The Effects of Varied Rest Periods Between Sets to Failure Using the Bench Press in Recreationally Trained Men

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Abstract. Richmond, S.R., and M.P. Godard. The effects of varied rest periods between sets to failure using the bench press in recreationally trained men. *J. Strength Cond. Res. 18(4):000–000. 2004.*—The purpose of this study was to determine the rate of recovery for recreational weight trainers between 2 sets of bench press to volitional exhaustion. Twenty-eight men performed 2 sets of the bench press at 75% of their previously determined 1 repetition maximum (1RM) to volitional exhaustion. Rest periods of 1, 3, or 5 minutes between sets were utilized on the 3 separate testing days. There was a significant decrease in the number of repetitions performed between the second sets at all rest periods. There were no significant differences in work performed (repetitions × weight) during the second set with the 3- and 5-minute rest periods, but the total work with a 1-minute rest period (1,389.1 ± 529.9) was significantly less than both the 3- (1,494.9 ± 451.0) and 5-minute (1,711.4 ± 478.0) rest period. The data indicated that subjects were unable to fully recover between the first and second sets of maximal resistance exercise, regardless of the rest period. However, subjects were able to maintain a performance level of 8–12 repetitions and sustain the total work performed per set with as little as 3 minutes rest between sets.

Key Words. resistance training, recovery time, repetitions

Introduction

C urrent physical conditioning programs have shifted from a strictly aerobic or cardiovascular fitness approach toward a more encompassing fitness approach, one that includes resistance training or weight lifting (3, 5, 12–14). Until recently, an emphasis on resistance training lead to countless programs and regimens, most designed solely upon anecdotal evidence and hearsay. The American College of Sports Medicine (ACSM) and the National Strength and Conditioning Association (NSCA) specifically address resistance training program recommendations based directly upon training research (3, 5, 7, 11–14). A primary area of concern within the scope of proper resistance training is the amount of rest between sets of exercises. The body requires rest in order for the muscles to recover and restore their enzymatic capacity to perform exercise (1). Within the muscle itself there are considerable variations in metabolic recovery rates and enzyme pathways utilized, resulting in considerable differences in performance (4, 9, 10, 15, 16). Therefore, additional research is required concerning what rest periods are needed between sets of resistance training for optimal performance.

The purpose of the present study was to determine the performance effects of varied rest periods required by recreational weight trainers for maximal recovery between sets of bench press to volitional exhaustion. For the current investigation, optimal performance is defined as the ability to perform a maximal number of repetitions to fatigue. Our hypothesis was that the 1-minute rest period would not allow an adequate amount of rest between sets in recreationally trained individuals. In addition, the 3- and 5-minute rest periods between sets of bench press to volitional exhaustion would allow for a recovery level capable of reproducing an equivalent number of repetitions for both sets.

Methods

Experimental Approach to the Problem

Subjects were recruited from university physical conditioning courses and local fitness establishments. A training history questionnaire was required to ensure that all subjects were indeed trained. Most training programs recommend a range of rest periods between 1 and 5 minutes—thus the rationale for a 1-, 3-, and 5-minute rest period. A resistance of 75% of one's 1 repetition maximum (1RM) should equate to approximately 8–12 repetitions according to common program recommendations (7, 11, 12). The bench press was chosen given the popularity of the exercise, and the exercise history from our subjects indicated that they all currently incorporated the bench press in their training programs. Additionally, 2 sets of the exercise were chosen to conform to the training conditions identified by the participants in their exercise history.

Subjects

Twenty-eight healthy men (21.5 ± 3.2 years) were recruited for this investigation. All subjects had a minimum of 8 weeks' resistance training experience, which was considered adequate to eliminate any training curve that may be associated with beginning lifters (2). Subjects also identified a training frequency of at least 3 d·wk^{-1} at a moderate to high intensity level using a program that incorporated the bench press. Further inclusionary criteria required the subject to lift a weight greater than or equal to his own body weight (BW; 1.2 ± 0.2 1RM·BW^{-1}). Descriptive statistics are listed in Table 1.

Initial Testing

Upon arriving for the initial testing, subjects were informed of the scope of the study and then asked to complete a medical history questionnaire, an exercise history questionnaire, and an informed consent as approved by the university's human subjects committee. Subjects were then assessed for height and weight using a wall-mounted stadiometer and an electronic scale (Toledo Model 24 electronic scale; Toledo Scale Co., Toledo, OH), respec-

Table 1. Anthropometric characteristics for recreational resistance-trained college-aged men.

	M	SD
Age (years)	21.5	3.2
Height (cm)	180.4	5.3
Body weight (kg)	87.2	14.4
1RM (kg)	106.5	21.5
1RM·BW^{-1}	1.2	0.2
75%1RM (kg)	80.0	16.1

$n = 28$ subjects.

tively. Following a light warm-up on the bench press using an Olympic-style bar on a bench rack (York Barbell Co., York, PA), subjects then performed a 1RM on the bench press using a previously established protocol (14). Briefly, subjects attempted to lift a progressively increasing resistance, resting approximately 3 minutes between attempts. The resistance was increased in a manner to achieve the 1RM in as few attempts as possible.

Prior to and throughout the course of the testing, all subjects were instructed to maintain current dietary status and activity levels, including following the same activity routines on days prior to testing. Subjects were also instructed to refrain from taking supplements until completion of the final test session. In addition, all test sessions were conducted within 2 hours of the same time of day. To standardize bench press techniques, subjects were required to use the same hand placement for each trial, as determined by the distance between the index finger and bar striations. Proper bench press technique, specifically touching the bar to the chest and full extension of the arms, were required for repetitions to be counted.

Treatment Conditions

Subjects began with a warm-up consisting of 5 minutes of low-resistance cycling on an ergometer and stretching of the involved muscle groups. Within approximately 3 minutes of completing the warm-up, subjects then performed a repetition to failure using 75% of their previously determined 1RM; actual resistance used was within 1.1 kg of the calculated value. Upon fatigue, subjects were instructed to rest for a period of 1, 3, or 5 minutes; rest periods were randomly assigned to subjects and test sessions. During the rest period, subjects were instructed to minimize activity, with the only movements allowed being walking and light stretching. Following the rest period, subjects performed a second set using the same weight, completing as many repetitions as possible to volitional exhaustion. Subjects performed the same protocol with the remaining rest periods during the 2 subsequent test sessions. Sessions occurred at least 2 days apart, but no more than 5 days apart, for approximately 2 weeks following the initial test session.

RESULTS

All statistical analyses were performed with the Statistical Package for the Social Sciences (SPSS, v.11.0; SPSS, Inc., Chicago, IL), and the level of significance was set at $p \leq 0.05$. The 1-, 3-, or 5-minute rest interval had no effect on the number of repetitions performed prior to these rest periods (11.9 ± 2.5, 11.5 ± 2.2, and 11.5 ± 2.3, respectively) as shown in Figure 1. The first set for all 3
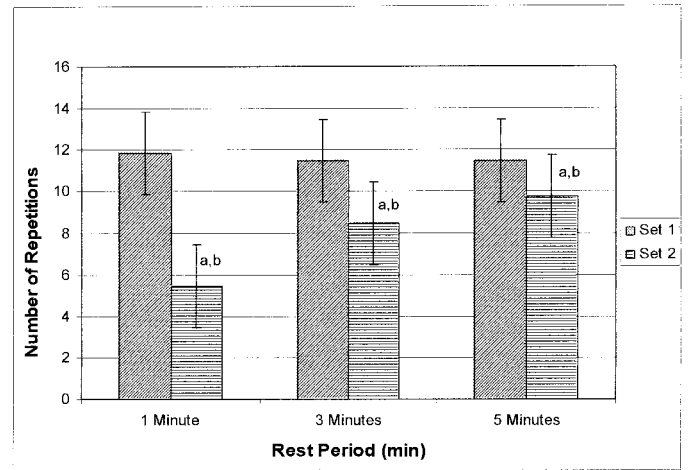

FIGURE 1. Number of chest press repetitions ($M \pm SD$) in response to 1-, 3-, and 5-minute rest periods. $n = 28$ subjects; a = significant difference from set 1 ($p \leq 0.001$); b = significant difference between set 2 of other rest periods ($p \leq 0.001$).
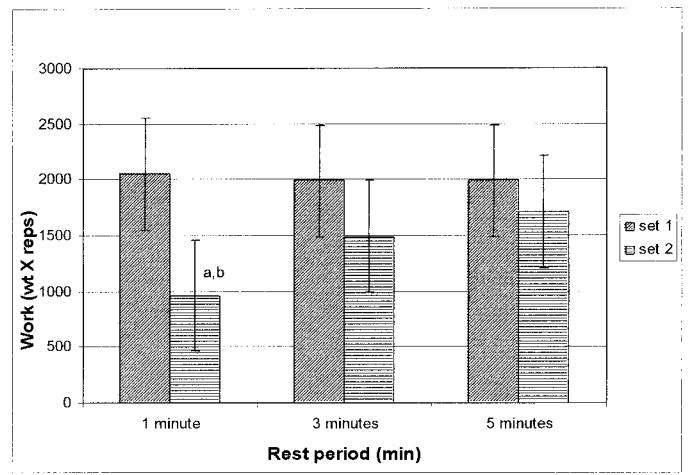

FIGURE 2. Total work performed ($M \pm SD$) in repetitions multiplied by weight in response to 1-, 3-, and 5-minute rest periods. $n = 28$ subjects; a = significant difference from set 1 ($p \leq 0.001$); b = significant difference from set 2 with 3- and 5-minute rest period ($p \leq 0.001$).

randomly assigned had a coefficient of variation within 2%, which was assumed to be representative of within-subject reliability. A repeated measures analysis of variance (ANOVA) revealed a difference between all sets at all rest periods. Post hoc analysis using a dependent t-test isolated significant differences to occur between the first set and second set of repetitions at all rest periods ($p \leq 0.05$). Also, the second sets at each rest period displayed a between-treatment significant difference ($p \leq 0.05$), indicating that second sets for the 1-, 3-, and 5-minute rest periods were significantly different from each other. The means and standard deviations for all test conditions can be found in Figure 1. Identical analyses were employed regarding total work performed (repetitions × weight). Again, there was no significant difference between the initial sets at the 1-, 3-, and 5-minute rest periods in total work performed (2,011.4 ± 464.3, 1,990.1 ± 447.2, 1,990.0 ± 470.9, respectively) as shown in Figure 2. There was no significant difference in total work per-

formed between the first and second set with both the 3- and 5-minute rest periods. However, the second set with a 1-minute rest was significantly different from the second set with both the 3- and 5-minute rest periods.

DISCUSSION

The primary findings of this study are (a) less repetitions were performed during the second set than the first set at all rest periods; (b) an 8–12 repetition range was achieved with the 3- and 5-minute rest period for both the first and second sets, but not with the 1-minute rest period; (c) the total work performed during the second set with a 1-minute rest period was less than with both 3- and 5-minute rest periods. There were no differences between the initial sets, indicating that any subsequent changes in performance are indicative of variations of rest periods. The results appear to demonstrate that regardless of the rest period utilized, the recovery time was not adequate enough to prevent a decrease in the number of repetitions performed. Recreational resistance-trained men seemed to require a recovery period of greater than 5 minutes to replicate the number of repetitions performed during multiple sets of the bench press. This is in sharp contrast to the results of previous research, which consisted of more experienced, competitively trained individuals (6–8, 11). However, it should be noted that with 3- and 5-minute rest periods, subjects were able to maintain an 8–12 repetition range, which was not the case with the 1-minute rest period. Again, this finding is somewhat contradictory to findings utilizing a protocol exploring various rest periods between sets of the 1RM bench press with power lifters, where it was found that only 1 minute of rest was required to fully recover between bouts of exercise (17). Additional research has also been conducted involving repeated sets of the bench press with competitive body builders and power lifters, which found no changes in performance with rest periods of as little as 3 minutes (6–8, 11).

There are differences between the current population and the previously mentioned populations; however, the variation in performances are most likely related to alterations in training techniques. The more competitively trained individuals most likely follow a more stringent training regimen with a much lesser degree of variability in training intensity and rest periods utilized between sets of exercise, resulting in enhanced performance characteristics. Additionally, the more highly trained individuals probably have a greater energy restoration capacity via enhanced enzymatic activity and are therefore capable of repeating their performances with shorter rest periods (1). This leads to the concept of a training effect or that the rest period implemented during training will have an impact on testing performance (1, 6, 8). It should be noted that these shorter rest periods were implemented into programs of more highly trained individuals, not the recreationally trained men used in the current study.

Future studies should identify the impact of various rest periods on sets with different percentages of an individual's 1RM. Gender differences associated with resistance training rest periods and strength recovery should be explored as well.

PRACTICAL APPLICATIONS

According to the ACSM and NSCA, individuals should train with rest periods of 3 to 5 minutes while performing 8–12 repetitions per exercise (7, 11, 12). The current results further justify these recommendations with subjects being able to maintain an 8–12 repetition range with the same resistance and as little as 3 minutes rest between sets. This notion is further supported by there being no significant differences in total work performed with a 3- and 5-minute rest period, but the total work with a 1-minute rest period was considerably less than the 3- and 5-minute rest period. When implementing these results, it is essential to address the training status and goals of the individual for whom the program is being designed. If the goal of training is to maintain the same number of repetitions, one may need to allow more than 5 minutes rest time between sets if utilizing the same resistance for multiple sets. However, a 3-minute rest period can provide an adequate recovery to maintain an 8–12 repetition range. With a 1-minute rest period, individuals should not expect to perform the same number of repetitions during subsequent sets of exercise. If shorter duration rest periods are utilized, it may be necessary to decrease the resistance being used.

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