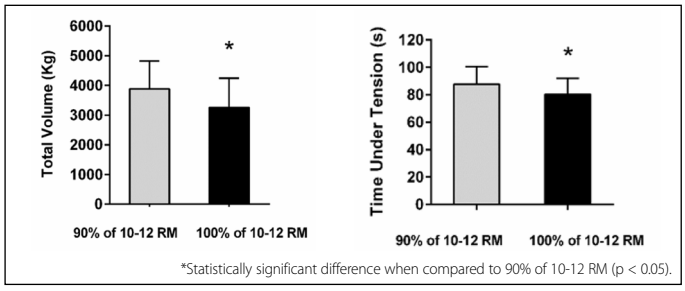

Figure 2. Total volume and time under tension of experimental sessions performed at different loads in the leg press exercise in trained young women (n = 18). RM = maximum repetitions. All values are presented as mean ± standard deviation.

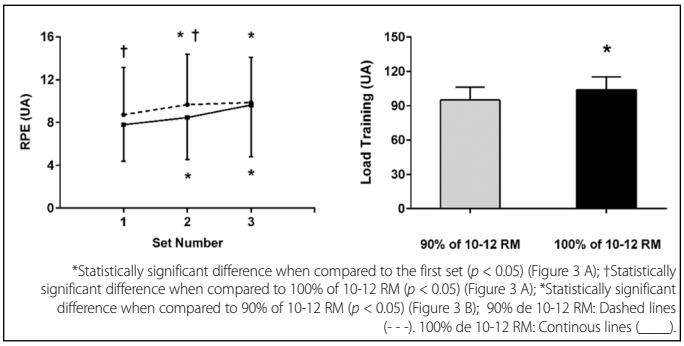

Figure 3. Ratings of perceived exertion (RPE) of sessions performed at different loads in the leg press exercise in trained young women (n = 18).

DISCUSSION

The results demonstrated a higher number of repetitions in the second and third sets in the session performed at 90% of 10-12 RM compared to the session at 100% of 10-12 RM. The present findings corroborated with previous evidence, showing reductions in the number of repetitions between the first and subsequent sets, when multiple sets were performed in a given RM zone, without reductions in the absolute load.[2-4] Different physiological mechanisms appear to contribute to this phenomenon during sessions of resistance exercise, including alterations in central and peripheral activation, as well as modifications in intracellular energy metabolism and contractile functions.[24-26] Benson et al.,[9] for example, showed that 90% and 100% of 10-12 RM promotes similar decreases in integrated electromyography (-18.1% and -16.8%) and increases in blood lactate in trained young people.

In the present investigation, the session performed at 90% of 10-12 RM demonstrated a significantly higher total volume (19.0%) than the session at 100% of 10-12 RM. Similar to our results, Jambassi Filho et al.[11] showed that a session performed at 90% of 10-12 RM in the elbow flexor exercise resulted in greater total volume (27.5%) when compared to the session at 100% of 10-12 RM, in young people. Calori et al.[13] also observed that 90% of 15 RM provided higher total volume (22.5%) when compared to 100% of 15 RM in the leg-press exercise in older people. Taken together, these findings suggest that higher total volume is observed with a small load reduction and the magnitude of the responses can be influenced by load, exercise, and age.

It has been shown that greater time under muscle tension during resistance exercise stimulates an increase in myofibrillar protein synthesis,[5] which may be important in optimizing muscle growth. In the present study, the session performed at 90% of 10-12 RM also produced greater time under tension (9.5%), compared to 100% of 10-12 RM. In this perspective, our results suggest that slight load reductions seem to be sufficient to cause increases in time under tension and, possibly, a greater potential anabolic response.

The RPE has been used to quantify intensity during sets and training load, i.e., perceived stress in entire training sessions.[18,20] In the present study, increases in the RPE were observed in the second and third sets when compared with the first set in both experimental sessions, indicating an increase in intensity in subsequent sets. Moreover, the RPE in the first and second sets was higher at 100% of 10-12 RM compared to 90% of 10-12 RM (12.1% and 14.2%, respectively). The session performed at 100% of 10-12 RM also caused higher training load (9.5%) compared to 90% of 10-12 RM, suggesting that performing three sets to concentric muscle failure at 100% of 10-12 RM promotes greater training stimulus than two sets of 12 repetitions and one final set to concentric muscle failure at 90% of 10-12 RM. These results are consistent with previous studies that analyzed the effects of different loads on RPE.[18,19] In recreationally trained women, Cotter et al.[27] verified that 70% of 1 RM promoted higher

RPE responses in chest press (third set) and lat pull-down (second and third sets) exercises compared to 40% of 1 RM. Thereby, it is plausible to suggest that the use of greater loads promotes higher subjective perception of effort during the sets, regardless of the manner in which the load is prescribed (percentage of 1 RM or RM zone).

From a practical standpoint, our findings indicate that the use of lower loads may be an alternative to maximize the total volume and time under tension, which may cause greater long-term adaptations in muscle strength and hypertrophy.[5-7] The lower RPE observed in the first and second sets in the session performed with less load may contribute, in a certain way, to pleasure and adherence to the training program. On the other hand, higher loads may be adopted to promote total training stimulus, which could also be a strategy to promote long-term adaptations.

According to the American College of Sports Medicine,[1] multiple exercises for major muscle groups are recommended resistance training program to provide an overall conditioning stimulus. Although the leg press exercise is conventionally prescribed in resistance training programs, the use of a single exercise is a limitation of our study. Analyses of physiological mechanisms associated with neuromuscular fatigue would also have provided further support to decreases in muscular performance in the session performed with higher load. Lastly, acute responses do not allow us to affirm, in fact, whether a small reduction in load can result in better muscular adaptations and, therefore, chronic adaptations remain speculative.

CONCLUSIONS

The findings of the present study suggest that reductions of 10% in load using the maximum repetitions method results in greater the number of repetitions in multiple sets, total volume, and time under tension of the lower limbs in young women. However, the session performed at 100% of 10-12 RM resulted in a higher RPE (first and second sets) and training load (RPE x duration of experimental sessions) compared with the 90% of 10-12 RM session. Future studies are needed to investigate the effects of different loads using the maximum repetitions method on long-term adaptations in young women.

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