38 - COMPARISON OF THE PERFORMANCE IN THE ONE-REPETITION MAXIMUM TEST USING TWO DIFFERENT INTERVALS OF RECOVERY

MAURO HELENO CHAGAS, RODRIGO CéSAR RIBEIRO DINIZ, FERNANDO VITOR LIMA
Universidade Federal de Minas Gerais / Escola de Educação Física Fisioterapia e Terapia Ocupacional / Laboratório do Treinamento em Musculação, Belo Horizonte, Minas Gerais, Brasil
mauro@eef.ufmg.br

INTRODUCTION

The capacity to develop muscular strength is considered a basic quality of the human organism and represents a prerequisite for the accomplishment of different related motor tasks to the profession, the leisure and the sport (ACSM, 2002). Therefore, the diagnosis of muscular strength is one of the topics of great relevance for researchers and different health care professionals (ABERNETHY, WILSON & LOGAN, 1995; BROWN & WEIR, 2001). Different procedures for the measurement of muscular strength are developed with the objective to provide more necessary and specific information concerning the manifestations of muscular strength.

The one-repetition maximum test (1 RM) is a procedure that has been applied in the diagnosis of muscular strength (ABERNETHY, WILSON & LOGAN, 1995), one that has been as popular in the scientific area as in the daily practice of resistance training (HOEGER et al., 1987). The 1 RM test is understood as "the heaviest load that can be lifted only once for a given range of motion" (SCHLUMBERGER, 2000; MAYHEW & MAYHEW, 2002).

In the accomplishment of muscular strength tests, a very frequent recommendation is the inclusion of a familiarization in the diagnostic procedure (HOWLEY & FRANKS, 1995; CRONIN & HENDERSON, 2004; DIAS et al. 2005; LIMA, CHAGAS & DINIZ, 2005). According to Sale (1988), one of the main factors that affect the stability of the performance in muscular strength tests is related to processes of neural adaptation concerning the specificity of the exercise. As for these mechanisms, the improvement of the synchronization would provide a higher activation of the agonist muscles, a more adjusted activation of the synergist muscles and a greater inhibition of the antagonist muscles of the movement and these would be basic adaptations to modify the strength performance (SALE, 1987). According to Schmidtbleicher (1992), such changes can occur very quickly.

Some researches (CRONIN & HENDERSON, 2004; DIAS et al. 2005; LIMA, CHAGAS & DINIZ, 2005) have investigated the influence of the familiarization in the 1 RM test in the bench press and had verified that the first 1 RM test, used to familiarize the volunteers to the measurement procedure, revealed to be significantly lower than the second 1 RM test. However, Weiss et al. (2004) have not found differences in the peak force and in the power in 1 RM tests carried out in the bench press using an isokinetic device and a dynamic constant external resistance one, when the tests had been separate for 2, 3, 4 or 5 days of rest. Therefore, further studies are necessary for showing the influence of familiarization and the duration of the different intervals between the familiarization and the final test. The information concerning the interval between maximum tests, which does not significantly influence the results, can reduce the number of visits the volunteers need to make to the laboratory. This will result, consequently, in shorter periods of data collection and possibly in the adhesion of volunteers.

The aim of this study was to verify the effect of one and 48 hours of recovery between 1 RM tests using the guided bench press in male individuals trained in resistance training.

MATERIAL AND METHODS

Sample

This study was carried out with the voluntary participation of nineteen male individuals trained in resistance training. To consider the subject as trained the following criteria were adopted: a minimum of 6 months of continuous training in weight training (ACSM, 2002) and the capacity of lifting, in the bench press, such a weight equivalent to his own body mass (SCHLUMBERGER, 2000). All the volunteers were informed of the objectives and procedures of the research and signed a consent form approved by the Ethics Committee of the Federal University of Minas Gerais (ETIC 338/03). The data concerning the description of the sample are presented in Table 1.

TABLE 1
Means and standard-deviation of age, body weight, height, time of training and frequency of training (n=19).

Age (years)	Body weight (kg)	Height (cm)	Time of training (months)	Frequency of training (days)
23,1 (± 3,4)	76,3 (± 9,8)	178,1 (± 8,0)	34,4 (± 23,3)	4,0 (± 1,2)

Instrumentation

In order to execute the bench press a 20 kg-guided bar (MASTER EQUIPMENTOS ®) and a horizontal bench were used. A metal connecting rod indicated the superior limit of bar displacement and a rubber stopper (12 x 6,7 x 2cm), located on the breastbone, indicated the inferior limit. A WELMY brand scale was used to calibrate the weight of different sizes and to measure the volunteer's body weight and height.

Procedures

Initially, the whole procedure was explained to the volunteers and they were requested to sign a consent form. After that, they answered to a questionnaire with questions about the exercises present in their current training program and the training load. Later, the volunteer's height and body mass were measured. Before initiating the test, the volunteers were instructed to carry out the preparatory activities they used to make in their own routine. These activities should be kept for the subsequent tests.

The subjects were requested to perform three repetitions with the bar without any additional weight to standardize the distance between the hands, the position of the head and consequently the position of the body in the bench, initial position of the bar (corresponding to the complete extension of the elbows) and the final position of the bar (characterized for the contact of the bar with the rubber stopper, placed on the breastbone). It was made with the objective to prevent variations in the volunteers position during the execution of the tests. These standardizations were reproduced in all the tests.

Three 1 RM tests in the guided bench press had been done. Test 1 was the initial test. Test 2 was performed in the same day of Test 1, with one hour of interval between them. Test 3 was performed with a minimum interval of 48 hours and a maximum interval of 96 hours after Test 1. The Test 3 was performed at the same time than Test 1.

All the three tests were carried out by the following orientations: a maximum of 6 attempts (MAYHEW & MAYHEW,

2002; CHAGAS, BARBOSA & LIMA, 2005) five minutes of recovery and gradual progression of the weight. All the volunteers continued their attempts until they were unable to lift the weight. Therefore, the value of 1 RM corresponded to the weight lifted in the previous attempt.

After determining the volunteer's 1 RM in Test 1, a one hour interval was established before the execution of Test 2. No physical activity was allowed during this interval. After this period of rest, Test 2 was carried out following the same protocol previously described. After a period of 48-96 hours, the volunteers returned to the laboratory to perform the last 1 RM test (Test 3). The same procedure described above was followed.

All the volunteers had been instructed not to perform any training involving the pectoralis major, anterior deltoid and triceps brachii muscles 24 hours before the 1 RM tests.

Statistical Analysis

The means obtained in the three 1 RM tests were compared using the one way analysis of variance (ANOVA) with repeated measures. The method of the contrasts was applied for the localization of the differences. The statistical analyses were undertaken using the SPSS 11.0 software. Statistical significance was set at á < 0,05.

RESULTED

Table 2 shows the data concerning the mean values and standard-deviation of the three 1 RM tests.

TABLE 2
Results of 1 RM tests

Test	Means (kg)	Standard deviation (kg)	CV (%)
1	91,16	10,8	12,0
2	89,05	9,9	11,0
3	90,21	11,6	13,0

CV = coefficients of variation

ANOVA one-way with repeated measures showed significant difference among the three 1 RM tests. The method of contrasts indicated that difference occurred only between Tests 1 and 2 (F=9,254; p=0,007).

DISCUSSION

As observed in the results, there was a variation in the performance when the three 1 RM tests, in the guided bench press in individuals trained in resistance training, were compared. In Test 2, which was carried out one hour later, the volunteers demonstrated a lower performance than that of Test 1. In Test 3, performed 48-96 hours later, the volunteers performances were not statistically different from Test 1.

As for the methodological aspect, the lack of standardization in the positioning, the instability in the performance and the circadian rhythm are factors that could cause variability in the performance of strength tests. As in this study the individual amplitude of the bar displacement, the distance between the hands and the position of the body in relation to the bar had been standardized and the attempts in which accessory movements (hip, trunk or lumbar region) took place were excluded. It's possible to consider that the variation in the performance between the tests was not caused by these aspects. As it's a test that requires the maximum strength of the individual it could also be expected that performance oscillations in the 1 RM test would occur throughout the test days. However, considering the fact that the sample of the present study was composed by trained individuals (34,4 ± 23,3 months of resistance training), a significant difference in the performance was not expected for a such a short period in which the tests were accomplished. According to Poliquin (1988), the circadian rhythm can influence strength performance, with alterations in the performance ranging from 10 to 20% throughout the day. However, the interval of one hour between Test 1 and Test 2 would likely not result in a significant difference between the mean values found in the tests. Test 3 and Test 1 were made at the same time.

Another aspect that contributes to strengthen the quality of the standardization is the small percentage difference in the coefficients of variation (CV) observed among the three tests. In the present study a CV of 11-13% was calculated. These values indicate that the sample was more homogeneous when compared with other studies with similar methodologies (LIMA, CHAGAS & DINIZ, 2005, CV = 19%; DIAS et al., 2005, CV = 19% for bench press exercise).

Due to the technical limitations, the minimum increase of the load between the attempts was 2 kg. As the difference between the means of Test 1 and Test 2 was 2,11 kg, lower increases could result in lower differences in the performance. Therefore, this aspect must be considered as a limitation of the study.

The number of attempts necessary to determine the value of 1 RM should also be considered when analyzing the results, for the resultant physiological stress of the previous test can also influence the next test. In this study, it was necessary an average of 5 (± 1,15), 3,47 (± 1,35) and 4.21 (± 0,92) attempts to determine the value of the 1 RM in tests 1, 2 and 3, respectively. This aspect must be analyzed, because the number of attempts could influence on the type of physiological demand imposed to the individual organism, resulting in higher necessities of recovery. As this study did not intend to analyze the physiological mechanisms related to the performance in the 1 RM test, this argument appears as a hypothesis for the explanation of the difference in the performance between tests 1 and 2.

CONCLUSION

According to the results of this study it can be concluded that the one-hour interval of recovery between 1RM tests was not enough so that individuals trained in resistance training could reproduce the same performance in the guided bench press. The minimum period of 48 hours of rest was adequate for the volunteers to obtain equal performances in the 1RM test.

REFERENCES

ABERNETHY, P.; WILSON, G.; LOGAN, P. Strength and power assessment: issues, controversies and challenges. **Sports Medicine,** v.19, p. 401-417, 1995

ACSM. Position stand on Progression models in resistance training for healthy adults. Exercise and physical activity for older adults. **Medicine and Science in Sports and Exercise**. v. 34, n. 2, p. 364-380, 2002

BROWN, L.E. & WEIR,J.P. ASEP procedures recommendation I: Accurate assessment of muscular strength and power. **JEPonline**. v.4, n.3, p.1-21, 2001

CHAGAS,M.H., BARBOSA, J.R.M., LIMA,F.V. Comparação do número máximo de repetições realizadas a 40 e 80% de uma repetição máxima em dois diferentes exercícios de musculação para o gênero masculino e feminino. **Revista Brasileira de Educação Física e Esporte**, 2005 (no prelo).

CRONIN, J. B. & HENDERSON, M.E. Maximal strength and power assessment in novice weight trainers. **Journal of Strength and Conditioning Research**, v.18, n.1, p.48-52, 2004.

DIAS, R.M.R; CYRINO, E.S.; SALVADOR, E.P.; CALDEIRA, L.F.S.; NAKAMURA, F;Y; PAPST,R.R.; BRUNA,N.; GURJÃO,A.L.D. Influence of familiarization process on muscular strength assessment in 1-RM tests. **Revista Brasileira de Medicina do Esporte**, v.11, n.1, p. 39-42, 2005
HOEGER, W. K., BARETTE, S. L., HALE, D. F., HOPKINS D. R. Relationship between repetitions and selected percentages of one repetition maximum. **Journal of Applied Sports Science Research**. v.1, p. 11-13, 1987.
HOWLEY, E.T.; FRANKS, B.T**. Manual Del Técnico En Salud y Fitness**. Barcelona: Editorial Paidotribo, 1995
LIMA, F.V.; CHAGAS, M.H.; DINIZ, R.C.R. O procedimento de familiarização altera o desempenho no teste de 1 RM? In: GARCIA, E. S.; LEMOS,K.L.M. **Temas Atuais em educação física e esportes X**. Belo Horizonte: Editora Health, 2005, p.187-198.
MAYHEW, D.L.; MAYHEW, J.L. Cross-validation of the 7-10-RM method for predicting 1-RM bench press performance in high school male athletes. **Journal of Health, Physical Education, Recreation & Dance**, v.12, p.49-55, 2002
POLIQUIN, C. Five steps to increasing the effectiveness of your strength training program. **National Strength and Conditioning Association Journal**, v.10, p.34-39, 1988.
SALE, D. G. Influence of Exercise an Training on Motor Unit Activation. **Exercise and Sport Science Review**, v.15, p.95-151, 1987.
SALE, D.G. Neural adaptation to resistance training. **Medicine and Science in Sports and Exercise**, v.20, p.135-145, 1988.
SCHLUMBERGER, A.**Optimierung von Trainingsstrategien im Schnellkrafttraining**. Köln: Strass und Buch Strauß, 2000.
SCHMIDTBLEICHER,D. Training for power events. KOMI, P. **Strength and power**. Londres: Blackwell Scientifics Publications, 1992, p. 381-395.
WEISS, L.W.; WOOD, L.E.; FRY, A.C.; KREIDER, R. B.; BULLEN, D.B.; GRINDSTAF, P.D.F. **The Journal of Strength and Conditioning Research**, v. 8, n. 4, p. 76570, 2004.

Mauro Heleno Chagas
Email: mauro@eef.ufmg.br Telefone: (031) 3499-2360

Rodrigo César Ribeiro Diniz
Email: rodrigocrd@hotmail.com Telefone: (031) 3532-3327

Fernando Vitor Lima
Email: fernandolimanet@netscape.net Telefone: (031) 3499-2362

Universidade Federal de Minas Gerais
Escola de Educação Física, Fisioterapia e Terapia Ocupacional
Laboratório do Treinamento em Musculação (LAMUSC)
Av. Presidente Carlos Luz, nº 4664, Pampulha, Belo Horizonte, MG.
Telefone: (031) 3499-2362

COMPARISON OF THE PERFORMANCE IN THE ONE-REPETITION MAXIMUM TEST USING TWO DIFFERENT INTERVALS OF RECOVERY

Abstract: The aim of this study was to compare the effect of two different intervals between tests in the one-repetition maximum (1 RM) performance in the bench press. The sample was composed by 19 male individuals with mean values of age, body mass, height, training experience and training frequency of 23,1 (± 3,4) years, 76,3 (± 9,8) kg, 178,1 (± 8,0) cm, 34,4 (± 23,3) months and 4,0 (± 1,2) times a week, respectively. The volunteers were submitted to three 1 RM tests (Tests 1, 2 and 3) in two different days. In the first day, Tests 1 and 2 were carried out. They were separated by a one-hour interval, when no physical activity was allowed. Test 3 was executed at least 48 hours after Test 1. Mean values of 91,16 (± 10,80) kg, 89,05 (± 9,85) kg and 90,21 (± 11,56) kg were obtained in Tests 1, 2 and 3, respectively. The difference between mean values were detected by using the one way ANOVA with repeated measures and the method of contrasts indicated significant differences (p<0,05) only between Tests 1 and 2. Thus, it can be concluded that a one-hour recovery does not allow individuals trained in resistance training to keep their performance in the 1 RM test in the guided bench press and that a 48-hours interval between tests is enough for the volunteers to obtain the same performance than that of the initial test.
Key words: 1 RM, one hour, 48 hours

COMPARAISON DU DéGAGEMENT DANS LE TEST D'UNE RéPéTITION MAXIME EN EMPLOYANT DEUX INTERVALLES DIFFéRENTS DE RECUPéRATION

Résumé: L'objectif de cette étude est de comparer l'effet de deux différents intervalles entre les tests au dégagement d'une répétition máxime (1 RM) dans l'exercice supine guide. L'echantillon a été composé parmis 19 individus du genre masculin, d'âges moyens, masse corporelle, taille, temps et fréquence d'entrainements étant de: 23,1 (± 3,4) ans, 76,3 (± 9,8) kg, 178,1 (± 8,0) cm, 34,4 (± 23,3) mois et 4,0 (± 1,2) entrainements par semaine, respectivement. Les volontaires ont été soumis à trois tests de 1 RM, test 1, test 2et test 3 dans deux jours différents. Les test 1 et 2 ont été realizés au premier jour, étant les mênes séparés d'une heure, sans des activités physiques. Aprês au moins 48 heures, du afait le troisième test. Les moyennes suivantes ont été obtennes: 91,16 (± 10,80) kg, 89,05 (± 9,85) kg et 90,21 (± 11,56) kg, dans les test 1,2 et 3, respectivement. Travers l'ANOVA *one way* avec des mesutles répétées, on a detecté des différences entre les moyennes, étant donné que la méthode des contrastes n'a indiqué ques des différences significatives (p< 0,05) entre les test 1 et 2. On peut ainsi arriver à la conclusion qu'une période d'une heure de récupération ne permet pas que des individus trainés en musculation mantiennent leur dégagement dans le test test de 1 RM à l'exercice supine guidé et encore qu'un intervalle de 48 heures entre les tests est souffisant pour que les volontaires égalent le dégagement obtenu dans le test initial.
Mots clés : 1 RM, une heure, 48 heures.

COMPARACIÓN DEL DESEMPENO EN EL TEST DE UNA REPETICION MÁXIMA UTILIZANDO DOS DIFERENTES INTERVALOS DE RECUPERACIÓN

Resumen: El objetivo del presente estudio fue comparar el efecto de dos diferentes intervalos en el desempeño durante la realización del test de una repetición máxima (1RM), utilizando el ejercicio de press banco plano guiado. La muestra compuesta por 19 individuos del género masculino presentaron una media de edad de 23,1 (3,4) años, masa corporal de 76,3 (9,8) kg, estatura de 178,1 (8,0) cm, tiempo de entrenamiento de 34,4 (23,3) meses y frecuencia de 4,0 (1,2) entrenamientos por semana. Los voluntarios fueron sometidos a tres tests de 1RM, test 1, test 2 y test 3, en dos días diferentes. En el primer día se realizaron los test 1 y 2 separados por un intervalo de una hora sin realizar actividades físicas. Después de 48 horas, como mínimo, tuvo lugar el test 3. Los valores obtenidos fueron de 91,16 (10,80) kg, 89,05 (9,85) kg, y

90,21 (11,56) kg en los tests 1, 2 y 3 respectivamente. A través de ANOVA *one way* de medidas repetidas, se detectaron diferencias entre las medias, siendo que el método de los contrastes determinó diferencias significativas ($p < 0,05$) únicamente entre los test 1 y 2. Los resultados de este estudio permiten concluir que el periodo de recuperación de una hora, no contribuye en individuos con entrenamiento en musculación a mantener su desempeño en el test de 1RM utilizando el ejercicio de press banco plano guiado, y por otro lado, que un intervalo de 48 horas entre tests es suficiente para que los voluntarios igualen el desempeño obtenido en el test inicial.

Palabras-chaves: 1 RM, 1hora, 48 horas

COMPARAçÂO DO DESEMPENHO NO TESTE DE UMA REPETIçãO MÁXIMA UTILIZANDO DOIS DIFERENTES INTERVALOS DE RECUPERAçãO

Resumo: O objetivo do presente estudo foi comparar o efeito de dois diferentes intervalos entre testes no desempenho no teste de uma repetição máxima (1 RM) no exercício supino guiado. A amostra foi composta por 19 indivíduos do gênero masculino, com médias de idade, massa corporal, estatura, tempo de treinamento e freqüência sendo de 23,1 (± 3,4) anos, 76,3 (± 9,8) kg, 178,1 (± 8,0) cm, 34,4 (± 23,3) meses e 4,0 (± 1,2) treinamentos por semana, respectivamente. Os voluntários foram submetidos a três testes de 1 RM, teste 1, teste 2 e teste 3, em dois dias diferentes. No primeiro dia foram realizados os testes 1 e 2, sendo os mesmos separados por uma hora sem realizar atividades físicas. Após 48 horas, no mínimo, foi executado o teste 3. Foram obtidas médias de 91,16 (±10,80) kg, 89,05 (±9,85) kg e 90,21 (±11,56) kg, nos testes 1, 2 e 3, respectivamente. Através do ANOVA *one way* com medidas repetidas, foi detectada diferenças entre as médias, sendo que o método dos contrastes indicou haver diferenças significativas ($p < 0,05$) apenas entre os testes 1 e 2. Assim, pode-se concluir que um período de uma hora de recuperação não permite que indivíduos treinados em musculação mantenham seu desempenho no teste de 1 RM no exercício supino guiado e que um intervalo de 48 horas entre testes é suficiente para que os voluntários igualem o desempenho obtido no teste inicial.

Palavras-chave: 1 RM, uma hora, 48 horas.