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The Effect of Rest Interval Length on Bench Press Performance With Heavy vs. Light Loads

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Abstract. Willardson, J.M., and L.N. Burkett. The effect of rest interval length on bench press performance with heavy vs. light loads. *J. Strength Cond. Res. 20(2):396–399. 2006.*—The purpose of the current study was to compare the effect of 3 different rest intervals on multiple sets of the bench press exercise performed with heavy vs. light loads. Sixteen resistance-trained men performed 2 testing sessions each week for 3 weeks. During the first testing session each week, 5 consecutive sets of the bench press were performed with 80% of 1 repetition maximum (1RM) and with a 1-, 2-, or 3-minute rest interval between sets. During the second testing session each week the same procedures were repeated with 50% of 1RM. The total repetitions completed and the sustainability of repetitions were compared between rest conditions and between loads. For each load, resting 3 minutes between sets resulted in significantly greater total repetitions vs. resting 2 minutes ($p = 0.000$) or 1 minute ($p = 0.000$) between sets. However, the sustainability of repetitions was not significantly different between loads ($p = 0.849$). These results can be applied to weekly bench press workouts that undulate between heavy (i.e., 80% 1RM) and light (i.e., 50% 1RM) intensities. When the training goal is maximal strength development, 3 minutes of rest should be taken between sets to avoid significant declines in repetitions. The ability to sustain repetitions while keeping the intensity constant may result in a higher training volume and consequently greater gains in muscular strength.

Key Words. recovery, repetitions, fatigue, strength, sets

Introduction

Resistance training has been recognized as an essential component of a comprehensive fitness program for individuals with diverse fitness goals. Individuals may participate in resistance training for rehabilitative reasons or in preparation for strenuous jobs such as fire fighting, law enforcement, or military service. Several training variables must be considered when prescribing a resistance exercise program.

Manipulation of training variables such as intensity, volume, frequency, repetition velocity, and rest between sets is dependent on the specific goals of the individual and the physical demands faced during daily life (1, 2). Although training variables such as intensity and volume have been researched most frequently in determining muscular adaptations, relatively little research has been conducted on the optimal rest interval between sets.

The length of rest interval must be sufficient to recover energy sources (i.e., adenosine triphosphate [ATP] and phosphocreatine), clear fatigue-producing substances (i.e., hydrogen ions), and restore force production (3, 17). Previous studies have demonstrated that the length of the rest interval was an important factor affecting the total repetitions that could be completed during a resistance workout (4, 6, 9, 15, 18). Because of the popularity of the bench press exercise, further research that examines rest intervals, specifically for this exercise, would be useful for athletes to sustain repetitions without excessive rest betweens sets. The ability to sustain repetitions while keeping the intensity constant may result in a higher training volume and, consequently, greater gains in muscular strength (11). Therefore, the purpose of the current study was to compare the effect of 3 different rest intervals on multiple sets of the bench press exercise performed with heavy vs. light loads.

Methods

Approach to the Problem

Data collection occurred over a period of 4 weeks. During week 1, maximal strength for the bench press exercise was determined for each subject on 2 different days using standardized procedures (5, 12). The highest value of the two 1 repetition maximum (1RM) measurements was used to determine the load assignments for the other testing sessions. During weeks 2, 3, and 4, subjects performed 2 testing sessions each week, the sessions being separated by 72 hours, the first with a load of 80% of 1RM and the second with a load of 50% of 1RM. Five sets were performed with each load to the point of voluntary exhaustion. The rest interval between sets was 1, 2, or 3 minutes counterbalanced. All subjects were required to perform 5 sets with each load and each rest condition one time, making this study a within-design study.

Subjects

Sixteen men were used during the research process (age, 26.75 ± 6.40 years; height, 178.75 ± 6.00 cm; body mass, 92.10 ± 19.61 kg). Maximal strength for the bench press averaged 119.89 ± 21.76 kg, and subjects were able to lift an average of 1.34 ± 0.29 times their body mass. All subjects were considered recreationally trained lifters and had practiced a body-building style of training that involved multiple sets performed with light to moderate loads (i.e., 50–80% maximal strength) combined with short to moderate rest intervals between sets (i.e., 1–2 minutes).

To qualify for inclusion in the study, subjects had to be apparently healthy, as determined by the Physical Activity Readiness Questionnaire. Prior to data collection, subjects were required to sign a consent form in accordance with human subject regulations. Subjects were per-

TABLE 1. Total repetitions 50% and 80% 1 repetition maximum.

Load	Rest	Minimum	Maximum	Mean	*SD*	Post Hocs	Significance
50%	1	45.00	75.00	59.13	10.31	1 vs. 2	0.000
	2	53.00	94.00	74.81	12.36	1 vs. 3	0.000
	3	65.00	105.00	87.69	13.15	2 vs. 3	0.000
80%	1	12.00	25.00	18.06	4.64	1 vs. 2	0.000
	2	16.00	34.00	23.06	5.95	1 vs. 3	0.000
	3	19.00	35.00	27.06	5.37	2 vs. 3	0.005

mitted to continue with their normal workouts throughout the research period, with the following exceptions: (a) subjects were asked not to perform the bench press other than during their scheduled testing sessions, and (b) subjects were asked not to work out on the same day before their testing session.

Procedures

Warm-up sets were performed prior to each bench press session. For the 50% test condition, subjects performed 1 warm-up set at 50% of the goal resistance for 10 repetitions. For the 80% test condition, subjects performed 2 warm-up sets; the first with 50% of the goal resistance and the second with 75% of the goal resistance, for 10 repetitions each (6, 18). Subjects were instructed to perform repetitions with the intent to move the resistance as rapidly as possible.

The bench press was performed with an Olympic bar through the full range of motion. Subjects descended to the point at which the resistance touched the chest, before pressing the resistance back to the starting point with the elbows extended. One spotter was used during all sets to assist in racking the resistance and to ensure that subjects maintained consistent and safe technique (i.e., hyperextending the lumbar spine or bouncing the bar off the chest was not permitted). The rest interval between sets was timed using a hand-held stopwatch.

Statistical Analyses

For each load, a 1-way repeated analysis of variance (ANOVA) was conducted to compare the total repetitions completed for each rest condition. Effect size, power, and linear and quadratic contrasts were calculated to assess the practical importance of the length of the rest interval on the total repetitions completed. The sustainability of repetitions was then compared by dividing the number of repetitions completed on each subsequent set by the number of repetitions completed on the first set, with the resultant percentages being used in a 2 (loads) by 3 (rest intervals) by 5 (sets) repeated ANOVA. Linear and quadratic contrasts were calculated to assess the performance patterns associated with repeated sets to exhaustion. An alpha level of 0.05 was used to determine significance for all comparisons.

RESULTS

For each load, a 1-way repeated ANOVA indicated that the total repetitions completed were significantly different between rest conditions ($p = 0.000$). Post-hocs were then conducted using the Bonferroni adjustment to determine specific differences (Table 1). The effect size statistics for the 50% and 80% loads indicated that 93.5% and 78.2% of the variance in the total repetitions completed could be accounted for by the length of the rest interval. For each load, the power statistic was 1.000, which indicated that these results would occur 1,000 times if this experimental design were tested on the same sample size. For each load, a significant linear relationship existed between the length of the rest interval and the total repetitions completed ($p = 0.000$; see Figure 1).

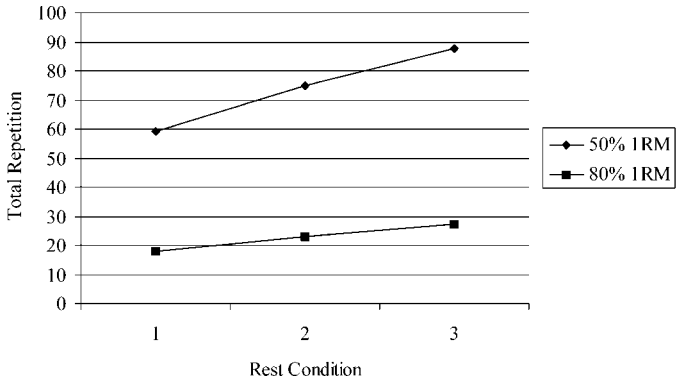

FIGURE 1. Performance patterns total repetitions. 1RM = 1 repetition maximum.

TABLE 2. Post-hoc sets and rest intervals.

Sets	Significance	Rest (minutes)	Significance
1 vs. 2	0.000	1 vs. 2	0.000
1 vs. 3	0.000	1 vs. 3	0.000
1 vs. 4	0.000	2 vs. 3	0.000
1 vs. 5	0.000		
2 vs. 3	0.000		
2 vs. 4	0.000		
2 vs. 5	0.000		
3 vs. 4	0.000		
3 vs. 5	0.000		
4 vs. 5	0.018		

The 2 (loads) by 3 (rest intervals) by 5 (sets) repeated ANOVA indicated that the sustainability of repetitions was significantly different between sets ($p = 0.000$) and between rest conditions ($p = 0.000$) but was not significantly different between loads ($p = 0.849$). Post-hocs were then conducted using the Bonferroni adjustment to determine specific differences between sets and between rest conditions (see Table 2). Significant linear ($p = 0.000$) and quadratic ($p = 0.000$) contrasts indicated that a large decline in repetitions occurred between the first set and the third set, followed by a small decline between the third set and the fifth set (Figure 2 and Table 3). Since the sustainability of repetitions was not significantly different between loads, Figure 2 represents the mean percentages of both loads combined.

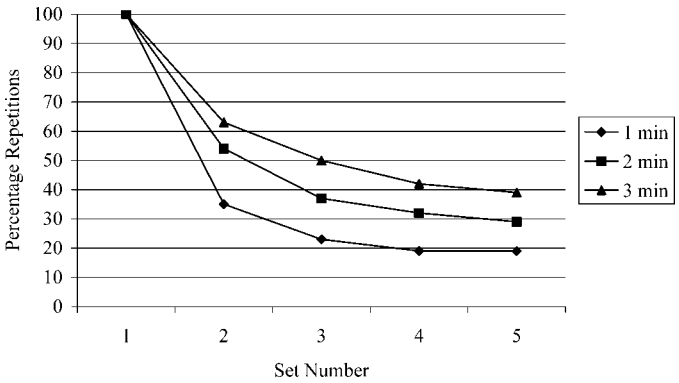

FIGURE 2. Mean percentage repetitions.

DISCUSSION

The results of the current study demonstrated that the sustainability of repetitions over 5 consecutive sets was similar for the 50% and the 80% of 1RM loads (Figure 2 and Table 3). These results were not consistent with what was expected for the 50% load. Because of the size principle of motor unit recruitment, the expectation was that a consistent number of repetitions would be performed over 5 consecutive sets as a result of the primary recruitment of fatigue-resistant slow-twitch motor units. Conversely, for the 80% load, the expectation was that a decline in repetitions would occur over 5 consecutive sets as a result of the increased recruitment of highly fatigable fast-twitch motor units (19).

The results of the current study might indicate that when the bench press is performed with loads between 50% and 80% of 1RM, there is comparable recruitment of slow- and fast-twitch motor units. The difference between loads might be in the time necessary to fully recruit all available motor units. The recruitment corridor between the slow- and fast-twitch motor units might exist at a percentage lower than 50% of 1RM (19).

Other studies have demonstrated that the length of the rest interval necessary to sustain repetitions depends on the magnitude of the load lifted. Wier et al. (16); Matuszak et al. (7); and Todd et al. (15) demonstrated that when training with maximal loads (≥90% of 1RM), rest intervals of 1 minute to 2 minutes were sufficient between repeated attempts. However, Kraemer (4), Willardson and Burkett (18), and Richmond and Godard (9) demonstrated that when training with submaximal loads (≤ 80% 1RM), rest intervals of 3 minutes to 5 minutes were necessary to prevent significant declines in repetitions.

In the current study, significant linear and quadratic performance patterns were demonstrated over the course of 5 consecutive sets. For each load, regardless of the rest interval, a large decline in repetitions occurred between the first set and the third set. However, following the third set, the repetitions began to plateau, and a small decline occurred between the third set and the fifth set (Figure 2).

This plateau might have been due to the rapid resynthesis of ATP and PCr, which made possible the performance of a consistent number of repetitions on the third, fourth, and fifth sets (3, 17). However, repetitions were not completely restored to the level of the first and the second sets, possibly as a result of the lingering effects of hydrogen ion accumulation (10, 13, 14). An interesting finding was that as the rest interval increased, the level at which the plateau occurred also increased. Although a 1-, 2-, or 3-minute rest interval was insufficient to completely sustain repetitions over consecutive sets, the 3-minute rest interval allowed for repetitions to be sustained at the highest level.

Studies that have examined strength increases have provided support for longer rest intervals between sets. Pincivero et al. (8) demonstrated that a 160-second rest interval was superior to a 40-second rest interval for producing isokinetic strength increases in the quadriceps and hamstrings. Likewise, Robinson et al. (11) demonstrated that a 3-minute rest interval was superior to 90-second and 30-second rest intervals for producing strength increases in the free-weight squat exercise. Pincivero et al. (8) and Robinson et al. (11) concluded that longer rest intervals allowed for the maintenance of training intensity, which led to greater strength increases.

PRACTICAL APPLICATIONS

The bench press is often the first primary exercise performed during workouts designed for the upper body. The results of the current study can be applied to weekly bench press workouts that undulate between heavy (i.e., 80% 1RM) and light (i.e., 50% 1RM) intensities. When the training goal is maximal strength development, 3 minutes of rest should be taken between sets to avoid significant declines in repetitions. The ability to sustain repetitions while keeping the intensity constant may result in a higher training volume and, consequently, greater gains in muscular strength. Another important factor to consider is whether sets are performed to failure; if not performed to failure, then 1 to 2 minutes of rest might be sufficient as a result of reduced metabolic demand.

How the results of the current study apply to other upper-body primary exercises (i.e., overhead press) or accessory exercises (i.e., triceps extension) is currently unknown, and further research is necessary. When training for maximal strength, an effective strategy might be to prescribe longer rest intervals of 3 minutes between primary exercises and shorter rest intervals of 1 minute be-

TABLE 3. Repetitions 5 consecutive sets (mean ± *SD*).

Rest	Load (%)	Set 1	*SD*	Set 2	*SD*	Set 3	*SD*	Set 4	*SD*	Set 5	*SD*
1	50	29.88	4.77	10.00	1.90	7.06	2.05	6.13	1.82	6.06	1.65
2	50	29.94	5.81	14.81	2.46	11.19	2.04	9.75	1.69	9.13	2.00
3	50	30.44	4.52	18.25	3.24	14.13	3.38	12.63	2.47	12.25	2.11
1	80	9.38	1.93	3.31	1.20	2.06	1.00	1.69	.95	1.63	.72
2	80	9.13	1.67	5.19	1.60	3.38	1.45	2.81	1.11	2.56	1.26
3	80	9.13	1.86	5.94	1.12	4.69	.95	3.81	1.22	3.50	1.03

tween accessory exercises. If repetitions cannot be sustained with 3 minutes of rest, the resistance can be lowered slightly. Coaches may consider initially prescribing 3 minutes of rest and then gradually reduce this period to 1 minute as athletes achieve higher levels of conditioning, demonstrated by the ability to sustain repetitions over consecutive sets.

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