Muscle Use During Exercise With a Mini Medicine Ball Compared to Other Abdominal Exercise Modalities

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KEY WORDS: exercise, exertion, core muscles, strengthening

ABSTRACT
Twelve subjects were examined to determine the level of muscle activity in the external obliques, rectus abdominus, transverse abdominus, quadriceps, hamstrings, biceps, and triceps during exercise with mini medicine balls following an exercise video. The medicine balls were about 8 inches in diameter and came in weights of 2, 4, and 6 lbs (0.9 kg, 1.8 kg, and 2.7 kg, respectively). Here, no ball exercise was compared with 2- and 6-lb ball exercise. Subjects were male and female in the age range of 20-40 years and free of cardiovascular or neurological disease. During the video, 7 exercises were evaluated and compared with abdominal crunches. The exercises were done with and without a medicine ball to further study the effect of adding the medicine ball to the exercises on muscle use. Data were compared to observe the effectiveness of the various weighted medicine balls in using the muscles for exercise as a means of physical training. The results of the experiments showed that, for the 2-lb ball, total muscle work was 12.5-times that of an abdominal crunch and specifically, for the core muscles, was 1.62-times greater than the abdominal crunch while with the 6-lb ball it was 2.16 times greater. Specific exercises were as high as 4-times greater muscle activity for the core muscles. Compared to squat exercise without a medicine ball, adding the 2- or 6-lb medicine ball increased the work on the gluteus maximus in the
squat by 1.4 times and as much as 4.4 times the work for other exercises. Thus, this exercise regime with the medicine balls was a better overall and faster workout than that seen with abdominal crunches or exercise without the medicine ball.

**INTRODUCTION**

Death rates from obesity and associated diabetes has been rising worldwide.\(^1\) While smoking\(^1\) and deficiency of essential vitamins such as vitamin D in the diet\(^2\) help predispose people to obesity and diabetes, much of the complications in obesity and diabetes described in the literature\(^3\) are also caused by lack of exercise. Thus in recent years, the importance of home exercise programs has increased in emphasis.\(^4\) Both heart disease and diabetes are inversely related to daily exercise and directly related to body mass index.\(^5\) Engaging in an exercise program can dramatically reduce the incidence of diabetes as well as associated complications,\(^6\) as regular physical exercise in cardiac patients,\(^7\) obese people,\(^8\) and people with diabetes\(^9\) reduces inflammatory markers.\(^10\) Further, back injury and lower back pain are also directly related to weakness of the core muscles including rectus abdominus and the erector spinae.\(^11\) Therefore, strengthening these muscles not only has been proven to reduce lower back pain but also increases balance in daily activities.\(^12,13\)

Unfortunately, exercises on commercial weight-lifting machines are very specific for particular muscles rather than groups of muscles. Most people who pay for gyms in health clubs don’t enjoy the ability to commit the hours necessary to exercise on several pieces of equipment and they therefore lose interest. There is also an added benefit of privacy when exercising at home not found in a health club. This is especially a concern for many women. In addition, busy schedules often make gym visits sporadic. Exercise needs to be continued on a regular basis to become effective.\(^14,15\)

Numerous types of abdominal (core) exercise programs have been developed.\(^16-19\) In the present investigation, we examined medicine balls of various weights. Medicine balls have been used historically for training upper and lower body muscles as well as core muscles.\(^20\) Medicine balls have been used in a variety of populations including resistance training in school-aged boys\(^20,21\) to increase the motor abilities and fitness in obese children,\(^22\) to activate shoulder and arm muscles during axial load exercises,\(^23\) to increase physical ability in softball athletes,\(^24\) for aerobic training in volleyball athletes,\(^25\) and in core endurance programs for rowing.\(^26\) Upper body exercises such as chest passes are routinely used by gymnasts,\(^27\) whereas many other exercises are used for coordination and to strengthen muscles.\(^28\)

In this study, a new type of mini medicine ball was tested. The difference between this and a conventional medicine ball is the size. This ball is only about 8 inches in diameter and comes in 3 weights: 2, 4, and 6 lbs (0.9 kg, 1.8 kg, and 2.7 kg, respectively). By following a

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**Table 1.** The general characteristics of the subjects.
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<th>Hamstring EMG (%)</th>
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commercial exercise video, the goal of this project was to see if this medicine ball was effective in training the upper body, lower body, and core muscle area simultaneously. Muscle activation while using no ball, or the 2- or 6-lb mini medicine ball during 7 exercises from the associated video was compared to abdominal crunches.

**SUBJECTS AND METHODS**

**Subjects**
The subjects in the study included 12 males and females. They were in the age range of 20-40 years. They were free of any cardiovascular and neurological diseases. The general characteristics of the subjects are listed in Table 1. All methods and procedures were explained to each subject who signed a statement of informed consent. This study was approved by the Human Review Committee of Azusa Pacific University.

**Determination of Muscle Activity**
To determine muscle activity, the electromyogram (EMG) was used. The EMG was recorded by using 2 electrodes and a ground electrode placed above the active muscle. The relation between tension in muscle and surface EMG amplitude is linear. Thus, the amplitude of the surface EMG can be used effectively as a measure of activity of the underlying muscle by simply normalizing the EMG in terms of a maximal effort. Muscle activity was therefore assessed by first determining the percent of maximum EMG to calculate the percent of muscle activity. The electrical output from the muscle was amplified with a biopotential amplifier with a gain of 2000 and frequency response that was flat from DC to 1000Hz (EMG 100 C amplifier, Biopac Inc., Goleta, California, USA). The amplified EMG was digitized with a 16-bit analog to digital converter and sampled at a frequency of 2000 samples/sec (MP 100, Biopac Inc., Goleta, California, USA). The software to analyze the EMG is Acknowledge 3.9.1 (Biopac Inc., Goleta, California, USA).

**Exercise**
Abdominal exercise was accomplished in 1 of 2 manners. First, abdominal crunches were used. Abdominal crunches involved the subject lying on the floor in a supine position with their hands behind their head and contracting the abdominal muscles to lift the trunk approximately 30° such that the shoulders just cleared the floor. Mini medi-
Exercise videos

The exercise video used in this study is called the strength building workout video. It is approximately 50 minutes long and involves a series of exercises using the mini medicine ball during upper body and lower body stretching and abdominal exercise. The following exercises were examined in this study: 1) The teeter totter. This exercise involved the subjects standing with their feet shoulder-width apart in a partial squat position and holding the ball against the chest. The subject side-flexed their trunk toward the left and right throughout their full range (Figure 1A). 2) Thigh-thigh-shoulder exercise. Here the subject was standing in a wide stance in a semi-squat position and the ball was rotated across the abdomen with arms extended from the hip to the contralateral hip, then from one shoulder toward the other (Figure 1B). 3) Around-the-world squats. This exercise involved the subject starting in a semi-squat position, holding the ball with arms extended. The subject began by squatting, holding the ball vertical toward the floor while squatting, and then circling the ball across the body and over the head, then returning to the semi-squat position (Figure 1C). 4) Around-the-world lunges. This exercise included a backward step lunge as the subject rotated the ball over their head in a circular pattern from side to side (Figure 2A). 5) Back lunge arm pull. This exercise involved the subject standing in a lunge position holding the ball above their head with their arms extended. The subject then lowered the ball toward their waist while simultaneously flexing their back hip and raising their knee in toward their chest (Figure 2B). 6) Toy soldier. The subject stood with their feet together and the ball held with their arms extending above their head. Keeping their arms extended, the subject lowered the ball to waist height directly in front of them, while simultaneously flexing an extended leg to meet as close to the ball as possible. The exercise is then repeated with the opposite leg (Figure 2C). 7) Tuck-up abdominal crunches. The subjects were in the supine position starting with the ball held over their head and arms straight. The ball was then brought over the body with the arms extended, while simultaneously one knee is brought in toward

Figure 2. Around-the-world lunges (A), back lunge arm pull (B), and the toy soldier (C).
the chest. The exercise was repeated with the opposite leg, then both knees brought into the chest (Figure 3A and B). 8) Lying leg lifts. The subject was in the supine position with one leg flexed and the other foot on the ball placed alongside the opposite foot. The subject then extended their hips, raising their body off the floor (so that only the shoulders and head touch the floor) using the leg in which the foot was placed on the other ball, while simultaneously straightening the opposite leg to extend in line with level of the knees (Figure 3C).

Statistical Analysis
Statistical analysis involved the calculations of means, standard deviations, and t-tests, analyzed using Excel, from Office 2007. The level of significance was set at $P < 0.05$.

Procedures
Subjects entered the lab in a controlled room temperature of 20°C ± 2°C. They rested comfortably in a seated position for 10 minutes before undergoing the exercises. During this time, electrodes were placed above the left and right obliques, rectus abdominus, back extensor muscles, biceps, triceps, quadriceps, hamstring, and gastrocnemius muscles. Subjects then exercised for 3 minutes doing standard abdominal crunches. Finally, after a 5-minute rest, subjects watched and followed the exercise video performing each of the 7 different exercises without a ball or with a 2- or 6-lb mini medicine ball.

RESULTS
Results of the experiment are shown in Figures 4 through 12. The no ball exercise condition is referred to as the 0-lb ball. Obviously, there is no such entity as a zero pound ball. Here the subjects went through the exercises as if they had a ball in their hands.

Teeter Totter Exercise
The results of this series of experiments are shown in Figure 4. The peak muscle activities for the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, and triceps are listed in Table 2. When the mini medicine ball was used, the muscle activity increased. For these muscle groups, with the exercise without the mini medicine ball, the average muscle activity was 17.3% ± 3.8% for these muscle groups and 17.2% ± 5.0% with the 2 lb ball; with the 6 lb ball, average muscle activity increased to 25.4% ±
4.9% for these muscles. The average duration of the exercise was $3.2 \pm 0.56$ seconds (Table 3). Figure 4 shows the average work for this exercise, calculated when the average muscle activity was multiplied by the duration of the exercise.
Figure 5. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the thigh-thigh-shoulder exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
Figure 6. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriiceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the around-the-world squats exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
Figure 7. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the around-the-world lunges exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
Figure 8. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the back lunge arm pull exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
Figure 9. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the toy soldier exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
Figure 10. Illustrated in the 3 panels of this figure is a calculated work of the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, triceps, and the total average work for all muscle groups for a single exercise involving the tuck-up abdominal crunches exercise. The upper panel shows the average muscle work without holding the ball, whereas the middle and bottom panels show the average work when lifting the 2-lb and 6-lb ball, respectively, for the exercise. Each panel shows the average results ± SD for all 12 subjects.
As can be seen here, the greatest work was in the rectus abdominus, quadriceps, gluteus maximus and triceps muscles respectively. This was especially true with the 6-lb mini medicine ball exercise. However, muscle activity was high for all muscle groups examined. Thus, the average work with no ball and the 2-lb ball was 46.6 ± 18.8 and 46.6 ± 18.5 work units, respectively, compared with 65.7 ± 24 work units for all muscle groups with the 6-lb ball.

**Thigh-Thigh-Shoulder Exercise**

As shown in Figure 5, the total muscle activity and total work was slightly different for the thigh-thigh-shoulder exercises. Whereas the majority of muscle activity was for the quadriceps, triceps, and rectus abdominus for the teeter totter exercises, for the thigh-thigh-shoulder exercises, there was significant activity for the quadriceps, back extensors, rectus abdominus, triceps, and gluteus maximus muscles, especially when using the 6-lb ball. The maximum muscle activities for the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, and triceps are shown in Table 2. For each muscle group, muscle activity with the 0- and 2-lb balls was not significantly different \((P > 0.05)\). However, comparing the 6-lb ball with the 2-lb ball and the 0-lb ball, muscle activity was significantly higher for each muscle group (analysis of variance [ANOVA], \(P < 0.05\)). The muscle activity with the 6-lb ball averaged 24.6% ± 5.4% of total muscle activity, which was significantly higher than the average muscle activity with the 0- and 2-lb balls (ANOVA, \(P < 0.01\)). With an average duration of 3.7 ± 0.8 seconds (Table 3), the work, as
shown in Figure 5, was similar for the 0- and 2-lb balls, but work was significantly higher for the 6-lb ball. Here, the average work was 48.2 ± 18.9 work units for the 0-lb ball, 49.8 ± 29.3 units for the 2-lb ball, and 82.0 ± 24.0 units for the 6-lb ball (P < 0.01 vs 0-lb ball and 2-lb ball average work).

**Around-the-World Squats**

For around-the-world squat exercise, the average muscle activity was higher than for the teeter totter or the thigh-thigh-shoulder exercise, averaging 20.1% ± 6.1% of muscle activity for all muscle groups with the 0-lb ball, 22.8% ± 8% of muscle activity with the 2-lb ball, and 29.8% ± 8.6% muscle activity with the 6-lb ball (Table 2). Muscle activity with the 2- and 6-lb balls was significantly higher than with the 0-lb ball (P < 0.05). The average duration of the exercise was 3.6 ± 1.3 seconds (Table 3). Here, due to the fact that squats were being done, the quadriceps had significantly higher activity than in the previous 2 exercises. For example, for the 6-lb ball, the quadriceps muscle showed activity of 62.3% ± 28.7% of total muscle activity as compared to the thigh-thigh-shoulder exercise quadriceps peak activity of 31.5% ± 14.1% of total muscle activity, a significance of P < 0.01. The lowest muscle activity was to the obliques whereas there was significant activity, as shown in Figure 6, for the rectus abdominus and triceps. Triceps work also progressively increased. For example, with the 6-lb ball, triceps activity was 26.4% ± 9.1% of total activity. When work was calculated, as shown in Figure 6, the average work was 55.5 ± 18.3 work units with the 0-lb ball, 63.8 ± 26.1 work unit with the 2-lb ball, and 88.5 ± 21.3 work unit with
the 6-lb ball. Thus, with the 2- and 6-lb balls, work was significantly higher than with no ball. Further, work with the 6-lb ball was significantly higher here than in the other 2 exercises (P < 0.05).

**Around-the-World Lunge**

Muscle activity changed here from the previous exercises because this exercise involved lunges, a different form of exercise. Unlike the other exercises, gluteus maximus activity, as shown in Figure 7, increased considerably in this exercise. This was especially true when using the 6-lb ball. Thus, looking at quadriceps, gluteus maximus, and hamstring activity with the 6lb ball, the muscle use for gluteus maximus was 35.1% ± 17.8% of total muscle activity, whereas the hamstring activity was 32.2% ± 22.3% of the total muscle activity (Table 2).

Quadriceps remained at similar levels at 30.5% ± 16.5% of the total muscle activity. Thus, the quadriceps activity here was less than with the around-the-world squats. Quadriceps activity and gluteus maximus activity significantly increased (P < 0.05) as compared to the activity of the biceps. For the biceps, activity significantly increased for the 6-lb ball from 26.0% ± 11.9% of the total muscle activity to 35.8% ± 18.7% of total muscle activity (P < 0.01). Triceps had similar activity as in the round the world squat as compared to rectus abdominus and the left and right obliques. Here, rectus abdominus activity for the 0-, 2-, and 6-lb balls averaged 25.1% ± 24.2%, 25.8% ± 26.3%, and 29.1% ± 26.3% total muscle activity, respectively. With an average duration of 3.2 ± 1.1 seconds, the average total work for this exercise was 73.5 ± 34.5 work units with the 6-lb ball compared to 51.2 ± 27.7 units with no ball (Table 3).

**Back Lunge Arm Pull**

As shown in Figure 8, for the back lunge arm pull exercise, the total work was somewhat less whereas muscle activity was fairly uniform for each of the 9 muscle groups examined; muscle activity was slightly higher for rectus abdominus, the back extensors, quadriceps, and gluteus maximus than in some of the other muscle groups. Thus, as shown in this figure, the peak muscle activity for the rectus abdominus, left obliques, right obliques, back extensors, quadriceps, hamstrings, gluteus maximus, biceps, and triceps were even for the 6-lb ball. The averaged muscle activity for all 9 muscles groups was 21.9% ± 4.5%, 24.7% ± 16.2%, and 30.2% ± 5.7% total muscle activity for the 0-, 2-, and 6-lb ball, respectively (Table 2). The increase in muscle activity for all 9 muscle groups between the 0-, 2-, and 6-lb balls was significant (P < 0.05). When looking at the total work, with an average duration of 2.47 ± 0.55 seconds, the total average work was 40.2 ± 13.2, 43.4 ± 16.1, and 56.4 ± 23.9 work units for the 0-, 2-, and 6-lb balls, respectively. This increase in work with each progressive ball was significant (P < 0.05). Total work here was, for each work load, less than in the lunges described in the paragraph above.

**Toy Soldier**

The results of the toy soldier exercises are shown in Figure 9. This exercise showed significant muscle activity for the gluteus maximus, quadriceps and back extensors. In addition, the core muscles also showed significant activity but not at the same levels as some of the other muscle groups (Table 2). The average muscle activity for each progressive exercise was 32.0% ± 8.6% muscle activity for 0-lb ball, 39.0% ± 13.4% muscle activity with the 2-lb ball, and 47.9% ± 16.3% muscle activity with the 6-lb ball. This increase in the percentage of total muscle activity was significant for each muscle group with progressively increasing work loads (P < 0.05). The increase
in work for the gluteus maximus, even with the 2-lb ball, was significantly higher than any other exercise described above (P < 0.01). With an average duration of 2.0 ± 0.43 seconds, the average work, as shown in Figure 9, displayed the peak muscle activity in the gluteus maximus, quadriceps, and back extensors described above. The total average work for this exercise was 55.6 ± 25.4, 62.3 ± 24.8, and 71.7 ± 26.4 work units with no ball, or the 2-lb and 6-lb balls, respectively. This increase in total average work for all the muscle groups was significant. Gluteus maximus showed the greatest work in this exercise, peaking with the 6-lb ball to 181.2 ± 121.2 work units.

**Tuck-up Abdominal Crunches**

The results of the tuck-up abdominal crunches exercise is shown graphically, as work, in Figure 10. As can be seen for this exercise, average muscle activity averaged 21.4% ± 6.6%, 25.5% ± 8.1%, and 32.7% ± 7.58% with the 0-, 2-, and 6-lb balls, respectively, as a percentage of the maximum activity of the muscles (Table 2). For this particular exercise, there was relatively high muscle activity except on the hamstrings and biceps muscles for all exercises. With an average duration of 3.98 ± 1.21 seconds, the average work with no ball was 56.8 ± 18.4 work units, with the 2-lb ball 70.4 ± 25.9 work units, and with the 6-lb ball 96.1 ± 27.4 work units (Table 3). Thus, this exercise exhibited the highest average work of any exercise that was accomplished (P < 0.01).

**Abdominal Crunches**

The result of abdominal crunch is shown in Figure 11. As can be seen in this figure, work was very light with the abdominal crunch, most of the work being done by the rectus abdominus muscles and the obliques (Table 2). The triceps showed some activity due to the placement of the arm behind the head and holding the arms in position, but activity was actually fairly low. An average muscle use of 10.0% ± 1.37% of total muscle activity was achieved. Compared to all the other exercises described above, for each muscle group, muscle activity here was significantly less (P < 0.01). With an average duration of 1.72 ± 0.39 seconds, the average work was 6.05 ± 2.0 work units (Table 3). Compared with the other exercises, even without use of the ball, the work was about 10% of the other exercises. When using a 6-lb ball, compared with some of the exercises such as the world squats or the toy soldier, the total work was about 1/15th that of the other exercises.

**Lying Leg Lift**

The final exercise was a lying leg lift, as shown in Figure 12. As can be seen here, the majority of muscle activity was on the hamstring, gluteus maximus, and triceps. This exercise did not use the balls. However, the average muscle activity was 29.7% ± 7.3% compared to 10% for the abdominal crunch. Thus, muscle activity was about 3 times the activity of a crunch. Furthermore, the duration was longer, averaging 3.96 ± 1.2 seconds. Thus, the total average of work averaged 63.1 ± 23.2 units, a value more than 10 times higher than that for the abdominal crunch.

**DISCUSSION**

Numerous studies have shown that exercising with a medicine ball can dramatically increase muscle use, especially in children. This is also true for adults, especially for the abdominal muscles. Thus, the use of medicine balls for exercise is joined by other core exercise devices. Medicine balls have been used in gyms as well as for resistance training for school boys and rehabilitation of the shoulder in adults. In the
present investigation, the use of mini medicine balls has been tested. This mini medicine ball comes in 2-, 4-, and 6-lb balls. The advantage of these medicine balls is that they are small and easy to store under the bed and therefore, a program is able to be implemented in the home environment to exercise the upper body muscles, lower body muscles, and core muscles. The core muscles are especially important because, when strengthened, there is reduced incidence of back injury and chronic low back pain.37-39

In the present investigation, various exercises on the mini medicine ball were compared to abdominal crunches. The muscle use in these studies showed that even with a 2-lb ball, the muscle activity during various exercises for the core muscles was much greater than that of the abdominal core muscles during sit ups. For example, during the tuck-up abdominal crunches exercises, the average core muscle recruitment for the 4 core muscle groups examined here was 37.1% of muscle activity compared with 13.68% for an abdominal crunch. This core muscle use was almost 300% higher for this exercise. Further, when the weight was progressively increased to the 6-lb ball, muscle activity was substantially higher, averaging 49.9% of total muscle activity for the abdominal muscles, showing an increase of about 400% over an abdominal crunch. Thus, abdominal muscles were exercised very extensively following the exercise video. Further, whereas crunches only uses a limited number of muscles, that is rectus abdominus and obliques, by using a mini medicine ball, significant muscle activity is also seen in the arm and leg muscles. Thus, the medicine ball provides a better whole body exercise workout than just doing abdominal crunches. Finally, these exercises were longer in duration than abdominal crunches, average, for all exercises, 3.3 seconds compared with 1.72 seconds for an abdominal crunch. Therefore, for each exercise, the total work was double that of the crunch alone due to the longer duration.

Further, unlike crunches where core muscle use was the only use except for some triceps activity to hold the arms behind the head, almost all muscle groups were active. Thus for the 9 muscle groups examined here, the average work was 41.6 for no ball, 55.7 for the 2-lb ball, and 75.2 for the 6-lb ball. The average work for a crunch was 6.1. Thus, there was 9.2 times the work of an abdominal crunch for a 2-lb ball and 12.5 times for the 6-lb ball. For all exercises averaged together, for the core muscles, the average muscle use was 1.62 times the core muscle use of a crunch with the 2-lb ball and 2.16 times the abdominal use for the 6-lb ball. Adding either the 2- or 6-lb ball showed a significant increase in work performed for the same exercises. The 2-lb ball made the exercise 1.3 times more effective while the 6-lb ball made the exercise 1.8 times more effective.

Exercise is generally conducted through movement of the body. The medicine ball exercises studied here, like many types of exercise, allowed for muscle use in many more muscles than simple abdominal crunches. It was interesting that even a 2-lb ball caused such a large increase in muscle use. However, the arms form a lever arm such that the effect of a 2-lb weight is to dramatically increase torque on the shoulders when the ball is held away from the body. Thus even the 2-lb ball would have its effect on muscle use amplified by the lever arm established by the arm’s length. This lever arm then increases additional muscle use even further on the core section of the body to stabilize the truck; here there is a double lever arm, one from the ball to the shoulder and a second from the shoulder to the lower abdominals, ampli-
fying the effect of the weight and the corresponding muscle use even further. As an example, the toy soldier, when looking at the rectus abdominus without the medicine ball, was 22.98% peak EMG amplitude and by adding the 2-lb ball almost doubled muscle use to 39.7% peak EMG amplitude. It is quite astonishing that a 6-lb ball can almost double the total body work performed, but predictable when analyzing the biomechanical effects of lever arms when used as part of exercise. Thus the use of small weight when leveraged with large lever arms can be very effective for increasing the intensity of exercise.

Finally, for people who might have had a hard time getting on and off the floor, this type of the workout is predominately in sitting or standing positions, which could provide a much safer environment than lying on the floor.

REFERENCES


