The Effect of Rest Interval Length on Repeated Maximal Bench Presses

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Reference Data

ABSTRACT
This study examined the effect of rest interval length on repeated one-repetition maximum (1-RM) bench press performance. Sixteen male college students (age = 22 ± 2 yrs) who were experienced in the bench press exercise volunteered for this investigation. On the first laboratory visit the subjects’ 1-RM was determined. The next four test sessions involved performing the 1-RM attempt two times, with the intertrial interval being 1, 3, 5, or 10 min. The results of a Cochran Q test found no significant (p > 0.05) difference in the ability to repeat a successful maximal bench press based on the rest interval lengths tested. These findings are consistent with previous research indicating a rapid return in maximal force production capabilities following a fatiguing task. These results indicate that 1-min rest intervals are sufficient for recovery between maximal strength tests.

Key Words: strength, fatigue, recovery

Introduction
Assessment of dynamic constant external resistance (DCER) strength capabilities typically involves determination of the one-repetition maximum (1-RM).Protocols for 1-RM measurement involve a trial-and-error method in which progressively heavier weights are lifted until no further lifts can be achieved (9). To date there is no standard for a minimal rest interval between successive attempts in 1-RM measures, despite the fact that fatigue from previous contractions may affect performance in subsequent attempts. Studies using the 1-RM bench press have arbitrarily employed rest intervals of 2 min (7), 2 to 3 min (1), or criteria such as “at least two minutes between each attempt” (11). It is possible that varying the rest interval lengths may affect the strength scores.

Sewall and Lander (7) reported that repeated 1-RM determinations for the squat and bench press were reproducible after 2, 6, and 24 hours. However, these results are applicable primarily to test-retest situations and offer little information on intertrial rest intervals. Additionally, in sports such as powerlifting, multiple maximal or near-maximal lifting attempts are performed during the course of competition. The rest intervals in these competitions can vary considerably. Therefore the purpose of this study was to examine the effects of different rest intervals on success in repeated maximal bench press trials.

Methods
Subjects
Sixteen male college students volunteered for this investigation (M age = 22 ± 2 yrs). The subjects had a minimum of 2 years of bench press experience and could bench press at least 125% of their body weight. Six of them had competed in powerlifting competitions. The study was approved by the institutional review board for human subjects; all subjects were screened for injury or illness with a health history questionnaire, and all signed an informed consent form before taking part in this investigation.

Bench Press Protocol
All bench press attempts were observed by an experienced powerlifting referee. The sequence of events in the bench press was as follows: The subject lay supine on the bench with head and trunk extended on the bench and feet flat on the floor. He then received a liftoff from a spotter, after which he lowered the bar to his chest. The referee’s verbal signal to lift the weight was given when the bar was motionless on the chest. After the signal, the bar was pressed vertically until the elbows were fully extended and the bar was held motionless for a signal from the referee to replace the bar (2).

Testing Protocol
The subjects visited the laboratory on five occasions. On the first visit they performed a series of single bench press attempts to determine their 1-RM load using a technique similar to that of Berger (1). Prior to testing, the subjects reported their estimated 1-RM based on past experience. The estimated 1-RM values
were used to facilitate the most appropriate determination of test weights. Subsequently, the subjects warmed up with 3 min of upper body ergometry at a light resistance followed by static stretching.

All subjects performed one warm-up set of 8 repetitions and one set of 3 repetitions at 50 and 70% of their estimated 1-RM, respectively. The warm-up was held constant across all test sessions. Subsequent single bench press attempts were performed with increasing loads of 2.26 to 9.0 kg until no further increases in weight could be lifted. Subjects rested 5 min between each attempt. Three to seven attempts were required to determine each subject's 1-RM to within 2.26 kg.

The four subsequent laboratory visits involved performing the previously determined 1-RM bench press attempt two times. The rest interval between 1-RM attempts was 1, 3, 5, or 10 min. The rest interval order was randomized across test sessions for each subject. The warm-up protocol, including submaximal one-repetition sets, was the same as that used in the initial 1-RM determination. A minimum of 5 days rest was required between each bench press session. For all five laboratory visits the ends of the bar were covered such that the subjects were not aware of the weight on the bar at all during the study.

**Analysis of Data**

A Cochran Q test (8) was used to test whether a second bench press attempt was equally likely to succeed after a 1-, 3-, 5-, or 10-min rest interval. A probability level of \( p \leq 0.05 \) was selected as the level of significance for this analysis.

**Results**

The descriptive characteristics of the subjects are presented in Table 1. On average the subjects could bench press 1.52 times their body weight, which indicated that the sample represented an experienced group of bench pressers. A paired t test showed there was no significant difference (\( p > 0.05 \)) between the subjects' estimated 1-RM and the measured 1-RM bench press.

The results of the Cochran Q analysis (\( Q = 5.25 \)) showed no significant (\( p > 0.05 \)) differences in the ability to repeat a successful 1-RM bench press following a 1-, 3-, 5-, or 10-min rest interval. Of the 16 subjects, only 4 failed the second 1-RM following 1 min of rest. No subjects failed following the 3-min rest interval, while 2 failed at 5 min and one failed at 10 min. Only one subject failed two times (at 1 and 5 min).

**Discussion**

The results of this investigation showed no significant differences across rest intervals on success in 1-RM bench press attempts following previously successful attempts. These data are consistent with previous research indicating a rapid return in maximal force production capability following a fatiguing task (5, 6, 10). Sahlin and Ren (6) found a recovery in maximal isometric force production following as little as 2 min of rest after a fatiguing isometric contraction (duration 52 sec). Stull and Clarke (10) found similar results with 1 and 3 min of rest following intense isometric and DCER exercise, respectively. Likewise, Hitchcock (5) found a recovery of maximal isokinetic quadriceps strength after 1 min of rest following submaximal cycle ergometer exercise (2 min) and after 4 min of rest following maximal cycle ergometer exercise (2 min).

The subjects in the present investigation were examined for DCER strength by performing 1-RM bench presses. Bench press durations are relatively short in comparison to the fatiguing tasks in the studies reported above (12). Thus it is likely that the short duration of the exercise in this investigation would result in a smaller metabolic cost and therefore a lower fatigue response than that seen in the above investigations. It seems probable, then, that strength recovery following a 1-RM bench press attempt may be less than 2 min. The results of this investigation support this contention.

It should be noted that a second 1-RM determination at the end of the study was not performed. Although the subjects may have improved their 1-RM capabilities over the course of the study, we consider it unlikely that they would have become significantly stronger during that time, especially considering their training status and the stress associated with the test protocol.

The results of this investigation may be interpreted in terms of the metabolic system used during 1-RM attempts. For maximal activities of less than 10 sec, the predominant energy system is the phosphogen system (3). Due to the short duration of the 1-RM, little energy would be derived from anaerobic glycolysis, and consequently decreased intramuscular pH as a result of lactic acid formation would not be expected (3). It is likely, then, that little intramuscular fatigue due to decreased pH would result from the initial 1-RM attempts.

Additionally, replenishment of phosphocreatine (PC) stores occurs very rapidly with half of the used PC replenished within 30 sec of recovery (4), provided that no further stress is applied to the phosphogen system. Thus the subjects' success on second 1-RM

<table>
<thead>
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<th>Characteristic</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
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<tr>
<td>Age (yrs)</td>
<td>22</td>
<td>2</td>
<td>19 — 25</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>175.6</td>
<td>5.9</td>
<td>168.3 — 186.5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>79.5</td>
<td>9.0</td>
<td>69.9 — 93.7</td>
</tr>
<tr>
<td>Estimated 1-RM (kg)</td>
<td>125.5</td>
<td>13.4</td>
<td>79.4 — 149.7</td>
</tr>
<tr>
<td>1-RM (kg)</td>
<td>120.8</td>
<td>17.8</td>
<td>79.4 — 145.2</td>
</tr>
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</table>
attempts was likely due to relatively low fatigue generation and rapid replenishment of PC stores. In fact, many of the subjects reported that the second 1-RM attempts were often easier than the first. There may have been a warm-up effect of maximal or near-maximal attempts. This phenomenon requires further study.

The results of this investigation have implications for strength testing in laboratory settings and competitive powerlifting competition. Although there is no standard rest interval for strength testing, the results of this study indicate that short rest intervals should not compromise the validity of 1-RM values. The shortest rest interval used in this investigation, 1 min, is shorter than is likely to be used in a laboratory setting. Consequently, the use of arbitrary rest intervals that are ≥1 min and based on practical considerations is appropriate. Similarly, current powerlifting competitions use the “rounds system” in which attempts by other lifters will occur prior to another attempt by a lifter who has already performed at least one attempt (2). Thus the format of competition should preclude any fatigue effect.

One should be cautious about generalizing these results. It is possible that different responses may occur with different exercise stressors such as the squat or power clean, which involve a much larger muscle mass. In addition, the effects of more than two successive 1-RM attempts have yet to be determined, as well as the time needed to recover following higher repetition stressors (e.g., 3-RM, 10-RM). Furthermore, the warm-up sets used in this study were separated by 5-min intervals. Thus we cannot eliminate the possibility that 1-min rest intervals may be too short for complete recovery if applied to a series of progressively heavier sets, as would be the case in typical 1-RM determinations.

Practical Applications

The results of this investigation indicate that rest intervals as short as 1 min do not impair the ability to reproduce maximal performances in the bench press exercise. Thus, testing of 1-RM bench press strength may be performed with rest intervals dictated by practical considerations as opposed to fatigue recovery. In addition, these data imply that fatigue recovery should not limit bench press performance under current competitive powerlifting situations.

References