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## **PARENTS' GUIDE TO BUILDING BETTER BONES**

Most parents recognize the need to encourage healthy eating habits in their children, and they have heard that calcium is important for building healthy bones. But did you know that keeping salt and animal protein intake low and fruit and vegetable intake high is every bit as important? Did you know that scientists are doubtful that drinking more milk has any significant benefit for growing bones?

In this booklet, nutritionists and doctors with the Physicians Committee for Responsible Medicine (PCRM) aim to set the record straight and help parents sort through the hype about calcium, milk, and bone health.

### **FOR STARTERS**

Most children have no problem developing normal healthy bones. In fact, children in Japan, China, and other countries consume much lower levels of calcium than their North American peers and still develop strong, healthy bones. That's because the human body is an efficient regulator of bone growth.

Just like our hair, skin, and lungs, bone is a living tissue that is constantly being built, broken down, and made anew. Throughout life, bones are taking up and releasing calcium and other minerals, a cycle that is influenced by a variety of factors, including diet, exercise habits, hormones, genetics, and certain diseases. According to two recent reviews of bone health in childhood, the largest influence on this cycle is genetics, accounting for 60 to 80 percent of the differences, with hormones related to growth and puberty second in importance.<sup>1,2</sup>

Children generally build bone at a slightly higher pace than they break it down. After adolescence, this cycle begins to shift a little so that bone building and breakdown generally keep pace with each other. Later in life, this bone-remodeling cycle tends to

head in the reverse direction—with more bone being broken down than is rebuilt. Of course, the extent of this weakening can range from barely noticeable to a serious condition called osteoporosis, depending on many lifestyle and dietary habits.

The minerals in a child's skeleton are completely replaced (or recycled) about five times between childhood and her or his 55th birthday.<sup>3</sup> Focusing on those actions that promote bone building and those that decrease bone breakdown will effectively improve bone health.

## **PROMOTING BONE BUILDING**

Bones are a matrix of collagen (the same material used for building joints and other body tissues), water, calcium, phosphorus, magnesium, and other minerals. Special cells are responsible for making new bone. Here are the most important steps your child can take to help keep these bone-building cells busy:

- Get moving! Play and exercise every day.
- Eat a diet rich in fruits and vegetables.
- Get vitamin D from the sun or from supplements.
- Get calcium from plant foods and fortified products.

### *Exercise*

Exercise gives bones a reason to live. When bones are put to work, especially in weight-bearing activities such as running, soccer, basketball, and weightlifting, they respond by becoming stronger and denser. Engaging in physical activity may be the most influential thing your child can do to promote adolescent bone health. A recent study published in the medical journal *Pediatrics* found that sedentary teens had lower bone density by age 18 than those who engaged in regular physical activity.<sup>4</sup>

In a study of women 45 years and older, those who exercised four or more times per week as teenagers were only one-fourth as likely to fracture a hip as those who exercised once or not at all each week.<sup>5</sup> Encouraging your children to get away from the computer or up off the couch to enjoy more active pursuits is great way to help them build healthy bones.

### *Fruits and Vegetables*

Will a glass of orange juice, a crunchy salad, or a bowl of vegetarian chili help grow strong bones? Absolutely. Increasingly, research is pointing to diets rich in fruits and vegetables for promoting bone health. A study published in the *American Journal of Clinical Nutrition* shows that higher intakes of fruits and vegetables throughout the teen

years improve bone density in adulthood.<sup>6</sup> An array of nutrients—vitamin C, vitamin K, potassium, and magnesium—found abundantly in fruits, vegetables, and other plant foods, have been shown to promote bone health.<sup>6-8</sup>

Vitamin C from citrus fruits, tomatoes, peppers, and other fruits and vegetables is essential for making collagen, the connective tissue that minerals cling to when bone is formed.

Vitamin K is thought to stimulate bone formation. It is found most abundantly in dark leafy greens like kale and spinach, but is also readily available in beans, soy products, and some fruits and vegetables.

Potassium decreases the loss of calcium from the body and increases the rate of bone building. Oranges, bananas, potatoes, and many other fruits, vegetables, and beans are all rich sources of potassium.

Magnesium, like calcium, is an important bone mineral. Studies have shown higher magnesium intakes to be associated with stronger bones. “Beans and greens”—legumes and green leafy vegetables—are excellent sources of magnesium.

Fruits and vegetables are also important for what they don't do. Some foods—especially cheeses, meats, fish, and some grains—make the blood more acidic when digested and metabolized.<sup>9</sup> These foods add to the body's “acid load.” When this happens, bone minerals, especially calcium, are often pulled from the bones to neutralize these acids.<sup>10</sup> Diets high in fruits and vegetables actually tip the acid-base scales in the opposite direction and make it easier for bones to hold onto their calcium.<sup>9</sup>

### *Vitamin D*

Vitamin D is a hormone produced by sunlight on the skin. It controls your body's use of calcium and is an important player in bone building.<sup>11</sup> A lack of adequate vitamin D results in rickets, a serious childhood bone problem. Avoiding rickets is as easy as getting a short daylight walk on most days or having a bowl of cereal with fortified soy or rice milk for breakfast. About 15 minutes of sunlight each day normally produces all the vitamin D your child needs. If your family gets little or no sun exposure, you can include any common multivitamin or a serving of a vitamin D-fortified food in your daily routine. Consuming too much causes problems, so be sure not to overdo it.

### *Calcium from Plant Sources*

Children and adults lose calcium from the body every day, so we need to replenish it. Healthful calcium sources are “beans and greens.” Broccoli, Brussels sprouts, collards, kale, mustard greens, turnip greens, and others are loaded with highly absorbable calcium and a host of other important nutrients. While these foods have a smaller amount of calcium per serving compared to dairy products, they have more calcium per calorie, and the calcium they contain is absorbed nearly twice as well as the calcium in cow's milk.<sup>12</sup>

One cup of cooked kale, for example, has the same amount of absorbable calcium (100 milligrams) as one cup of cow's milk with less than half the calories. Beans are a good source of calcium, too. Choose from baked beans, chickpeas, tofu, or other bean products, and you will find a taste to please every palate. Just a few ounces of tofu, a bowl of vegetable chili or creamy Broccoli Potato Soup (see recipe on page 12) will provide your child with another healthful helping of absorbable calcium.

If you are looking for a concentrated calcium source, calcium-fortified orange and apple juices as well as enriched soy and rice milks contain 300 milligrams or more of calcium per cup in a highly absorbable form. Your child only needs two-thirds of a cup of fortified orange juice, one cup of fortified soymilk, or one-third cup of Total Plus cereal to get the same amount of absorbable calcium as a small carton of cow's milk. Children readily enjoy tasty and healthy treats made with these calcium-rich foods, such as Orange Power Pops (see recipe on page 12) or cereal topped with berries and rice milk.

## **AVOIDING EXCESS BONE LOSS**

A normal part of the bone-recycling process is the breakdown and release of calcium and other minerals into the bloodstream. These minerals are filtered through the kidneys and lost through the urine. Minimizing this loss is a smart strategy for protecting bones. Here are important steps you and your child can take to avoid excess bone loss:

- Limit salty foods.
- Avoid protein from animal sources.
- Keep children away from smoking.
- Avoid caffeine.

### *Salt*

Researchers have known for a long time that higher salt (sodium) intake leaches calcium from the bones.<sup>13</sup> The kidneys have the job of filtering excess salt into the urine. When they let the sodium pass out of the body, calcium flows out with it. This means the more salt your children consume, the more calcium they lose, and the more they need in their

diets to replace the calcium that is leaving. Lowering salt intake will reduce bone breakdown and calcium loss. To do this, you may want to eliminate salty snack foods and canned goods with added sodium, and reduce or eliminate salt use on the stove and at the table.

### *Protein from Animal Sources*

In 1992, a researcher from Yale University studying animal protein intake and hip fracture rates in 16 countries around the world found that those with the highest meat, fish, egg, and dairy product consumption had the most fractures.<sup>14</sup> They speculated that protein from animal products might stimulate bone breakdown and encourage calcium loss from the body. Since then, other researchers have confirmed this observation.<sup>15,16</sup> As you will recall, animal protein-dense foods make the blood more acidic. The body responds by pulling calcium and other minerals out of bones to neutralize the acid and sending it out in the urine. Building your child's diet from fruits, vegetables, grains, and legumes is a good way to reduce this excess calcium loss and protect bones.

### *Smoking*

You already know that smoking increases susceptibility to colds and other respiratory illnesses and increases the risk of heart attacks and cancer. But did you know that smokers excrete more calcium than non-smokers? A study of identical twins showed that if one twin was a long-time smoker and the other was not, the smoker had a 40-percent higher risk of a fracture.<sup>17</sup>

### *Caffeine*

It may surprise you to learn that the caffeine in sodas, coffee, and other beverages and foods slightly increases the loss of calcium from the body.<sup>18</sup> Try to get in the habit of serving water with meals. You may also want to keep little bottles in the refrigerator for kids on the go. It makes good parenting sense to offer water first and nutritious juices, soy, or rice milks second.

## **CALCIUM SOURCES FOR BUILDING BONES**

Calcium and other minerals are the raw materials necessary for building bones. Like bricks to a bricklayer, calcium is necessary, but is not the only element needed for bone building. Bricklayers need bricks, mortar, a water source, the right weather, and some manual assistance to get the job done. In a way, the same holds true in the construction of bone.

### **Recommended Calcium-Rich Foods**

<b>Food</b>	<b>Serving Size</b>	<b>Calcium Per Serving</b>	<b>Calcium Absorbed Per Serving*</b>	<b>Amount Needed to Absorb Approx. 100 mg Calcium</b>
Total Plus cereal	3/4 cup	1,000	301	1/3 cup
Orange juice, calcium-fortified	1 cup	300	108	7/8 cup
Soy milk, calcium-fortified	1 cup	300	93	1 cup
Basic Four cereal	1 cup	306	92	1 cup heaping
Sesame seeds, unhulled	1 oz.	280	58	13/4 oz.
Firm tofu, calcium-set	3 oz.	172	53	2/3 cup
Kale, frozen	1/2 cup	90	53	1 cup
Turnip greens, frozen	1/2 cup	99	51	1 cup
Instant oats	1 packet	158	48	2 packets
Mustard greens, frozen	1/2 cup	76	44	1 1/8 cups
Chinese cabbage, bok choy, boiled	1/2 cup	79	43	1 1/8 cups
White beans, cooked	1 cup	161	35	2 3/4 cups
Broccoli, frozen	1/2 cup	47	29	1 2/3 cups
Brussels sprouts, boiled	1/2 cup	28	18	2 3/4 cups
Spinach, boiled	1/2 cup	122	6	8 cups

\*Estimated based on published absorption fractions.

### Other Calcium-Rich Foods

Food	Serving Size	Calcium Per Serving	Calcium Absorbed Per Serving*	Amount Needed to Absorb Approx. 100 mg Calcium
Lowfat yogurt, plain	8 oz.	400	128	3/4 cup
2% milk	1 cup	297	95	1 cup
Cheddar cheese	1 oz.	204	66	1 1/2 oz.
Mozzarella cheese, part skim	1 oz.	183	59	1 3/4 oz.
Processed cheddar cheese spread	1 oz.	160	51	2 oz.

\*Estimated based on published absorption fractions.

It makes sense to choose calcium sources that benefit bones in more ways than one. Good calcium sources not only contain plenty of calcium, they also must be absorbed reasonably well by the body. Beyond that, a healthful calcium source also contributes to a diet that promotes bone building and prevents bone loss. In the table below, foods that contain at least 30 milligrams of absorbable calcium are given a score based on the number of attributes the food has for promoting bone building. Foods with scores of 3 or higher are considered the “best” sources of calcium. To arrive at this “Bone Health Score,” the foods received one point for each of the following bone-building criteria:

1. Not an acid-forming food
2. Low in salt (low sodium)
3. Rich in potassium (K<sup>+</sup>)
4. Rich in vitamin C (Vit C)
5. Rich in vitamin K (Vit K)
6. Rich in magnesium (Mg<sup>++</sup>)
7. Rich in vitamin D (Vit D)

## Other Bone-Building Attributes of Calcium-Rich Foods

Calcium-Rich Food	Not Acid Forming	Low Sodium*	K+ Rich*	Vit C Rich*	Vit K Rich*	Mg++ Rich*	Vit D Rich *	Bone Health Score
Kale, frozen (1/2 cup)	+	+	+	+	+			5
Chinese cabbage, bok choy, boiled (1/2 cup)	+	+	+	+	+			5
Orange juice, calcium-fortified (1 cup)	+	+	+	+				4
Mustard greens, frozen (1/2 cup)	+	+		+	+			4
Turnip greens, frozen (1/2 cup)	+	+		+	+			4
White beans, cooked (1 cup)	+	+			+		3	
Soy milk, calcium-fortified (1 cup)			+			+	+	3
Firm tofu, calcium-set (3 oz.)	+	+			+		3	
2% milk (1 cup)			+				+	2
Sesame seeds, unhulled (1 oz.)	+				+		2	
Lowfat yogurt, plain (8 oz.)			+					1
Total Plus cereal (3/4 cup)				+				1
Basic Four cereal (1 cup)								0
Instant oats (1 packet)								0
Cheddar cheese (1 oz.)								0
Processed cheddar cheese spread (1 oz.)						0		

Note: These foods are all good sources of calcium and all have nutrients other than the ones listed. The Bone Health Score represents the number of bone-building attributes these calcium-rich foods contain. Based on potential renal acid loads of food groups.

Source: Remer T, Manz F. J Am Diet Assoc. 1995;95:719-7.

\*Low sodium is less than 35 milligrams per serving; potassium (K+) rich and magnesium (Mg++) rich is more than 10 percent of Recommended Daily Intake (RDI); vitamin C, vitamin D, and vitamin K rich is more than 25 percent of the RDI.

## WHY DAIRY PRODUCTS DON'T MAKE THE CUT

Dairy products are often cited by the dairy industry as being good sources of calcium simply because they contain calcium and are “readily available.” But there is more to the story than that. Concerned parents want more from a calcium-rich food than availability in the supermarket. They also want to know whether giving the recommended two to three servings of milk or other dairy products will actually help their children grow strong bones and whether these foods are likely to promote the long-term health of their children.

### *Milk Helps Bones?*

There is much debate over whether long-term consumption of dairy products helps bones at all. A good deal of evidence suggests that it does not. Several studies of teenagers have found that their adult bone health is related to their physical activity level earlier in life, but not to the amount of milk or calcium they consumed.<sup>4,5</sup> Milk consumption is apparently no help later in life either. In a 12-year Harvard study of 78,000 women, those

who got the most calcium from dairy products received no benefit and actually broke more bones than the women who got little or no calcium from dairy.<sup>19</sup> Similarly, a 1994 study of elderly men and women in Sydney, Australia, showed that those who consumed the most dairy products had double the hip fracture rate of those who consumed the least.<sup>20</sup>

These findings indicate that despite the amount of calcium in dairy products, other dairy compounds accelerate calcium loss. Animal proteins and salt are two likely suspects. To make matters worse, in North America, dairy products are often consumed by people who already have high-salt, meat-based diets.

### *Cow's Milk Is Risky*

Researchers have linked cow's milk consumption to a number of childhood ailments from minor to very serious. In children under the age of one, risks include iron deficiency, colic, and increased risk of Type I diabetes. Naturally, the best beverage for infants and small toddlers is mother's breast milk. Even after the first year, food allergies to milk and milk products are common. A recent study also linked cow's milk consumption to chronic constipation in children.<sup>21</sup> Many children and teens with irritable bowel syndrome, autism, asthma, and allergies improve when they stop drinking cow's milk.

Milk proteins, milk sugar, fat, and saturated fat found in dairy products may pose health risks for children and lead to chronic diseases such as obesity, diabetes, some types of cancer, and formation of atherosclerotic plaques that can lead to heart disease. The consumption of three servings of whole milk each day adds up to a total of 450 calories and more than 24 grams of fat, most of which is artery-clogging saturated fat.

The dairy industry often suggests that drinking milk or chocolate milk instead of soda will reduce problems with overweight, reduce sugar intake, and improve bone health. But the nutritional facts say otherwise. Two-percent chocolate milk has 80 percent more calories and the same amount of sugar as an equivalent serving of cola.

### *Milk Makes Many Children Sick*

Many children by their fourth or fifth birthdays have grown out of their ability to digest the milk sugar lactose. Drinking milk can cause stomach pain, gas, bloating, diarrhea, and other uncomfortable symptoms in lactose-intolerant children. There is no need to take pills or buy special lactose-reduced dairy products. Instead, you might look at this change as a signal that breast milk is no longer needed, and that cow's milk shouldn't take its

place. It is a time to expand your child's diet to include a wide variety of plant-based foods.

### *Dairy Products Edge Out Healthier Foods*

Plant foods are chock full of important nutrients that strengthen immune function, improve bone strength, and protect against cancer and heart disease. For example, complex carbohydrates, vitamin C, fiber, folate, iron, and antioxidants are not found in dairy products, but are plentiful in vegetables, fruits, and beans. And plant food sources of calcium are low in saturated fat and always devoid of cholesterol.

## **PUTTING IT ALL TOGETHER**

As a parent you already have plenty of opportunities for worry. Your child's bone health need not be one of them. A few simple guidelines will keep children on the right track—a diet built from grains, legumes, vegetables, and fruit, along with plenty of activity, and avoiding smoking, severe dieting, salty foods, and excess protein from meats, eggs, and cheeses is all you need to do. Your child's body will take care of the rest.

Together, these factors, along with your child's hormones and genes, will determine the strength of his or her bones. When it comes to bone health, it pays to look beyond the “get more calcium” message and offer your child a diet that both promotes bone building and reduces bone loss. Because dairy products are high in salt, animal protein, calories, and fat, plant sources of calcium, along with vitamin D and calcium-fortified products, are the preferred foods for your child's bones.

## **REFERENCES**

1. Bachrach LK. Acquisition of optimal bone mass in childhood and adolescence. *Trends Endocrinol Metab* 2001;12:22-8.
2. Wosje KS, Specker BL. Role of calcium in bone health during childhood. *Nutr Rev* 2000;58:253-68.
3. Abrams S, Van Loan M, Hunt C, Wood R. Report of the Special Committee to assess Physicians Committee for Responsible Medicine petitions regarding the milk mustache campaign. U.S. Department of Agriculture, June 19, 2001.
4. Lloyd T, Chinchilli VM, Johnson-Rollings N, et al. Adult female hip bone density reflects teenage sports-exercise patterns but not teenage calcium intake. *Pediatrics* 2000;106:40-4.
5. Nieves JW, Grisso JA, Kelsey JL. A case-control study of hip fracture: evaluation of selected dietary variables and teenage physical activity. *Osteoporosis Int* 1992;2:122-7.

6. New SA, Bolton-Smith C, Grubb DA, Reid DM. Nutritional influences on bone mineral density: a cross-sectional study in premenopausal women. *Am J Clin Nutr* 1997;65:1831-9.
7. New SA, Robins SP, Campbell MK, et al. Dietary influences on bone mass and bone metabolism: further evidence of a positive link between fruit and vegetable consumption and bone health. *Am J Clin Nutr* 2000;71:142-51.
8. Schaafsma A, de Vries PJF, Saris WHM. Delay of natural bone loss by higher intakes of specific minerals and vitamins. *Crit Rev Food Sci Nutr* 2001;41:225-49.
9. Remer T, Manz F. Potential renal acid load of foods and its influence on urine pH. *J Am Diet Assoc* 1995;95:791-7.
10. Barzel US. The skeleton as an ion exchange system: implications for the role of acid-base imbalance in the genesis of osteoporosis. *J Bone Min Res* 1995;10:1431-6.
11. Swaminathan R. Nutritional factors in osteoporosis. *Int J Clin Pract* 1999;53:540-8.
12. Weaver CM, Plawcki KL. Dietary calcium: adequacy of a vegetarian diet. *Am J Clin Nutr* 1994;59:1238S-41S.
13. Nordin BEC, Need AG, Morris HA, Horowitz M. The nature and significance of the relationship between urinary sodium and urinary calcium in women. *J Nutr* 1993;123:1615-22.
14. Abelow BJ, Holford TR, Insogna KL. Cross-cultural association between dietary animal protein and hip fracture: a hypothesis. *Calcif Tissue Int* 1992;50:14-8.
15. Sellmeyer DE, Stone KL, Sebastian A, Cummings SR. A high ratio of dietary animal to vegetable protein increases the rate of bone loss and the risk of fracture in postmenopausal women. *Am J Clin Nutr* 2001;73:118-22.
16. Remer T, Manz F. Estimation of the renal net acid excretion by adults consuming diets containing variable amounts of protein. *Am J Clin Nutr* 1994;59:1356-61.
17. Hopper JL, Seeman E. The bone density of female twins discordant for tobacco use. *N Engl J Med* 1994;330:387-92.
18. Heaney RP, Rafferty K. Carbonated beverages and urinary calcium excretion. *Am J Clin Nutr* 2001;74:343-7.
19. Feskanich D, Willett WC, Stampfer MJ, Colditz GA. Milk, dietary calcium, and bone fractures in women: a 12-year prospective study. *Am J Publ Health* 1997;87:992-7.
20. Cumming RG, Klineberg RJ. Case-control study of risk factors for hip fractures in the elderly. *Am J Epidemiol* 1994;139:493-503.
21. Iacono G, Cavataio F, Montalto G, et al. Intolerance of cow's milk and chronic constipation in children. *N Engl J Med* 1998;339:1100-4.

## HEALTHY CALCIUM-RICH RECIPES FOR KIDS

*From the kitchen of Jennifer Raymond*

### **Broccoli Potato Soup**

*Makes about 1 1/2 quarts*

Broccoli is a nutritional powerhouse, and this creamy soup makes it appealing to children.

2 1/2 cups vegetable broth  
1 onion, chopped  
2 garlic cloves, minced  
2 potatoes, diced  
4 cups broccoli florets  
1/2 teaspoon cumin  
1/2 teaspoon salt  
1/4 teaspoon black pepper  
1 tablespoon tahini (sesame seed butter)  
2 cups fortified, unsweetened soymilk

Heat 1/2 cup of vegetable broth in a large pot, then add onion and garlic and cook, stirring occasionally until soft, about 5 minutes.

Add diced potatoes and remaining broth, then cover and simmer until potatoes are tender, about 15 minutes.

Add broccoli and simmer until tender, about 5 minutes. Stir in cumin, salt, pepper, and tahini.

Transfer small batches to a blender and purée until very smooth, adding some of the soymilk to each batch. Return to pot and warm over low heat until steamy.

Per 1-cup serving: 140 calories; 5 g protein; 27 g carbohydrate; 2 g fat; 5 g fiber; 373 mg sodium; 135 mg calcium; calories from protein: 14%; calories from carbohydrates: 72%; calories from fats: 14%

### **Orange Power Pops**

*Makes 8 popsicles*

These creamy popsicles are a great way to add protein, calcium, potassium, and other nutrients to the diets of finicky eaters.

1 12.3-oz. package Mori-Nu Lite Silken Tofu (firm)  
1 cup calcium-fortified orange juice concentrate  
1 cup fortified vanilla soymilk  
1/4 cup maple syrup  
2 ripe bananas

Combine all ingredients in a blender and process until completely smooth. Pour into popsicle molds or paper cups and freeze.

Per popsicle: 131 calories; 4 g protein; 28 g carbohydrate; 1 g fat; 1 g fiber; 28 mg sodium; 234 mg calcium; calories from protein: 12%; calories from carbohydrates: 82%; calories from fats: 6%

### **FOR FURTHER INFORMATION**

Healthy Eating for Life for Children by Amy Lanou, Ph.D., and PCRM's expert panel is full of helpful nutrition information for parents, or you may wish to consult [www.pcrm.org](http://www.pcrm.org) or Food for Life by PCRM president Neal Barnard, M.D., available through your local bookstore, or contact PCRM for these and other publications.

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