Comparison of Number of Repetitions and Repetition Rate in 5 Sets of 65%1RM Bench Press and Biceps Curl Exercise

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Abstract

The purpose of this study is to investigate the changes in the number of repetitions and the repetition rate according to the exercise mode when performing 65%1RM resistance exercise at the 1-minute rest interval and the 3-minute rest interval. Sixteen healthy male subjects were treated with Bench press and Biceps curl of 65%1RM intensity at 1 and 3 minute rest intervals. The number of repetitions for each set of 1 minute rest interval showed a significant decrease from 1set to 5set in bench press. biceps curl showed a significant decrease from 1set to 4set. The repetition rate according to the exercise mode with a 1-minute rest interval showed a significant difference from 2sets to 4sets. In the repetition rate for each set, bench press showed a significant decrease from 1set to 5set. biceps curl showed a significant decrease from set 1 to set 4. The number of repetitions according to the exercise mode with a 3-minute rest interval showed a significant difference from 2sets to 5sets. In the number of repetitions for each set, bench press showed a significant decrease from 1set to 5set. biceps curl showed a significant decrease from 1set to 4set. The repetition rate according to the exercise mode with a 3-minute rest interval showed a significant difference from 2sets to 5sets. In the repetition rate for each set, bench press showed a significant decrease from 1 set to 5 sets. biceps curl showed a significant decrease from 1set to 4set. In summary, the decrease in the number of repetitions according to the set progression in the resistance exercise of the endurance depends on the exercise mode, and the increase of the rest interval or the decrease of the weight-intensity should be considered when aiming for more exercise.

Keywords: Resistance Exercise, Exercise Mode, Rest Interval, Number of Repetition, Repetition Rate

1. Introduction

Resistance exercise is known to contribute to the improvement of sports performance and the treatment and prevention of some diseases, and research is being conducted to understand how to achieve the purpose of exercise more effectively for individuals [1]. The American College of Sports Medicine is the main training variable of resistance training, intensity, set and number of repetition (i.e., volume), inter-set rest interval,

exercise sequence, repetition velocity, training frequency, and exercise type [2]. Resistance exercise can be classified according to several criteria considering the number of joints involved, and can be classified as a multi-joint(MJ) or a single-joint(SJ) exercise [3]. The MJ, which is the main exercise that uses two or more joints, and the SJ, which is an auxiliary exercise that uses only one joint, are generally organized together in the resistance exercise program [4]. Most authors assume that MJ are more effective because they can lift more weight than SJ and recommend emphasizing MJ to maximize strength [2]. However, MJ may have higher metabolic stress than SJ [5], and some authors have suggested that SJ promotes greater muscle hypertrophy because it is easier to learn than MJ and is less dependent on neural factors [6].

It is known that it is effective to perform multiple sets that generate more training volume than a single set, which is a low training volume [7], during the resistance exercise program, and it is expected that the rest interval between sets will be an important variable for exercise professionals [8]. However, the rest interval between sets is not considered to be an important variable compared to weight-intensity and training volume (number of repetition), and scientific verification is insufficient [9]. Inter-set rest intervals depend on the training goal or energy system that targets a specific response to the fitness level, and interacts with training variables such as weight intensity, exercise volume, exercise sequence, and number of repetition [1]. At the same intensity, the acute responses and chronic adaptations of the neuromuscular and endocrine systems differ [10], because the resting interval affects acute metabolism [11], hormonal and immune cell responses to resistance exercise [12,13], and subsequent sets of volume [14,15] and power output [16]. Therefore, the rest interval between sets seems to be an important variable that can directly affect the amount of training and fatigue to achieve the purpose of resistance exercise.

On the other hand, although it is natural that the repetition frequency decreases as the rest interval is shorter in all exercise modes, there are few studies verifying the effect of the length of the rest interval between sets on the MJ and the SJ [17]. In the previous study that investigated total repetition by resting time when performing SJ with 50%1RM intensity, the resting interval of 1 minute was significantly lower than the resting interval of 3 and 5 minutes, raising questions about the resting interval setting of SJ joint exercise[5]. In addition, in the study of bench press, machine chest fly, leg press, and leg extension exercises at 10RM intensity, there was no difference in the number of repetitions between 3 and 5 minutes of rest intervals in MJ, and similar PRE was observed regardless of rest intervals in all exercise modes[9]. In addition, the study conducted bench press and machine chest fly exercises at rest intervals of 1, 2, 3 and 5 minutes at 10RM intensity did not cause a significant decrease in the total number of repetitions at rest intervals of 3 minutes or more, and RPE significantly increased with the set progress regardless of the training method[18].

As such, MJ and SJ may have many differences in implementation methods and effects, but few studies have examined them[3], and although careful adjustment of resting periods can be an important factor in designing resistance training sessions[19], the majority of studies have attempted only MJ and weight loads above moderate-intensity[20, 21]. Therefore, comparing the amount of exercise according to the exercise mode at rest intervals, which have not been studied relatively compared to the intensity and repetition frequency, which are widely investigated, will contribute to general recommendations for future resistance exercise prescriptions. In this study, the weight load of 65%1RM, which can be used for muscle endurance training, was applied to Bench press (bench press), one of the representative multi-joint exercises, and Biceps curl (biceps curl), a single joint exercise that has not been investigated, at 1 minute rest interval and 3 minute rest interval.

2. Experiment Materials and Methods

2.1 Experimental Approach

To investigate the effect of 2 different rest periods between sets (1 and 3 minutes) on the maximum number of repetition, data were collected using a randomized and counterbalanced within-subjects design. The test of 1RM was determined on nonconsecutive days, 1 week before the exercise protocols for all subjects. Subjects performed the 2 exercise(bench press and biceps curl) method sessions at 7-day intervals.

2.2 Subject

The subjects of 16 physically active, healthy males(age: 26.88±1.75 years, height: 176.31±1.66 cm, Weight: 82.69±4.59 kg) and with no history of lower-limb injury in thepast 12 months, were recruited to participate in this study. All of the selected subjects were fully educated about the significance of the study, the expected benefits, theinherent risks and inconveniences, and signed a consent form that they could bestopped at any time by their will.

2.3 Test of One Repetition Maximum

To determine the weight of 65%1RM of bench press and biceps curl, the Haff and Tripplet literature was referred and then applied to the measurement environment to test the maximum weight of bench press once twice a week before the experiment, and 65%1RM was calculate. measured based on 1RM measured a 2 week ago. The first set was prepared with a weight that can be repeated 5 to 10 times during 1 RM measurement, and the weight load of 5-10 kg was increased after 1 minute rest to lift it. After that, the rest time was provided for 2 minutes, and the weight of 5-10 kg was increased to determine the weight expected to be repeated 2-3 times, and then lifted and provided a 2-4 minute rest. Then, the weight of 5-10 kg was further increased to try 1 RM. When the bench press was successful, the weight was further increased after a 2-4 minute rest, and when the bench press failed, the weight of 2.5-5 kg was decreased after a 2-4 minute rest, and the 1 RM was determined by retrying. The weight was determined based on the number of times performed in the correct posture, and an assistant was placed to prevent the risk of injury during measurement.

2.4 Experimental Procedures

Seven days to 14 days after the last 1RM test, subjects performed the first of 4 different training sessions (72 hours between sessions). In each session, 5 sets with 65%1RM loads were performed. A randomized within-subject design was used to determine the exercise (bench press and biceps curl) in combination with the rest interval (1 or 3 minutes) used in each session. The warm-up before each session consisted of 2 sets of 12 repetitions at 40 % of 64 %1RM load of the exercise being tested that day.

A 5-minute rest interval was instituted after the second warm-up set before the first experimental set. Subjects were verbally encouraged to perform all 5 sets with full repetition maximums. The total number of completed repetitions was recorded after each set, and the repetition rate was calculated as % by setting 1 set as the maximum value.

2.5 Statistical Analysis

For data processing measured in this experiment, the mean and standard deviation of all variables were calculated using the IBM SPSS Statistics (ver 22.0) statistical program. For data processing measured in this

experiment, the mean and standard deviation of all variables were calculated using the IBM SPSS Statistics (ver 22.0) statistical program. Number of repetitions by set were analyzed using the repeated measurement two-way ANOVA method, and if significant differences were found, post-hoc was performed using the bonferroni method. The statistical significance level was set α = .05.

3. Result

3.1. 1-minute rest interval condition

3.1.1. Difference of number of repetition on 1-minute rest interval

Table 1 shows the results of the repeated measurement two-way ANOVA for the number of repetitions of the 1-minute rest interval. The number of repetitions of bench press and biceps curl at the 1-minute rest interval had no interaction effect between exercise mode and set. bench press showed a significant decrease up to 1-5 sets, and biceps curl showed a significant decrease up to 1-4 sets.

Table 1. Difference of repetition on 1-minute rest interval (Mean±SD)

	1 set	2 set	3 set	4 set	5 set		F	p
Bench press	20.19 ±1.28	9.31 ±1.58[†]	6.38 ±1.31[†ʃ§]	5.25 ±1.24[†ʃ§]	4.56 ±1.09[†ʃ§‖]	Exercise mode	4.273	.056
biceps curl	20.63 ±2.25	7.75 ±2.29[†]	5.13 ±1.71[†ʃ§]	4.25 ±1.48[†ʃ§]	3.88 ±1.59[†ʃ§]	Set	939.402	.000
						(E) x (S)	3.445	.053

[†] Significant difference to set 1.

[ʃ] Significant difference to set 2.

[§] Significant difference to set 3.

[‖] Significant difference to set 4.

3.1.2 Difference of repetition ratio on 1-minute rest interval

Table 2 shows the results of repeated measures two-way ANOVA for the number of repetitions of the 1-minute rest interval. The repetition rate of bench press and biceps curl at the 1-minute rest interval had an interactive effect between exercise mode and set. From 2 sets to 4 sets, there was a significant difference according to the exercise mode. bench press showed a significant decrease up to 1-5 sets, and biceps curl showed a significant decrease up to 1-4 sets.

Table 2. Difference of repetition ratio on 1-minute rest interval (Mean±SD)

	1 set	2 set	3 set	4 set	5 set		F	p
Bench press	100.00 ±0.00	46.08 ±6.96†	31.67 ±6.69^{†ʃ§}	26.10 ±6.22^{†ʃ§}	22.71 ±5.74$^{†ʃ§‖}$	Exercise mode	10.070	.006
biceps curl	100.00 ±0.00	37.72 ±10.90¶†	24.86 ±7.98^{¶†ʃ§}	20.60 ±6.83^{¶†ʃ§}	18.96 ±7.96^{†ʃ§}	Set	1143.917	.000
						(E) x (S)	5.261	.001

† Significant difference to set 1.

^{ʃ} Significant difference to set 2.

§ Significant difference to set 3.

$^{‖}$ Significant difference to set 4.

¶ Significant difference to exercise mode

3.2. 3-minute rest interval condition

3.2.1. Difference of number of repetition on 3-minute rest interval

Table 3 shows the results of repeated measures two-way ANOVA for the number of repetitions of the 3-minute rest interval. The number of repetitions of bench press and biceps curl at the 3-minute rest interval had an interactive effect between exercise mode and set. From 2 sets to 5 sets, there was a significant difference according to the exercise mode. bench press showed a significant decrease up to 1-5 sets, and biceps curl showed a significant decrease up to 1-4 sets.

Table 3. Difference of repetition on 3-minute rest interval (Mean±SD)

	1 set	2 set	3 set	4 set	5 set		F	p
Bench press	20.19 ±1.38	14.50 ±2.16^{†ʃ}	11.31 ±2.36^{†ʃ}	9.81 ±2.51^{†ʃ§}	8.63 ±2.00$^{†ʃ§‖}$	Exercise mode	8.851	.009
biceps curl	20.56 ±2.48	12.25 ±3.62¶†	8.81 ±2.46^{¶†ʃ}	7.31 ±2.02^{¶†ʃ§}	6.63 ±1.15^{¶†ʃ§}	Set	659.836	.000
						(E) x (S)	6.386	.003

† Significant difference to set 1.

^{ʃ} Significant difference to set 2.

§ Significant difference to set 3.

$^{‖}$ Significant difference to set 4.

¶ Significant difference to exercise mode

3.2.2. Difference of repetition ratio on 3-minute rest interval

Table 4 shows the results of repeated measures two-way ANOVA on the number of repetitions of the 3-minute rest interval. The number of repetitions of bench press and biceps curl at the 3-minute rest interval had an interactive effect between exercise mode and set. From 2 sets to 5 sets, there was a significant difference according to the exercise mode. bench press showed a significant decrease up to 1-5 sets, and biceps curl showed a significant decrease up to 1-4 sets.

Table 4. Difference of repetition rate on 3-minute rest interval (Mean±SD)

	1set	2set	3set	4set	5set		F	*p*
Bench press	100.00 ±0.00	71.72 ±8.47[†∫]	55.96 ±10.47[†∫]	48.21 ±10.10[†∫§]	42.53 ±8.55[†∫§‖]	Exercise mode	19.255	.001
biceps curl	100.00 ±0.00	58.89 ±13.29[¶†]	42.65 ±10.44[¶†∫]	35.35 ±7.81[¶†∫§]	32.47 ±5.92[¶†∫§]	Set	640.587	.000
						(E) x (S)	6.959	.003

[†] Significant difference to set 1.

[∫] Significant difference to set 2.

[§] Significant difference to set 3.

[‖] Significant difference to set 4.

[¶] Significant difference to exercise mode

4. Discussion

Resting interval between sets in resistance exercise is an important variable to consider when planning a training program because it directly affects the number of repetitions of subsequent sets [22]. The main result of this study is that the reduction rate of the number of repetitions of multi-joint exercise and single-joint exercise in multiple sets is different. In the 1-minute rest interval condition, there was no difference in the number of repetitions according to the exercise mode (bench press and biceps curl), but it was confirmed that there was a difference between 2-4 sets in the repetition rate.

These results are consistent with the claims of related previous studies [9]. In all exercise modes, the number of repetitions from 2 sets fell to less than 50 %, and a 1-minute rest interval does not allow sufficient recovery time [23]. It is considered that it is necessary to set a longer rest interval than the generally recommended short rest interval (1~2 minutes). In 3-minute rest interval condition, there was a significant difference between the exercise mode (bench press and biceps curl) and the set. In bench press, the number of repetition decreased from 4 sets to less than 50 %, and in biceps curl, the number of repetition decreased from 3 sets. This result means that the total number of repetitions that can be completed increases as the interval of rest between sets increases, and it is consistent with the related study that the interval of rest for 3 minutes showed a higher number of repetitions than the interval of rest for 1 minute [23, 24].

Since resistance was constant in all sets, the difference in momentum can be explained by achieving an absolutely greater number of repetitions at the three-minute rest interval, but a decrease in repetitions could mean a higher mobilization rate of type II fibers and could be attributed to decreased intramuscular matrix and fatigue following metabolic reactions [25]. According to similar previous studies, long resting intervals between sets prevented greater recovery and loss of repetition times under loads of 8-15RM [26-28]. In addition, the number of repetitions that decreased regardless of resting interval in all exercise types is consistent with the previous study that reported that the number of repetitions decreased as the set progressed at all resting intervals (2 min, 5 min) when leg press, leg extension, and leg curl exercise were performed [29]. This means that there is a factor that inhibits exercise performance apart from the energy temperament recovered from resting time between sets.

On the other hand, the number of repetitions of biceps curl tended to decrease more than that of bench press, which is consistent with the previous study that the MJ (bench press) showed more repetitions than the SJ (biceps curl) [30, 31], which means that the secondary movers share the weight load, which can prevent the

number of repetitions from failing or decreasing in subsequent sets [9]. The results of this study are also believed to be due to the fact that bench press, the MJ, uses larger muscles or uses more muscles than the biceps curl exercise, the SJ.

In addition, in the previous study comparing the momentum of the pec deck fly and the bench press, the total momentum of the bench press was high, but the number of repetitions between sets decreased less in the pec deck fly. In the case of MJ, there was no difference in the response of lactic acid according to the rest interval, but in the case of SJ, the lactic acid concentration increased significantly as the rest time was shorter [5]. After 20 weeks of biceps curl exercise and bench press exercise, it was reported that muscular strength increased in bench press exercise and hypertrophy increased in biceps curl exercise, and neuromuscular responses could be changed according to exercise mode [6]. It is considered that the recovery time required for MJ and SJ is different and the resting interval should be different according to exercise type.

5. Conclusion

The purpose of this study was to investigate the changes in the number of repetitions and the rate of repetitions by conducting Bench press, a multi-joint exercise, and Biceps curl, a single-joint exercise, for 5 sets at long resting intervals (3 minutes) and short resting intervals (1 minute) during 65%1RM endurance resistance exercise. In order to investigate this, bench press and biceps curl were performed in 5 sets at 65% 1RM intensity, and the break time was 1 minute and 3 minutes.

As a result, the number of repetitions per set of 1 minute rest interval showed a significant decrease from bench press to 1 set 20.19±1.28, 2 set 9.31±1.58, 3 set 6.38±1.31, 4 set 5.25±1.24, and 5 set 4.56±1.09. biceps curl decreased significantly to 1 set 20.63±2.25, 2 set 7.75±2.29, 3 set 5.13±1.71, and 4 set 4.25±1.48. The repetition rate according to the exercise mode of 1 minute rest interval showed a significant difference from 2 set to 4 set. The repetition rate by set showed a significant decrease in bench press to 1set 100.00±0.00, 2 set 46.08±6.96, 3 set 31.67±6.69, 4 set 26.10±6.22, and 5 set 22.71±5.74.1set 100.00±0.00, biceps curl 2 set 37.72±10.90, 3 set 24.86±7.98, 4 set 20.60±6.83 showed a significant decrease.

The number of repetitions according to the exercise mode of the 3-minute break interval showed a significant difference from 2 set to 5 set. The number of repetitions by set showed a significant decrease in bench press to 1 set 20.19±1.38, 2 set 14.50±2.16, 3 set 11.31±2.36, 4 set 9.81±2.51, and 5 set 8.63±2.00. biceps curl decreased significantly to 1 set 20.56±2.48, 2 set 12.25±3.62, 3 set 8.81±2.46, and 4 set 7.31±2.02. The repetition rate according to the exercise mode of the 3-minute break interval showed a significant difference from 2 set to 5 set. The repetition rate by set showed a significant decrease in bench press from 1 set 100.00±0.00, 2 set 71.72±8.47, 3 set 55.96±10.47, 4 set 48.21±10.10, 5 set 42.53±8.55. biceps curl decreased significantly to 1 set 100.00±0.00, 2 set 58.89±13.29, 3 set 42.65±10.44, and 4 set 35.35±7.81.

In summary, the decrease in the number of repetitions according to the set progression in the resistance exercise of the endurance strength depends on the exercise mode, and the increase of the rest interval or the decrease of the weight load should be considered when aiming for more exercise.

Acknowledgment

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