ORDER OF EXERCISE

The Multiple Mini-circuit Weight-training Program

Everett Harman, Ph.D., C.S.C.S.

and

Peter Frykman, M.S., C.S.C.S.
Occupational Physiology Division
U.S. Army Research Institute of Environmental Medicine
Natick, Massachusetts

In a typical weight-training program, the lifter completes all sets of each exercise before going on to the next exercise. Rest periods between sets of the same exercise are usually in the range of one to three minutes, and tend to be longer between exercises. The average time per set, which includes both lifting repetitions and rest, normally falls in the 2 1/2 to four-minute range, which translates to 1 1/4 to two hours for a workout involving three sets of each of 10 exercises. Serious bodybuilders often use very short inter-set rest intervals, particularly when peaking for competition (3).

Although many lifters conduct their workouts at a comfortable pace with little attention to time between sets, inter-set rest interval is an important factor in resistance-training program design, along with exercises selected, poundages, repetitions and sets. Heavy weight, low repetitions and long rest periods are most suited to increasing strength, while lighter weight, more repetitions and shorter rest periods are preferable for improving local muscle endurance and bodybuilding (1, 3).

Limited availability of time is always a factor in strength training. The resistance-exercise program of a high school or college athlete must be scheduled around the time demands of class attendance, academic assignments, sport technique training and other activities. Most adults who are not professional athletes have work and family commitments that make it difficult to schedule adequate time for physical conditioning. Such is the case for most amateur athletes, workers who engage in strength training to better perform physically demanding jobs, recreational athletes who exercise for a competitive edge, and working adults who wish to maintain or enhance the appearance and functionality of their bodies and to prepare.
themselves for the occasional situation where a strength reserve is needed. Thus, an exercise program that produces the desired training effect in a minimum amount of time can be of great benefit to many people.

Circuit weight training is an alternative to the typical strength-training sequence, and is relatively time economical. It usually involves performing one exercise set on each of eight to 12 weight-stack machines, with very short rest intervals between sets (2, 8). The full cycle of one set per exercise may be repeated two or three times. Circuit training has been used mainly by those seeking local muscle endurance along with modest gains in strength and muscle size, without great investment in time. Circuit training also has been shown to provide some cardiovascular conditioning (4, 5, 6, 7) because when short rest periods are used, heart rate can be maintained within the cardiovascular training zone (albeit the lower end of the range). The training zone generally is considered to be 70 to 90 percent of the individual's maximum heart rate. For an individual who has been medically cleared, and under the supervision of qualified personnel, maximum heart rate can be determined by observing where heart rate fails to increase even with increasing exercise intensity (e.g., treadmill speed or cycle ergometer workload). Otherwise, maximal heart rate (beats per minute) can be estimated as 220 minus one's age in years (7).

Because of the continuous nature of the circuit workout, the lifter also must become accustomed to relatively high levels of total body lactic acid (9). It is not surprising that circuit training can improve local muscle endurance during exercise of relatively high intensity (5). Such adaptation is useful for many sports, especially those involving repeated maximal or near-maximal muscular exertions (1).

Circuit training has never been popular among serious lifters or athletes training for sports in which strength is a major factor, due to the general feeling that it has limited value for building strength and muscle size. Also, circuit training has been used most often with weight-stack machines rather than free weights, because the time needed to change bar weights slows the passage of people through the circuit.

Circuit weight training may be less effective than standard weight training in improving strength and muscle size, because conventional circuit training usually calls for lighter weights than does standard weight training and doesn't provide the same degree of control over rest periods between sets of the same exercise. Because the trainee doesn't return to the same exercise until all other exercises in the circuit have been completed, the muscles involved in a given exercise have a much longer rest period than normally occurs between the same-exercise sets of a standard weight-training program.

The Multiple Mini-Circuit

We have developed a method we call the multiple mini-circuit (MMC) weight-training program, which we feel provides virtually all of the benefits of both standard weight training and circuit training (gains in muscle strength and size, improved resistance to fatigue, modest cardiovascular training effect, and economy of time).* The program can be used with free weights or weight-stack machines, or a combination of both. Similar programs may have been developed elsewhere, but to our knowledge none has been described in print.

Basic Principles of the Program

Time per set. The lifter should strive for an average time of 1 1/2 minutes per set, so that a 30-set workout can be completed in 45 minutes, or a 40-set workout in an hour. After adaptation to the pace (which might take several weeks), it is not difficult to use the same poundages, sets and repetitions per exercise as with the standard weight-training program.

* The cardiovascular benefits of circuit weight training are much lower than those of continuous whole-body exercises like running, cycling or swimming. Therefore, circuit weight training should not be considered a substitute for standard aerobic exercise. Even athletes not training for sports where aerobic exercise provides a competitive advantage should be encouraged to engage in regular aerobic exercise in order to maintain health and cardiorespiratory fitness.
## Table 1. Two MMC Routines for the Same 12-exercise Total-body Workout

<table>
<thead>
<tr>
<th>Two exercises per mini-circuit</th>
<th>Three exercise per mini-circuit</th>
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<tbody>
<tr>
<td>2. Squat</td>
<td>2. Squat</td>
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<tr>
<td></td>
<td>3. Weighted sit-up</td>
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<tr>
<td>1. Seated row (machine)</td>
<td>1. Seated row (machine)</td>
</tr>
<tr>
<td>2. Leg curl (machine)</td>
<td>2. Leg curl (machine)</td>
</tr>
<tr>
<td>1. Military press</td>
<td>3. Calf raise</td>
</tr>
<tr>
<td>2. Weighted sit-up</td>
<td></td>
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<tr>
<td>1. Lat pulldown (machine)</td>
<td>1. Pullover</td>
</tr>
<tr>
<td>2. Leg extension (machine)</td>
<td>2. Shoulder shrug</td>
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<tr>
<td>1. Pullover</td>
<td>3. Back extension (machine)</td>
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<td>2. Shoulder shrug</td>
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<tr>
<td>1. Calf raise</td>
<td></td>
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<tr>
<td>2. Back extension (machine)</td>
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Even though total workout time might be only half to two-thirds as long. It is possible to average even less than 1 1/2 minutes per set, but such a fast pace may begin to cut into poundages and repetitions, thereby impeding progress in strength development. The faster pace, however, may be useful for athletes whose sports require continuous high-intensity exercise for several minutes (e.g., wrestling).

**Dividing the workout into mini-circuits.** The workout is broken down into mini-circuits of two, three or four exercises each, depending on the rest period desired between sets of the same exercise. For example, if a program consists of 12 exercises (A, B, C, D, E, F, G, H, I, J, K and L) and a relatively short rest period between sets of the same exercise is desired, the exercises can be grouped into two-exercise mini-circuits (e.g., AB, CD, EF, GH, IJ and KL). For the first pair, one performs a set of exercise A, then moves with little or no rest to a set of exercise B, then back to exercise A, etc., until the desired number of sets are completed. For three sets per exercise, the AB group is performed as A, B, A, B, A. B. Then the CD pair is performed as C, D, C, D, C, D. The same pattern is repeated for each exercise pair until all pairs are completed. With exercises grouped in pairs, and 1 1/2 minutes per set, there are three minutes between the start of each set of a given exercise. Because the actual lifting repetitions generally take 20 to 30 seconds, that means about a 2 1/2 minute rest for each muscle group between sets of the same exercise.

If more rest is desired between sets of the same exercise, the mini-circuits each can consist of three rather than two exercises. For the above series, that could be ABC, DEF, GHI, JKL. For three sets per exercise, the ABC mini-circuit would be performed as A, B, C, A, B, C, A, B, C. The other mini-circuits would be performed similarly. There would be 4 1/2 minutes between the start of each set of a given exercise and a rest period of four minutes between sets of the same exercise. One may even wish to have four exercises in each mini-circuit if a long rest period is desired between each set of a given exercise. The time for the entire workout is not affected by the number of exercises per mini-circuit, only by the total number of sets in the workout. The three- and four-exercise mini-circuits are particularly useful when averaging less than 1 1/2 minutes per set, because they provide adequate rest for individual muscle groups even at the faster overall exercise pace.

**Selecting the exercises for each mini-circuit.** To ensure that a muscle rests between sets of the same exercise, it is important that the exercises within each mini-circuit involve different muscle groups and body movements. One would
not put the bench press and military press into the same mini-circuit, because both involve elbow extension and work the deltoids and triceps. An exception to this rule would be a bodybuilding workout involving supersets of exercises for the same muscle. **Table 1** shows two MMC routines involving three sets each of the same 12 exercises; one routine uses two and the other three exercises per mini-circuit. The two-exercise mini-circuits involve shorter rest periods between sets of the same exercise than do the three-exercise mini-circuits.

**Time economy of the MMC routine.** The MMC routine yields considerable time savings that can result in the following benefits:

- The same quantity and quality of training can be accomplished in considerably less time, freeing up time for sport technique training, academic work and other pursuits.
- A greater volume of training can be completed in the same amount of time. This allows muscle groups and body movements ordinarily neglected in a workout to be given greater attention. Because of the greater volume of exercise that can be accomplished in the MMC workout, coaches must be especially attentive to overtraining.
- Motivation can more readily be maintained at a high level when the athlete can complete a strength-training workout in a reasonable amount of time.
- The lower time requirements of the MMC routine can encourage involvement in resistance training among people who feel they cannot make the time commitment required by a standard routine.

**Unsplitting the split routine.** Many lifters unnecessarily split their exercise routines into two or three segments, each of which is performed two days per week, for a total of four or six lifting days per week. The main reason for splitting is that the extended inter-set rest intervals make the workout too long. Using the MMC program, a thorough, total-body workout can be completed in 1 1/4 to two hours, eliminating the need to split the routine. The lifter can make similar progress doing the same total work in an MMC routine performed three times per week as in a split routine performed six times per week. A twice-per-week MMC routine is effective for maintaining previous strength gains, and is particularly useful for avoiding strength decrements during a sports season, when it is difficult to schedule time for workouts.

The MMC structure is not incompatible with the split routine, even though it can eliminate the need for splitting. If a lifter wishes to use a split program, the MMC structure still can provide the advantage of reduced time per workout or more exercise in a given amount of time.

**Variations on the MMC workout.** There is nothing sacred about the MMC routines described here. The basic principles of the MMC can be applied with flexibility, creativity and attention to the needs of the individual. For example, in a workout where both the bench press and squat are performed in six-set ramps (half pyramids), the lifter may feel comfortable with shorter rest periods at the lighter weights, but may need longer rest periods at the higher weights. In that case, a mini-circuit may be used in which the exercise sets are performed in the order depicted in **Table 2**. It can be seen that this mini-circuit is a combination of a two-exercise and a three-exercise mini-circuit, in which the bench press and squat each are performed for six sets and the sit-ups are performed for three sets.

Lifters and coaches should be attentive to which mini-circuits work best for each individual and muscle group. A workout can be comprised of a combination of two-, three- and four-exercise mini-circuits. The number of sets and repetitions needn’t be the same for all exercises.

The MMC workout may be conducted with partners if desired. For instance, for an AB exercise pair, one partner can do exercise A while the other does exercise B. The two partners switch exercises repeatedly until the
Table 2. An MMC with Shorter Rest Periods Between the First 3 Same-exercise Sets, and Longer Rest Periods Between the Last 3 Same-exercise Sets

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<tbody>
<tr>
<td>1.</td>
<td>Bench press</td>
<td>2.</td>
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</table>

This design is appropriate when later sets are more fatiguing than earlier ones (e.g., the ascending ramp or half-pyramid, where both weight handled and effort increase with each set).

desired number of sets are completed. The partners then move on to the next mini-circuit. Similarly, three partners can work together on three-exercise mini-circuits. Because most exercises don’t require a spotter, partners can spot each other when necessary and still maintain the average pace of 1 1/2 minutes per set.

Compatibility with other training techniques. The MMC structure works well with periodization, pyramids, supersets, plyometrics and virtually all other common resistance exercise techniques. With any of these training modalities, MMC can reduce the time required to perform a given number of exercise sets or increase the number of sets that can be performed in a given amount of time.

Acknowledgement

The authors would like to thank Steven Mittelmann, a personal trainer and former powerlifting coach, for contributing valuable information and insight.

Disclaimer

The views and opinions contained in this article are those of the authors alone and should not be construed as an official U.S. Department of the Army position, policy or decision.

References

A Movement-oriented Approach to Exercise Prescription

Choose the best answer for each question.

1. The number 146 represents the number of muscles:
   A. on both sides of the body involved in gross body movement.
   B. on one side of the body involved in gross body movement.
   C. involved in upper-body exercises.
   D. involved in lower-body exercises.

2. The power clean should be described as a:
   A. single-joint exercise.
   B. uniaxial exercise.
   C. body-part exercise.
   D. multi-joint exercise.

3. The recommended alternative to the body-part and muscle-group program is referred to as the:
   A. functional approach.
   B. movement-oriented approach.
   C. dynamic approach.
   D. A and B.

4. An important deficiency of the movement-oriented approach to training is that it lacks:
   A. standard terminology.
   B. development as a comprehensive system.
   C. specifying direction of movements for multi-directional body joints.
   D. All of the above.

5. A term not considered a standard anatomical plane is:
   A. sagittal.
   B. diagonal.
   C. frontal.
   D. transverse.

6. Movements permitted in the sagittal plane include:
   A. flexion and extension.
   B. abduction and adduction.
   C. rotation.
   D. circumduction.

7. Associated with the reduced likelihood of overuse injuries and overtraining are programs that feature:
   A. single-joint exercises.
   B. multi-joint exercises.
   C. body-part exercises.
   D. uniaxial joint exercises.

8. A movement identified as receiving little or no attention in most exercise programs is:
   A. transverse shoulder abduction.
   B. transverse shoulder adduction.
   C. transverse hip abduction.
   D. transverse hip adduction.

9. Which of the following was mentioned as a contributory factor to muscle injury:
   A. muscle hypertrophy
   B. muscle temperature
   C. muscle imbalance
   D. muscle arrangement

10. The authors contended that the goal is to select exercises that are sport specific and that:
    A. involve solely negative movements.
    B. involve solely positive movements.
    C. provide resistance through the appropriate ranges of motion.
    D. focus on small muscle groups.

The answers to this quiz will be in Volume 14, Number 2 of the NSCA Journal.

Answers to the C.S.C.S. CEU Quiz in Volume 13, Number 6 of the NSCA Journal:

Correction: The answers printed in Volume 13, Number 6 for the C.S.C.S. CEU Quiz in Volume 13, Number 5 were incorrect. The correct answers are: