



While some people will have a bias toward free weights or machines, the judicious use of both will probably maximize exercise benefits.

By Matt Brzycki

THE TWO MOST popular types of equipment for weight training are free weights (barbells and dumbbells) and machines (either selectorized or plate-loaded). Yet while today's equipment has come a long way from the Indian clubs and kettlebells that were in vogue until the turn of the century, there is still debate about what type of strength equipment is the best to use.

Weight history 101

In 1902, the Milo Barbell Company manufactured the first adjustable, plate-loaded barbell in the United States. The plate-loaded barbell — patterned after the Berg-Hantel barbell from Germany — was a tremendous breakthrough in weight training. For the first time, a barbell could be loaded in a relatively short time with the desired amount of weight. Previously, a different barbell was needed for each different weight.

For the next half century, the barbell was arguably the single most popular and productive tool for weight training. In the '40s and '50s, a number of body builders made plate-loaded machines of bars, pipes, pulleys and cables to do away with the most awkward free-weight positions, and some of them marketed the devices to the public. Looking to "build a better barbell," Arthur Jones designed and built the first Nautilus machine in 1948 — a prototype pullover model — in Tulsa, Okla. (although he did not begin selling and delivering his machines until late 1970). In 1957, the original Universal Gym Company developed the first multi-station selectorized weight-training machine. Invented by Harold Zinkin, this revolutionary machine featured several exercise stations

with separate "stacks" of flat weight plates that traveled up and down solid steel guide-rods. Adjustments in weight could be made quickly and easily through the use of a selector pin.

The so-called "fitness boom" of the 1970s served as a springboard for the emergence of exercise machinery and its subsequent popularity as a training modality. Arriving almost simultaneously with the acceptance of machines was a fiery and emotional debate over which of the two modalities (free weights or machines) was better for weight training.

Issues and answers

Why the squabble? Much of the debate centers on muscular response and athletic specificity.

Muscular response. It is said that free weights are more advantageous for building muscular size and strength, while machines are merely for toning and shaping muscles. But is this a reasonable assertion?

To examine this matter, it's first necessary to understand the requirements for increasing the size and strength of

Muscles cannot "know" whether the source of the resistance is a barbell, a dumbbell, a selectorized machine, a plate-loaded machine or a cinder block.

muscles. First, a resistance (or "load") must be applied to a muscle. Second, the resistance must be made progressively more challenging from one workout to the next. It's that simple. Certainly, other ingredients are also important in weight training, but to improve muscular size and strength, these are the two basic requirements.

What about the nature of the resistance? A number of studies show that muscle development occurs the same way, whether using free weights or machines. A 10-week study compared groups training three times per week with either free weights or machines.⁵ Both groups significantly increased strength and lean body mass and decreased body fat.

Matt Brzycki is the coordinator of health, fitness, strength and conditioning at Princeton University. He has authored three books, co-authored another and written more than 150 articles on strength and fitness for 30 different publications.

There were no significant differences between the groups. Similar results were found in another 10-week study examining a group using machines and a group using free weights.⁴

The bottom line is that muscles cannot possibly "know" whether the source of the resistance is a barbell, a dumbbell, a selectorized machine, a plate-loaded machine or a cinder block. The sole factors in determining muscular response from weight training are genetic makeup and level of intensity — not the equipment used.

Athletic specificity. The second area of controversy generally pertains to specificity. Some individuals feel that specific sports skills can be improved by simulating them with added resistance. Unfortunately, the motor-learning literature does not seem to support this assertion. In one study, competitive swimmers were filmed while sprinting the butterfly.³ The films were digitized and analyzed by computer. Among other things, it was found that swimming using resistance was done with noticeably different — and less effective — stroke mechanics compared to swimming without added resistance. In effect, the swimmers were performing different strokes.

The same result occurs when attempting to mimic the movement pattern of a particular sports skill in the weight room with a barbell or dumbbell. No exercise done in the weight room — with a barbell, dumbbell or machine — will help improve specific sports skills. At best, this is a waste of time and energy.

Another related argument is that balancing a barbell or a dumbbell is advantageous because this balance will carry over to sports skills. Once again, the relevant research does not appear to confirm this claim. In one study, six tests of dynamic and static balance were examined, and it was found that the abilities supporting one test of balance were separate from those supporting another.¹ In other words, the ability to balance a barbell is quite different from the ability to balance the body during a handstand or any other skill requiring balance. Adds John Thomas, the strength and conditioning coach at Penn State, "[Using] free weights may develop general balance, but not specific sport skills."

While watching a basketball game, volleyball match or any other athletic event, try to figure out which teams use free weights, which use machines, which use a combination and which use nothing at all. Obviously, it would be impossible to tell since the source of resistance matters very little, if any, in a person's response to weight training.

Pros and cons

There are a number of pros and cons to both free weights and machines that may have an impact on your choice of equipment.

Advantages of free weights. Free weights have the following advantages over machines:

1. With a limited or tight budget, the most important consideration in the choice of equipment may be cost, since machines are generally much more expensive than free weights. A complete line of state-of-the-art selectorized equipment (10 to 12 machines) could easily cost more than \$40,000. That same number of plate-loaded machines would be much less expensive, but remember a possible "hidden" cost: A few thousand pounds of plates may need to be purchased.

2. Most machines designed for commercial use perform only one or two functions. A bicep-curl machine, for example, can only be used to exercise the biceps. In comparison, a bar and a few hundred pounds of plates can be used for just about every muscle in the body. So, free weights give more variety per dollar.

3. It's safe to say that when it comes to free weights, "one size fits all." Indeed, free weights can accommodate just about everyone, regardless of their size. On the other hand, those who are at an extreme in terms of height and/or limb length may not be able to fit properly on some machines. For this reason, machines present a major drawback for many adolescents who wish to strength train.

4. Balancing free weights requires a greater involvement of synergistic muscles. However, Ken Mannie, the strength and conditioning coach at Michigan State, points out that, "the rate and level at which [the synergistic muscles] act merit additional study."

Advantages of machines. Machines have the following advantages over free weights:

1. Some exercises can be performed efficiently only with machines, including hip abduction, adduction and flexion, leg curls, leg extensions, lat pulldowns and neck exercises.

2. Most machines can provide variable resistance. As an exercise is performed, the biomechanical leverage of the skeletal system changes, making the movement feel easier in

With most machines, the weight is balanced so that a person will be able to concentrate on the proper performance of the exercise.

some positions and harder in others. A properly designed machine automatically varies the resistance to match the changes in biomechanical leverage. In positions of inferior leverage (and inferior strength), the machine creates a mechanical advantage and a lower level of resistance; as the skeletal system moves into a position of superior leverage (and superior strength), the machine creates a mechanical disadvantage and a higher level of resistance. The end result is greater muscular effort throughout the range of motion (ROM). During a typical free-weight exercise, there is adequate resistance for muscles in their weakest positions, but not enough in their strongest positions. Because of this, the amount of resistance that can be used is limited to that which can be handled in the position of least leverage. There are, however, a few free weight exercises that provide somewhat adequate resistance throughout most of the movement, including wrist flexion/extensions, shoulder shrugs and calf raises.

3. People are required to balance the resistance when using free weights. Having to do this can be viewed as a drawback. Some people — particularly beginners — might worry more about balancing the weight than about performing the movement properly. Furthermore, people are likely to spend excessive energy in balancing the weight. With most machines, the weight is already balanced so that a person will be able to concentrate on the proper performance of the exercise. By not involving synergistic muscles to balance the weight, machines can also work the target muscles to a greater degree.

Continued on page 40

For fitness, the interference of one exercise type with the other is negligible.

sired goals, then resistance training should precede endurance conditioning.

Types of gains

Clients may wonder if the gains from one type of training will interfere with the gains from the other. For the average person, this should not be a concern. Whereas single-mode training, such as resistance or endurance training, has been shown to increase muscular strength and aerobic capacity, respectively, concurrent training has been shown to increase both of these traits together, although to a lesser magnitude. In other words, combining both modes of exercise will enable exercisers to maximize benefits and enhance their well-being and health, while minimizing time in the club.

Conclusion

Concurrent resistance and endurance training can be beneficial for clients. With the proper exercise prescription, order and dedication, improvements can be made in fitness level and capacity, and overall health. **FM**

Free Weights/Machines

Barbell exercises over the head should only be performed with a spotter.

Continued from page 37

4. Most people don't have an abundance of free time to spend in the weight room. Workouts are generally more time-efficient when machines are used. The resistance on machines can be set by simply moving a selector pin rather than by fiddling around changing plates.

5. In general, machines provide direct resistance over a greater range of motion (ROM) compared to a similar free-weight exercise. A machine pullover, for example, can provide direct resistance over as much as 270 degrees ROM around the shoulder joint. By comparison, a barbell or dumbbell pullover provides only about 100 degrees of direct resistance for the same musculature (the latissimus dorsi). Therefore, a pullover done on a machine is much more efficient than a pullover done with free weights since the targeted muscles are exercised over a greater ROM. This holds true for just about all machine exercises compared to their free-weight counterparts.

6. Many free-weight exercises do not provide the targeted muscles with an adequate stretch. For instance, a barbell bench-press restricts the stretching of the chest muscles — a person could stretch them further but is unable to do so because the bar must stop at the chest. Almost all machine-type bench presses have movement arms with an opening for the chest. This enables a greater stretch so that flexibility isn't compromised. It should be noted that performing free-weight exercises with dumbbells can allow a better stretch than with a barbell.

7. Machines are more practical than free weights during rehabilitation. With a left-knee injury, many free-weight exercises would be quite difficult or uncomfortable (if not impossible) to perform. However, the entire upper torso, right leg and possibly even both hips could still be trained using machines. A person could even continue to exercise on most machines with an arm or leg in a cast. For instance, if the wrist were in a cast and a person could not grasp a barbell or dumbbell, many upper-body exercises on machines, including the "pec dec," pullover and lateral raise, could still be performed.

REFERENCES

1. ACSM position stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine and Science in Sports and Exercise* 30(6): 975-991, 1999.
2. Baechle, T.R. *Essentials of Strength Training and Conditioning*. Human Kinetics: Champaign, Ill., 1994.
3. Dolezal, B.A., and J.A. Potteiger. Concurrent resistance and endurance training influence basal metabolic rate in nondieting individuals. *Journal of Applied Physiology* 85(2): 695-700, 1998.
4. Foss, M.L., and S.J. Keteyian. *Fox's Physiological Basis for Exercise and Sport*. WCB McGraw-Hill: Boston, Mass., 1998.
5. Sale, D.G., J.D. MacDougall, I. Jacobs and S. Garner. Interaction between concurrent strength and endurance training. *Journal of Applied Physiology* 68(1): 260-270, 1990.
6. Sforzo, G.A., F.G. Micale, N.A. Bonnani, M. Muir and J. Wigglesworth. A new training technique: Cardioresistance training. *ACSM's Health and Fitness Journal* 2(6): 11-17, 1999.
7. U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion: Atlanta, Ga., 1996.

8. Any barbell exercise that involves lifting a weight over the head — such as a bench press or a seated press — should only be performed with a spotter. With machines, a spotter is rarely needed, since it's virtually impossible to get pinned underneath a bar or stuck with a weight in a compromising position.

So, what's best?

There are advantages to both free weights and machines. No doubt, some people will always prefer one over the other, and that's all right as long as the favoritism is not born out of misconceptions or commercial bias. Remember, the bottom line is that muscles do not respond one way with free weights and another way with machines. To quote Dan Riley, the long-time strength and conditioning coach of the Washington Redskins, "The equipment used is not the key to maximum gains. It's how you use the equipment."

So, keep an open mind when it comes to selecting equipment for weight training. If you don't have a preference, then vary workouts with free weights *and* machines. **FM**

REFERENCES

1. Drowatzky, J.N., and F.C. Zuccato. Interrelationships between selected measures of static and dynamic balance. *Research Quarterly* 38: 509-510, 1967.
2. Maglischo, E.W., C.W. Maglischo, D. Zier and T.R. Santos. The effect of sprint-assisted and sprint-resisted swimming on stroke mechanics. *Journal of Swimming Research* 1(2): 27-33, 1985.
3. Mannie, K. Barbells vs. machines: Balancing a weighty issue. *Coach and Athletic Director* 67(7): 6-7, 1998.
4. Messier, S.P., and M. Dill. Alterations in strength and maximal oxygen uptake consequent to Nautilus circuit weight training. *Research Quarterly for Exercise and Sport* 56: 345-351, 1985.
5. Pipes, T.V. Variable resistance versus constant resistance strength training in adult males. *European Journal of Applied Physiology* 39: 27-35, 1978.
6. Riley, D. Redskin conditioning. Washington Redskins: Ashburn, Va., 1996.
7. Thomas, J. Penn State football strength training. Penn State University: University Park, Pa., 1998.