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Strong Bones

by Thomas Kurz

The position stand of the American College of Sports Medicine on physical activity and bone health makes two main points:

1. Bone mass is accumulated mainly in childhood and adolescence, possibly into the 30s. Later on, the bone mass may be preserved or lost depending on physical activity, nutrition, and hormonal status.

2. The most effective exercises for increasing or preserving bone mass are those that generate high forces through the bones, such as impact activities (jumping, plyometrics) and high-intensity resistance training.

It seems that healthy children instinctively seek impact activities. As I remember myself, around the age of 10, together with other boys I was jumping off walls and small buildings (over 2 m high) and also over deep ditches. Later on, between 14 and 16, the jumping was less frequent but more challenging—can you jump down a flight of stairs or out of a moving streetcar?

In girls, plyometrics and other high-impact activities cause significant gains of bone mass in early puberty (Tanner stages II and III; ages 10.8–12.6). At an earlier stage (Tanner I, age 9.4) the plyometrics did not cause significant gains of bone mass in girls. In girls, exercise seems to most effectively build bone mass during Tanner stages II through IV (ages 10.8–13.5).

Keep in mind that there is more to bone strength than bone mass alone—namely, the bone's internal architecture, which also responds to high-impact activities and resistance training. High-intensity loading may still strengthen bones even at ages when bone mass does not increase significantly.

After the age of 40, bone mass decreases by about 0.5% or more per year, regardless of sex, but the rate of bone loss varies in different parts of the skeleton and is likely influenced by nutrition, hormonal status, and habitual physical activity.

In women, hormonal changes during the menopause result in rapid bone loss in addition to the age-related bone loss, which is not prevented by even very vigorous physical activity. Nevertheless, hip fracture risk, as an indicator of bone strength or functionality, can be reduced by vigorous physical activity. Actually, postmenopausal women in the highest quintile of physical activity and not on hormone therapy had the same reduction of hip fracture risk (over 60% as compared with sedentary women) as women on hormone therapy. The advantage of exercise is that these highly physically active women did not have to put up with side effects of hormone therapy—although there is evidence that hormone therapy makes exercises that generate high-intensity loading forces on the bones more effective at preserving bone mass.

Fat-free mass (mostly muscles) is "a stronger determinant of bone mass with aging than either total body mass or fat mass" (Kohrt et al. 2004). Activities that preserve muscle mass may also preserve bone mass (Kohrt et al. 2004). So, walking is not good enough, jogging and stair climbing are better, but moderate-to-high-intensity resistance training is really good.

Low-intensity resistance training (three sets of 20 repetition maximum or approximately 50% of 1RM) does not cause as much increase in bone mass density as moderate-intensity training (three sets of 8 repetition maximum or more than 75% of 1RM) in estrogen-deficient women.

A little jumping (50 vertical jumps on 6 days per week of mean height 8.5 cm [3.3"], which produced mean ground reactions of 3.0 times body weight in the young women and 4.0 times in the older women) was not effective in increasing bone mass density in postmenopausal women not on hormone therapy, even though the same exercise was effective in premenopausal women—resulting in a significant increase of 2.8% in femoral bone mass density after 5 months (Bassey et al. 1998).

For preserving bone mass in middle-aged and older men, the same types of exercises were effective as those that preserved bone mass in postmenopausal women. Older men who did moderate-to-high-intensity resistance training (75–90% maximum strength, four sets of 5–10 repetitions per set) increased their bone mass density (Yarasheski,

Highlights

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Campbell, and Kohrt 1997), while those who participated in only low-to-moderate-intensity training (intensities ranging from 50–80% of the 1RM) did not (McCartney et al. 1995). Men who jogged nine or more times per month had higher bone mass density than those who jogged less often. To preserve gains in bone mass density, one has to continue the exercise.

Living bone is continuously remodeling itself—resorbing old bone tissue and depositing new bone tissue depending on nutrition, hormonal balance, and mechanical stress acting on the bone. This process lasts one's lifetime. A study of gymnasts showed that bone mass increased 2–4% during the competitive season and decreased 1% during the off-season. Of course, too much mechanical stress, from exercising often to excessive fatigue or without sufficient rest, may weaken the bones and lead to stress fractures.

The deformation that occurs in bone under mechanical stress may cause an increase of formation and a decrease of resorption within the normal remodeling cycle, or it may directly stimulate bone-forming cells to increase their activity (McArdle, Katch, and Katch 1996). Various mechanisms have been proposed for the transformation of mechanical stress into stimuli to enhance bone formation. These include piezoelectric potentials, release of prostaglandins, increased blood flow in bone, microdamage, and hormonal response. These mechanisms may act independently or in concert, depending on the loading and the characteristics of the bone (Chilibeck, Sale, and Webber 1995).

The bottom line: Increased mechanical stress is accompanied by a decrease of bone resorption coupled with a smaller increase of bone formation where bone tissue is compressed. The bone tissue's capacity for remodeling in response to mechanical stress is retained into old age.

In the 19th century, surgeon Julius Wolff stated that every change in the function of a bone is followed by certain definite changes in its internal architecture and its external shape (Wolff's law).

To put it briefly, heavy usage leads to heavy bone, and disuse results in decrease of bone mass—light and weak bones.

Exercises That Strengthen Bones

The best means to increase bone density are weight-bearing exercises that involve many muscle groups and direct the force vectors through the spine, hips, and shoulder girdle, such as squats, deadlifts, cleans, shoulder presses, and bench presses (Conroy and Earle 1994). Body-weight exercises can be as effective as weightlifting exercises if they direct the forces in a similar way and are intense enough (e.g., jumps and depth jumps, handstands, and pushups in handstands). Deadlifts are harder to substitute for with body-weight exercises because trunk extensions or leg raises in prone position do not allow for directing as much force through the spine as lifting a heavy bar.

Lifting weights in isolated movements is not a good means of increasing bone density or bone strength. Research by Chilibeck et al. (1996) shows that women who did 20 weeks of resistance training on a Universal-type machine increased their muscular strength in trained movements but not their bone mineral content or density.

Women who did 27 weeks of gymnastics training increased their lean tissue mass more than the women in the previously quoted study (6.7% versus 3.7%) and significantly increased their bone mineral mass (Nichols et al. 1994). Similar results were achieved with 6 months of high-impact exercises (Bassey and Ramsdale 1994). The natural whole-body loading in the gymnastics and high-impact exercises improved lean tissue and bone density more than the Universal-type machine.

In the case of exercise that puts mechanical stress on the bones mainly through muscle contraction rather than through impact with the ground or other objects, "it seems likely that increases of bone mass will occur only if the exercise is of sufficient intensity to cause an increase in muscle mass" (Kohrt et al. 2004). But keep in mind that Olympic weightlifters, who have very dense bones, have much less muscle mass than bodybuilders. This is because exercises of Olympic weightlifters generate far greater muscle tensions and so are done in much shorter sets than those of bodybuilders. Short sets have less effect on the muscles' metabolism and so cause less hypertrophy.

Animal studies show that multiple short exercise sessions are better than one long session. This has not been studied in humans.

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Lean Body Mass, Exercise, and Protein Supplements

by Thomas Kurz

The amount of protein you eat decides how well your muscles and bones recover and grow after your workouts—how much lean body mass you gain. (Of course, your total caloric intake has to cover your daily energy needs.)

A recent article in *Strength and Conditioning Journal* quotes several studies showing that increasing protein intake helps to increase lean body mass, as well as peak power and work capacity (Antonio 2005).

In one of these studies, experienced weightlifters who supplemented their daily diet with 30 grams of either soy protein or whey protein gained lean body mass while they did a bodybuilding-type strength training program. The control group, who trained the same but did not take the extra protein, did not make significant gains in lean body mass.

Another study has shown that adding 20 grams of whey protein to healthy young adults' daily diet increased their peak power and 30-second work capacity and augmented their antioxidant defenses.

A study investigating the effect of protein supplementation with meat in older people showed no adverse effects on bones. Actually, the increased protein intake was associated with higher levels of a bone growth factor and lowered levels of markers of bone resorption. The daily protein intake was increased from 0.78 gram to 1.55 grams per kilogram of body mass while reducing carbohydrate intake (substituting protein calories for carbohydrate calories).

For those who believe that increased protein intake may harm healthy people, the article quotes a study showing that protein intake under 2.8 grams per kilogram of body mass does not impair kidney function in well-trained athletes.

Several studies of protein supplementation have shown that for gaining lean body mass, it does not matter whether the protein comes from whole foods (meat, fish) or from protein supplements containing mainly soy or whey.

I prefer to get my protein from whole foods because these studies of soy or whey supplements lasted only a few weeks, so the long-term effects of taking these supplements are not known. After all, what we eat affects our overall health, not just our muscle mass. You can read about soy at www.westonaprice.org/soy/index.html. To find information about whey protein and its most and least beneficial forms, use the search feature at the same Website (www.westonaprice.org).

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What's New at Stadion Publishing Company

A few months ago, we decided to start two new businesses: Real Self-Defense LLC and Never-Thought-of-It Enterprises, and I head both of them.

We spun off Real Self-Defense LLC (www.real-self-defense.com and www.self-defense.info) from Stadion Publishing, Inc. because

a) Stadion is best known for the quality of its books and videos on sports training, but only a minority of our customers are seriously interested in self-defense;

b) our future self-defense products will be for people who take self-defense seriously and will have very little in common with sports. These products will be more in line with the video *Self-Defense: Tools of Attack* (www.self-defense.info/sdgs.html); and

c) I am the president of Real Self-Defense LLC, so only I will decide what products to make and how, without any considerations for political correctness.

The reason for starting Never-Thought-of-It Enterprises is this: I came up with some product ideas that were not suitable for a publishing company because these are not books or videos. Some have to do with sports training and some with self-defense—because of my interest in martial arts. For example, I was looking at advertisements for self-defense weapons—walking sticks, canes, sword canes, umbrellas with hidden blades—some of them illegal to carry in many places and others, while legal, attracting attention. I mean, how many able-bodied persons look natural with a walking stick or a cane?

So I produced something better: a weapon that is legal to own and carry everywhere (even on an airplane) and that anyone can carry without arousing suspicion or looking unnatural. It has no illegal parts and no blades.

It is the Unbreakable Umbrella. It is made of space-age materials. It weighs about 1.5 lb. (710 g), yet when supported at both ends it can withstand a 250 lb. person standing on it, and afterward it operates as if nothing happened. (Yes, after supporting all that weight, it opens and protects from the rain like the best umbrella. In fact, it is the best umbrella.) It strikes as hard as a hardwood staff or a steel pipe.

I invite you to see the Unbreakable Umbrella in action. You can watch short videos showing its capabilities at www.real-self-defense.com/umbrella.html. The first video shows both the bending test and the striking test, and other videos show defenses, disarms, and immobilizations done with this umbrella. Some applications are pure self-defense, some are arresting techniques—useful for bodyguards and plainclothesmen.

The Unbreakable Umbrella can support me, or even a much heavier person, without breaking or bending permanently. Visit www.real-self-defense.com to see what else it can do.

Q and A on STRETCHING and TRAINING

■ ***What are your thoughts about protein supplements such as whey protein? Do protein supplements make a big difference for someone who does strength training? I am considering buying whey protein, but I would like to know your opinion on it.***

Yes, protein supplements do make a big difference because an increased protein intake combined with strength training helps you rebuild and even gain muscle mass.

Here is my opinion on whey protein:

A food or a combination of foods that is good for you has to be good for all systems of your body. So, if you feel good, digest it well, and experience no negative changes in any aspect of your health or any area of your body, then the food or the supplement is good for you. If, on the contrary, your breath smells worse, or you get more acne or develop hemorrhoids, or your tolerance for caffeine worsens (you can't sleep well after the same amount of tea or coffee you tolerated well before), or anything gets worse, then perhaps the new food is not good for you. It may be harmful no matter what else you eat and drink, or it may be harmful because of something else you eat or drink or do not eat or drink. For example, if you increase your protein intake you better make sure you are well hydrated, so drink more water and fewer dehydrating drinks such as tea and coffee.

■ ***I have been following your methods and have found them to be excellent and very well explained.***

I am wondering if you have any advice to offer on shin conditioning for people who train in Muay Thai.

Will many reps of squats with no weight and reps of squats with weight increase bone density in the legs, thus making it safer when kicking with the shin? Will bone density continue to increase the more reps you do?

Have you advice with regard to kicking the heavy bag to condition the shin, or will this just cause irreversible damage?

Any information I have come across on this type of conditioning is from instructors who don't know how to stretch properly or sequence exercises in the correct order. Is there anywhere I could find this sort of information from someone versed in sports science?

Bone density is positively associated with muscle strength (the stronger you are, the denser your bones). Resistance training increases bone density and thickness (see photos on page 558 of *Physiology of Sport and Exercise* by Jack H. Wilmore and David L. Costill, published in 1999). Just as maximal strength depends on the total tonnage lifted (resistance multiplied by reps), so does bone density. You can learn about this topic from the position stand of the American College of Sports Medicine on physical activity and bone health.

High-intensity efforts of long duration, especially if the activity is non-weight-bearing, diminish bone density. So, swimming and bicycling are not good means of increasing bone density. Bicycle racers during the Tour de France, for example, lose a considerable amount of bone mass.

To toughen the shins, you have to work on more than just bone density and thickness. You need to toughen the skin so it protects the nerves and blood vessels running in it and in the periosteum (on the surface of bones). Damage to the nerves and blood vessels of the periosteum may cause death of the bone and loss of a limb. You also need to strengthen the muscles and ligaments of the knee and ankle so the impact does not damage these joints.

I suggest very gradual progression from rubbing the shins to rolling increasingly hard and heavy objects on them, as well as from striking soft and light bags to increasingly heavy and hard.

If you know someone knowledgeable in applications of dit ta jow (Chinese liniments), then ask how to use them. Of course, this toughening has to be done in addition to resistance training.

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