Effects of a Short-Term Resistance Program Using Elastic Bands Versus Weight Machines for Sedentary Middle-Aged Women

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Abstract

Colado, JC and Triplett, NT. Effects of a short-term resistance program using elastic bands versus weight machines for sedentary middle-aged women. *J Strength Cond Res* 22(5): 1441–1448, 2008—This study was designed to determine whether different effects on functional capacity and body composition were produced by using different devices (elastic bands (EBs) versus weight machines (WMs)) with the same resistance training program. Forty-five healthy sedentary middle-aged women volunteers were chosen and randomly assigned to 1 of 3 groups: 21 subjects trained using EBs (EBG), 14 in trained using WMs (WMG), and 10 were controls (CG). Both exercise groups trained with a periodized muscular endurance program twice a week for 10 weeks, with a total of 6 exercises per session for the major muscle groups. Exercise intensity was equalized by jointly monitoring the same targeted number of repetitions (TNRs) and rate of perceived exertion in active muscles (RPE-AM). Functional capacity was assessed by using knee push-up (KPU) and 60-second squat (S) tests. Body composition was measured using an 8-polar bioelectrical impedance analyzer. The results for both the EBG and WMG show a decrease in fat mass ($p = 0.05$ and $p < 0.01$, respectively) and an increase in both the fat-free mass ($p < 0.05$ and $p < 0.01$, respectively) and the number of repetitions in the KPU ($p < 0.05$ and $p < 0.01$, respectively) and S tests ($p < 0.01$ in both). None of the variables measured for the CG varied significantly. It can be concluded that, independently of the device used, the combined monitoring of TNRs and RPE-AM can be a valid tool for controlling the resistance exercise intensity and can lead to healthy adaptations. EBs can thus offer significant physiological benefits that are comparable to those obtained from WMs in the early phase of strength training of sedentary middle-aged women.

Key Words targeted number of repetitions, active muscle rate of perceived exertion, functional capacity

Introduction

Early postmenopause is a critical time for sarcopenia (5), one of the most serious public health problems affecting women today (14). Sarcopenia is a reduction in fat-free mass (FFM). FFM decreases by approximately 50% from 20 to 90 years of age. The rate of decline begins to become very apparent from the age of 30 onward and increases considerably after the age of 50. There is a clear relationship between loss of FFM and reduced muscular strength, functional capacity, and quality of life (5,21). Although increasing life expectancy is an important public health aim, it is even more important that it be accompanied by maintenance of functional health (21). Consequently, strategies to maintain or increase FFM in middle-aged women must be devised, including the development of resistance training programs (23). A general resistance training program with a few single- and multiple-joint exercises for the major muscle groups, using light resistance at submaximal effort, few sets, and weekly sessions can be effective in the initial stages of training for sedentary subjects to increase FFM, muscle endurance, and muscle power (2). Improvement of the muscle endurance of the upper extremities, combined with improvement of the power of lower extremities favors an increase in functional capacity and enhances quality of life (18,35).

The American College of Sports Medicine (ACSM) states that it might be ideal to start a resistance training program with weight machines (WMs) (2). However, access to machines requires both facilities and financial resources. Although several companies have developed innovative machines that are small, easy to transport, and less expensive, there are often no community programs that provide access to these machines. In addition, the average dropout rate in formal exercise programs is approximately 50% in the first

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year of participation (12). It is possible that acquiring WMs for home use may increase adherence. However, figures from the United States show that although spending on machines for home training tripled from 1986 to 1996 (from about $1.2 billion to about $3 billion), the machines were then used very little, stored, or sold (12). Therefore, it is necessary to assess whether WMs are really the best option for activity programs for diverse sectors of the population, for example, middle-aged women, or whether other devices that can be acquired by associations on limited budgets and by individuals for home use can be equally effective.

Elastic resistance devices such as elastic bands (EBs) are being increasingly used for muscular conditioning for different aims and population types, as they are more affordable and more accessible (i.e., can be performed anywhere) than WMs (19,39). These devices allow for a larger range of motion with both concentric and eccentric muscle contractions (29). EBs also allow one to exercise in a controlled, safe manner by changing grip width or rubber stiffness to achieve a greater or lesser intensity of effort (3,22). In addition and unlike free weights, the direction of the resistance does not depend on gravity since it is aligned with the orientation of the elastic device (17). The effects of EB training have almost always been compared in mixed programs using EBs together with WMs and/or other equipment (8,12,34), and with subjects using them in nonsupervised at-home programs (7,20,27). However, when examining the design and characteristics of these studies, doubts arise over the real effectiveness of both WMs and EBs when compared separately and in supervised programs. Another aspect that affects the widespread application of elastic resistance programs is the lack of objective criteria for the systematic monitoring of intensity and consequently the possibility of prescribing medium and long-term training programs (39).

The present study was therefore designed to implement a short-term supervised muscular endurance program to see whether there are differences in FFM and functional capacity adaptations when using 2 different devices such as WMs and EBs. We hypothesized that the effects of the program ought to be the same independently of the device used, as long as exercise intensity was equalized by jointly monitoring the targeted number of repetitions (TNRs) and the rate of perceived exertion in active muscles.

Methods

Experimental Approach to the Problem

A randomized group design was used to assess the effects of 2 types of resistance devices using the same resistance training program in the early phase of strength training for sedentary middle-aged women. In order to ensure that the programs used with both strength training devices (EBs and WMs) were similar, we chose exercises with comparable body stabilization characteristics that involved the major muscle groups in similar agonistic fashion. In addition, the movements were carried out slowly (2 seconds concentric, 4 seconds eccentric), as recommended for untrained individuals (2). In order to equalize the intensity of the exercise with both devices, the TNRs was maintained (6,22) while applying the RPE-AM by using the OMNI Resistance Exercise Scale for the active muscles (OMNI-RES AM) (16,24,33). The subjects thus varied the grip width of the EBs or the number of plates for the WMs to adjust the resistance of the different resistance devices to the TNRs and OMNI-RES AM value prescribed at each particular moment. The same recovery period times and interset characteristics were applied and the same procedure was applied to the other training parameters. As well as trained and qualified technical personnel who always led each training session, at least one trained monitor was always present to corroborate the correct application of the methodology. This means that this study was a highly supervised training study. Muscle function and body composition testing was performed before and after the resistance training program in order to determine the effects of said training program. All the women complied strictly with the program, with a minimum 95% attendance at training sessions. No women were injured during the training program.

Subjects

Seventy-two female volunteers were medically screened before participation to ensure that they were not taking medication or hormone therapy and that they were all functionally independent with no neurological, cardiovascular, metabolic, inflammatory, or musculoskeletal conditions that would preclude their participation and their ability to perform a low- to moderate-intensity physical exercise program. All the women were of similar socioeconomic status, were housewives, and performed similar activities in their daily lives. They were generally healthy, active, and living independently in the community. None had ever participated in resistance training exercises and had not been involved in aerobic-type exercise in the previous 4 years. None had a history of manual labor. All the women had a natural menopause, with amenorrhea at least 1 year before the start of the study (average time of amenorrhea, 4.37 ± 2.86 years). Twenty-seven women who did not comply with the criteria for inclusion in the study were excluded. Each participant was randomly assigned to one of 3 groups. Statistical analysis showed that the groups did not differ with regard to any of the variables applied and evaluated in this study. Finally, the EB group (EBG) consisted of 21 women aged 54.14 ± 2.87 years and weighing 69.23 ± 10.2 kg, the WMs group (WMG) consisted of 14 women aged 51.07 ± 6.81 years and weighing 62.38 ± 9.63 kg, and the control group (CG) was made up of 10 women aged 53.9 ± 1.85 years and weighing 65.91 ± 9.75 kg. All subjects were informed of the training and testing involved by means of a consent form. The women were all told not to modify their behavior or diet and were strictly forbidden to do any other type of physical exercise. The study was approved by a research commission from the Department of Health Sciences, Physical Activity and Sport at the Catholic University of Murcia (Spain).

Procedures

Despite the fact that for untrained middle-aged and older individuals it is recommended to carry out at least 8–9 evaluation sessions at every pre- and poststudy stage in order to ensure the validity of the different strength testing measurements (32), the broad sample used for the present study meant that only 2 evaluation sessions could be carried out for each stage (32), although we also used a CG to check for possible learning effects. Measurements were made in the same week, in a controlled environment at a room temperature of 22 ± 0.1°C. The body composition tests were always performed 24 hours before the muscle function tests, which were performed 72 hours after ceasing heavy exertion and the first functional tests of each pre- and post-period. For both the pre- and post-tests, the subjects attended a familiarization session to learn or review, as required, the techniques for performing the tests 48 hours before carrying out the first muscle function tests. Therefore, the evaluation week consisted of the following: a test familiarization or review session (Monday), the first body composition measurements (Tuesday), the first functional capacity measurements (Wednesday), rest day (Thursday), the second body composition measurements (Friday), the second functional capacity measurements (Saturday). All tests resulted in very high interclass correlation coefficients of $R \geq 0.90$ for test-retest reliability. All measurements for testing (pre- and post-training) were made using identical equipment, positioning, test technicians, and technique for each subject. The examiners were appropriately trained and qualified.

Functional Capacity. The knee push-up test is recommended by the American College of Sports Medicine (1) as a component of the minimum tests before implementation of a training program. The results determine the muscular endurance of the extensor muscles of the elbow and the horizontal adductor of the shoulder. Assessment of physical performance of the lower extremities is another dynamic measurement of muscle function and is normally used as a predictor of functional capacity and independence (14). The squat is a functional multiple-joint exercise that has been widely studied as a training and evaluation exercise (1). This exercise was therefore chosen for the current investigation and was performed for the greatest possible number of repetitions in 1 minute with a thigh position parallel to the floor at the bottom of the range of movement and without assistance movements using other body segments. The tests took place in the morning, 1.5 hours after the subjects had had their normal breakfast and as long as they had slept for at least 8 hours the night before. During the tests, the examiners encouraged the women to obtain the best scores they could, using the same advice for all the women and for the different tests. Each test was supervised by the same examiner, with 2 reference examiners who attended to monitor strict compliance with protocol. The subjects performed a specific warm-up protocol, with the knee push-up test always performed before the squat test and with a minimum recovery period of 10 minutes between the 2 tests. The subjects were tested at the same time for pre- and post-testing.

Body Composition. Bioelectrical impedance analysis (BIA) is commonly used for evaluating body composition, with the Tanita model being one of the most widely used bioelectrical impedance analyzers. However, it has been shown that these devices are not as accurate as other methods, such as hydrodensiometry, dual-energy x-ray absorptiometry (DXA) and air displacement plethysmography (15). However, the new 8-polar bioelectrical impedance analyzers are significantly more accurate than traditional bioelectrical impedance analyzers, showing a satisfactory correlation with DXA (25). Here we should underline the fact that the new Tanita model (BC-418 8-contact electrode BIA system) is more accurate than the older models of the same make (e.g., the foot-to-foot BC-305 and the BC-310) and provides high correlations with DXA in regional lean soft-tissue, whole-body skeletal muscle mass, and body fat percentages (31). However, more research is still needed to improve the accuracy of these new devices so that they provide population-specific equations (26) and offer enhanced precision and accuracy when assessing body composition (4). This means that the data gathered by using these devices should be treated with care and the values obtained should never be directly compared to those obtained using other bioelectrical impedance devices or other methods. For this study, a BC-418 8-contact electrode BIA system (Tanita Corp., Tokyo, Japan) was used to determine body composition. All subjects were assessed in compliance with the guidelines proposed by Dixon et al. (13) and the manufacturer, thus ensuring more accurate results. Indeed, even before the evaluation the gender of the subjects and their physical training status was entered into the BIA analyzer to favor more precise use of the predictive equations provided by the manufacturer. Values for whole-body FFM mass and whole-body fat mass were obtained by using this device.

Training Protocol

Women were instructed in the different exercise techniques during 2 sessions before beginning the training program, following the criteria of body position, ranges of motion, and respiration described by Colado (9) and Colado and Chulvi (10). In addition, in these 2 sessions, the women were familiarized with and trained in controlling exercise intensity through the combined use of TNRs and perception of effort through OMNI-RES AM (33), with the latter using the protocol recommended by Gearhart et al. (16). The women had to increase or decrease grip width to make adjusting the resistance easier. To this end, 20 symmetrical reference points 2.5 cm apart were marked from the central point of the rubber band. The central point was given a value of 20 and the neighboring points were given a value of 19, with the value of each successive point decreasing to the end of each side of the EB. This meant that the higher values were linked to shorter grip widths and thus to greater resistance to the movements carried out.

In each of these familiarization and training sessions, the women were instructed in 6 different exercises of the 12 used in the program (Figure 1). Each woman was trained in the techniques used for each exercise and then performed several sets at minimum resistance to ensure that they were performed correctly. They were then asked to choose a WM weight with the plates or a symmetrical EB grip width that allowed them to perform a total of 20 maximum repetitions (RM) with the correct technique, meaning that they could not perform more repetitions using the selected resistance with the correct technique without altering the resistance imposed by the strength training device. As well as having to complete 20 repetitions in each series of the training program, it was decided not to use the 1 repetition maximum (1RM) test, as it cannot be applied directly to standardize training load when using EBs as resistance devices. Previous studies have shown that training load can be reliably standardized using moderate resistance EBs with a goal-based multiple-RM test (28). As was to be expected, 3–8 attempts were needed to find the correct resistance (32), with a 2-minute recovery period between each failed attempt. Once they had identified the resistance that allowed them to perform a set of 20 repetitions with maximal volitional effort, they were allowed a similar rest period and asked to repeat exercise using the same effort. In both cases, they were asked to associate the effort for the muscle groups involved with quantitative value of 10 or a qualitative value of "extremely hard or heavy," recording the kilograms or the numerical value of the EB grip width separation as an objective reference value before starting the training program (28). They then performed the exercise again for the same number of repetitions with extremely light resistance and were asked to

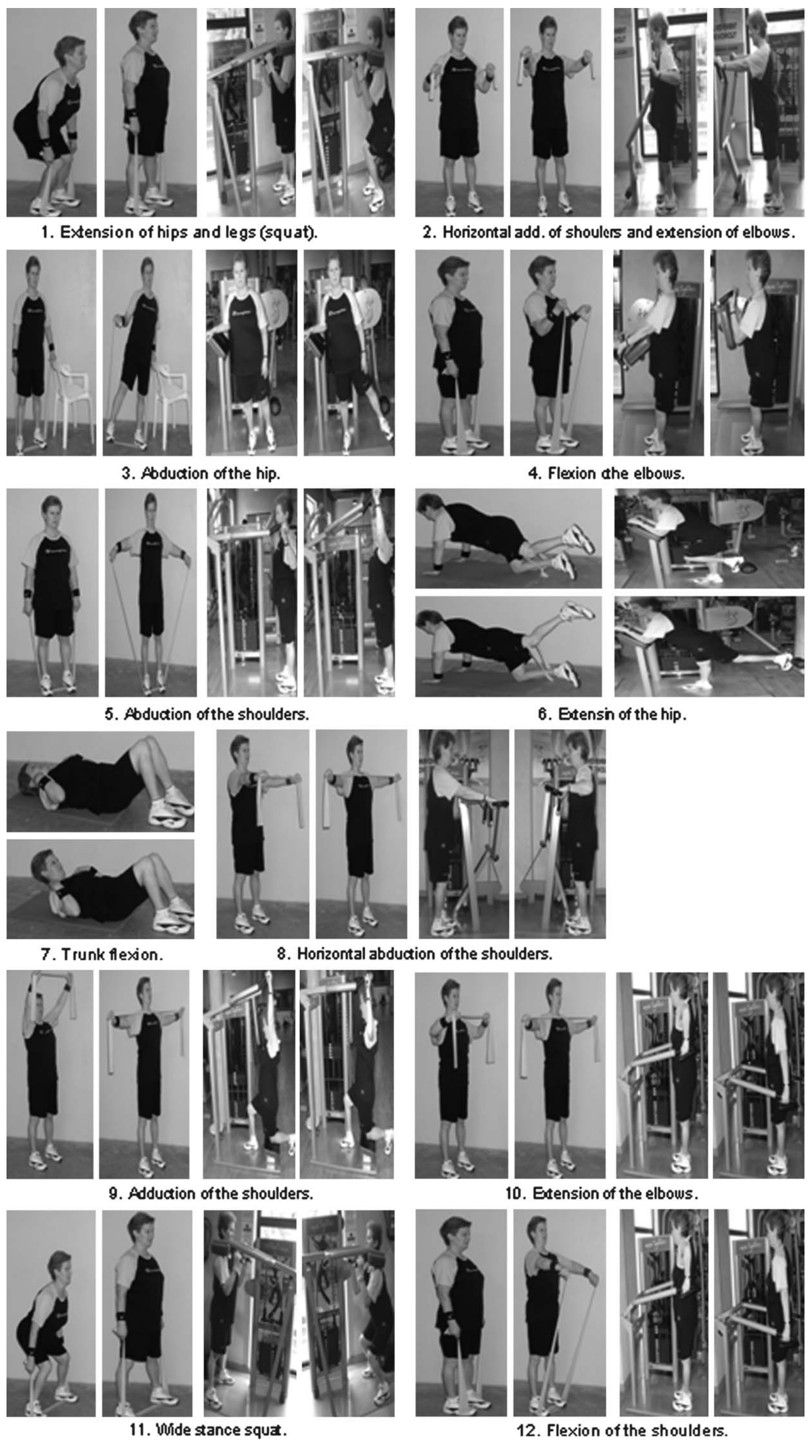

FIGURE 1. Exercises used in the different circuits performed (see Table 1; exercise numbers correspond to the exercise numbers in Table 1).

TABLE 1. Protocol and exercise list.

	Exercise no.
Week 1, 2, 7, and 10 circuits	1, 2, 3, 4, 5, 6, 7*
Week 3, 4, and 8 circuits	8, 6, 9, 1, 10, 11, 7*
Week 5, 6, and 9 circuits	5, 6, 11, 4, 12, 1, 7*

See Figure 1; exercise numbers correspond to the exercise numbers in Figure 1.
*This exercise is compensatory and was performed at the end of every circuit.

associate said effort with a qualitative perception of "extremely easy or light" and/or quantitatively with a value of 1. The speed of performance of the movements was at all times the same as that used during the whole training program (2 seconds concentric, 4 seconds eccentric). From these familiarization sessions onward, the OMNI-RES was always visible during each training session. The EBs used were light-intensity Thera-Bands (38) with a relaxed length of 1 m. Each woman always trained with the same EB. Using the correct grip width, the subjects had to perform the movement without the band fully losing tension in the eccentric phase and complete the concentric phase until the maximum amplitude defined was reached. Switching machines (TECA S.r.l., Ortona, Italy) were used for the machine exercises.

The periodized training program lasted for 10 weeks, with 2 sessions per week. Six exercises that involved the major muscle groups of the whole body in an agonistic manner were always used (Figure 1), with a total of 20 repetitions performed at an intensity of 5 or "somewhat hard" OMNI-RES AM for the first 4 weeks of adaptation, and the next 6 weeks at 7 or "hard" OMNI-RES AM. In the first 4 weeks, 2 sets were performed for the lower and 1 set for the upper extremities; from weeks 5 to 8, the number of sets was equalized for the upper and lower body, and for weeks 9 and 10, the number of sets was increased to 3. Between exercises, there was an active recovery period of 30 seconds consisting of gentle jogging. Since this study was not intended to improve cardiovascular endurance, this was not addressed in the training program. In order to increase motivation, the order of the exercises and the way in which they were performed was changed every week in the same way for both groups (Table 1). The sessions were always monitored by the same qualified technicians and were also supervised by trained monitors in order to corroborate the methodology, performance, materials, room conditions, and program adherence. Warm-up and cool-down protocols were designed and followed by both groups.

Statistical Analyses

The homogeneity of the dependent variables was checked using Levene's test, and their normality was also evaluated using Kolgomorov-Smirnov statistics. Descriptive statistics were then calculated. *T* tests were used for within-group differences and the analysis of independent (between-group) samples was carried out using analysis of variance with post hoc multiple comparisons using the Tukey test. All differences with $p \leq 0.05$ were accepted as statistically significant and those with $p \leq 0.01$ as very significant.

TABLE 2. Changes in functional capacity and body composition.

	Elastic band group		Weight machine group		Control group	
	Mean ± *SD*	Change	Mean ± *SD*	Change	Mean ± *SD*	Change
Fat-free mass, kg						
Pre	40.8 ± 3.2	+0.5*	40.1 ± 4.0	+1.0†	39.9 ± 2.8	+0.2
Post	41.3 ± 3.2		41.1 ± 3.8		40.1 ± 3.0	
Fat mass, kg						
Pre	28.4 ± 7.4	−0.5*	22.3 ± 6.1	−1.1†	26.03 ± 7.7	−0.3
Post	27.8 ± 7.1		21.2 ± 5.7		25.72 ± 7.9	
Knee push-up test, no. of reps						
Pre	15.7 ± 9.2	+4.8†	14.1 ± 3.8	+8.8†‡	14.3 ± 6.5	−0.9
Post	20.5 ± 9.2		22.9 ± 9.3		13.4 ± 6.4	
Squat test, no. of reps						
Pre	27.8 ± 3.8	+7.6†‡	31.3 ± 2.5	+6.6†‡	27.5 ± 3.2	+0.5
Post	35.4 ± 6.9		37.9 ± 4.0		28.0 ± 6.1	

No statistically significant differences were found between the three groups for any of the assessments carried out in the pre-test.
*Significant intragroup difference between pre- and post-test ($p \leq 0.05$).
†Very significant intragroup difference between pre- and post-test ($p \leq 0.01$).
‡Significant difference from the control group ($p \leq 0.05$).

Results

As shown in Table 2, both exercise groups significantly increased their FFM and significantly decreased their fat mass in a very discrete and similar fashion, with none of the differences that could be expected in evolution of the CG. In addition, regarding muscle endurance of the upper extremities and the muscle power of the lower extremities, during the training period, both exercise groups improved their scores for both tests in a similar manner, there being no differences in the evolution of the CG, although certain significant differences did appear in the final values obtained by both physical exercise groups regarding the values of this group (Table 2). Finally, we should point out that although the variations in body composition and muscular endurance of the upper extremities appear to be greater with WM training than with EB training, there are no statistically significant differences to confirm this.

Discussion

Although we can still assume that the stimulation provided by elastic resistance devices for strength training is less effective than that provided by free weights or WMs (19), studies such as that of Kraemer et al. (22) already highlight the fact that, using the correct methodology, we can generate a quality of resistance that can closely mimic that obtained with traditional weight devices and, therefore, obtaining the high levels of neuromuscular adaptation as with traditional devices. However, different studies have traditionally emphasized the difficulty of controlling the intensity of strength training using EBs. This is due to the different elongation coefficients of the bands and their modification during use, suggesting an urgent need to find specific equations for each type of elastic band (39), as well as evaluating them when it comes to comparing their applications (29). However, this approach is not really applicable to the daily reality of technicians and nonsupervised users, therefore highlighting the fact that this proposal is out of step with the real needs of populations not involved in rehabilitation programs using EBs.

In order to carry out a direct comparison of weight resistance and elastic resistance devices for strength training used in the same training program, this study proposes the combined use of OMNI-RES AM (24,33) and TNRs (6,22) to generate in a controlled way the correct stimuli for neuromuscular conditioning. Although recent years have seen validation of the use of the perception of effort for monitoring intensity during resistance exercises (16,33), there are relatively few research studies that have tried to apply this resource in sedentary middle-aged populations in field situations and then to evaluate their presumed effectiveness. In addition, it is even more necessary to apply this tool during the use of strength training programs where the exact value of the resistance is difficult to quantify, as is the case with EBs and even aquatic resistance exercises (11). It is also generally known that the OMNI-RES was designed to be applied to strength training with weight devices (33) and has not yet been validated for use with EBs. However, from the very beginning, we believed that it could also be useful for monitoring the muscular effort caused by any device that increases the resistance to a given movement. In addition to the OMNI-RES AM, and taking as our point of reference the interesting study carried out by Kraemer et al. (22), the subjects of our research study were also required to monitor the TNRs. In this case, however, instead of performing the exercises for a certain range of repetitions with a maximum character of effort, the OMNI-RES AM was used to achieve submaximum intensity thresholds, as was the case initially with "somewhat hard" and later with "hard." Submaximum efforts have also been confirmed to be very effective and physiologically less stressful for subjects such as those in this study (40). Therefore, the evidence obtained could suggest the method used here could facilitate the prescription of resistance programs using EBs as resistance devices. However, the basic physical fitness of the subject should be taken into consideration when recommending a particular type of EB according to the stiffness it offers to the elongation movement created, thus guaranteeing that the subject receives adequate resistance from the start of the movement (22,38).

Although a 10-week program with 2 sessions per week is a very short period and a minimal stimulus to invoke significant structural adaptations, the methodology used here with EBs generated a modest increase in the FFM. Despite the fact that in the early phases of training, strength is produced mainly by neural adaptations (18) and that it was traditionally accepted that low-intensity resistance programs were not very effective in increasing FFM and strength (37). Studies using young subjects, such as that of Tanimoto and Ishii (37), and middle-aged women, such as that of Takarada and Ishii (35), have shown that short-term programs using low-intensity resistance exercises with short interset rest periods are effective for increasing FFM and strength, as was the case in our study. This therefore highlights the fact that both physical performance and the associated physiological adaptations may be linked to the intensity and number of repetitions performed and that both training criteria can be monitored by using TNRs and OMNI-RES AM in combination, as was done in the current study. This procedure has thus managed to systematically generate minimum resistances that, together with the short recovery times, were able to produce positive neuromuscular adaptations. However, the data gathered show that the final number of knee push-ups performed by the WMG was much greater than that of the CG, although this was not true for the EBG. We believe that this difference may be due to the fact that, of the 7 exercises progressively used for the muscles of the upper extremities, 6 of the exercises performed with the WMs were multijoint, while this was the case with only one of those performed with the EBs. This factor may have led to more pronounced neuromuscular improvement in the WMG, as their set volume was greater than that of the EBG due to combined muscle involvement with both agonistic and synergistic characteristics (30). In the same way, and even though not reflecting a statistically significant intergroup difference in the final values, if we consider that the evolution of FFM in the WMG was more pronounced than in the EBG, this could be attributed to the greater training volume factor mentioned above, as the WMG used a total of 9 multiple-joint exercises, while the EBG only used 3. However, the fact that there were no statistical differences in muscle development may confirm that modest protocols as regards to the final number of sets performed by muscle groups may be effective in the early phase of adaptation to strength training of untrained individuals (30) and that in the early stages, these protocols provide a good stimulus for significantly increasing functional capacity and lean mass discretely. Perhaps a much more precise selection should be made when equalizing the exercises selected for longer training programs, paying attention not only to the involvement of the agonist muscle groups but also to that of the muscle groups acting synergistically, so as to be able to equalize total training volume by comparing different resistance devices in order to generate more concrete evidence.

Therefore, given the difficulty that exists in systematically graduating intensity in strength training programs using EBs, and that this could be reason why supervised EBs resistance programs are usually more effective than those performed at home without supervision by trained personnel (36), there is an evident need to identify simple and useful criteria such as those used here, which are easy to understand and apply by subjects not used to physical exercise. In this way, said subjects can use these criteria to control the intensity of their EB resistance exercises when performing them without supervision. This methodological approach was completely successful in controlling intensity, as both the muscle endurance of the upper extremities and the muscle power of the lower extremities improved very significantly, as well as there being no statistical differences between the groups. The percentage of improvement achieved with EBs in our study is somewhat higher than that obtained in previous studies (20,27), showing that the right methodological approach makes training with EBs just as effective as that carried out with WMs. As a result, the findings of this study have allowed us to identify 2 factors that can be crucial for the implementation of resistance training programs by a wide spectrum of the general public in community environments. The first of these factors is the confirmation of the effectiveness of EB resistance devices that are financially accessible and widely applicable when compared to WMs. The second is the confirmation that the combined use of OMNI-RES AM and TNRs is a valid and comprehensive tool for controlling intensity in programs such as that followed here. We are aware of the possible limitations of the evaluation instruments that we used to demonstrate our hypothesis, but understand that the rigorous way in which they were used guarantees the accuracy of the data obtained. We believe that these findings can be used as the basis for other studies using more expensive and sophisticated evaluation instruments. We should also emphasize the fact that the results of this study are limited to the early phases of strength training of middle-aged untrained women using low-intensity resistance programs, and it is necessary to carry out longer term studies with other subjects and intensities in order to obtain an overall comparison of the effects that can be generated by EB resistance devices as opposed to those generated by WM resistance devices. Indeed, the use of high resistance has been shown to be totally effective and necessary to improve both the muscle power and bone development of older and middle-aged individuals, meaning that it is very important to make the same comparison as has been done here, but with a lower TNRs (e.g., 9–11 repetitions) and an OMNI-RES AM perception close to the "very hard" or quantitatively to 8–9. In case these studies were realized and positive results were obtained, the program followed here could be the first step toward programs of greater intensity, thus complying with the progression criteria suggested by the ACSM (2), especially for novice lifters.

Practical Applications

Although improvements in the amount of FFM and gains in functional capacity appear to be greater with WMs resistance training, there are no statistically significant differences to confirm this. Therefore, on the basis of the results obtained, it can be stated that EB resistance training produces adaptations similar to those with WMs resistance training in the early phases of strength training as long as perceived exertion through OMNI-RES AM and TNRs are taken into account. This fact should be emphasized to both the technical personnel teaching classes with resistance devices and to all those who decide to follow a nonsupervised program, something that leads us to believe that these suggestions should be included in the manuals and videos available on the subject.

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