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Decreasing the Incidence of Osteoporosis-Related Injuries Through Diet and Exercise

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Synopsis

Osteoporosis is the most common systemic bone disorder in the United States. It affects 15 million people—primarily women—causing thousands of injuries and deaths per year at a cost estimated at $3.8 billion annually.

Two important factors in preventing osteoporosis are regular exercise and adequate calcium intake throughout life. Studies have shown that the average daily consumption of calcium by premenopausal and postmenopausal American women is between one-third and one-half that needed to maintain a positive calcium balance and prevent the loss of bone mass.

This proposal elaborates the following specific ways that our health care and educational institutions can change these prospects: (a) a screening program for women of all ages, to identify those most at risk for developing osteoporosis; (b) an increase in the recommended daily dietary allowance for calcium; (c) a public information campaign about osteoporosis, using television and radio; (d) an investigation of the feasibility of calcium additives in the American diet; and (e) the establishment of an organization to develop educational programs and monitor research in osteoporosis prevention. Now is the time to make the appropriate efforts to better the prospects for millions to enjoy a long and healthier life.

OSTEOPOROSIS IS THE MOST COMMON systemic bone disorder in the United States. One of every three women living in the United States either has osteoporosis or will eventually develop it. The condition affects 15–20 million people, causes thousands of injuries and deaths per year, and costs $3.8 billion annually (*1–7*).

Osteoporosis results from an imbalance between bone formation and bone resorption. Women are primarily affected by this condition, which leads to compression vertebral fractures, broken wrists, and fractured hips.

Although the cause of osteoporosis has not been determined, researchers generally agree that the pathological effects of this condition can be lessened and often eliminated simply by maintaining an adequate dietary intake of calcium throughout life and getting regular exercise (*5,6,8*). Unfortunately, this information has yet to reach the general public or many health professionals. This is a public health issue, and it deserves to be the focus of a major public health education effort. Simple lifestyle and dietary changes could improve the quality of life for millions of women and save billions of dollars in health care costs.

The following statistics demonstrate the enormous impact that osteoporosis has on our society:

1. By the age of 65, one-half of women with no noticeable pathology will have a decreased bone mineral content below the fracture threshold (*3,5*).
2. Eighty percent of the 1 million fractures annually in women over 50, and 90 percent of the fractures in women over 60, result from osteoporosis (*2,9,10*).
3. Seventy-five percent of all hip fractures in the United States, totaling 200,000 per year, are the result of osteoporosis. Twenty percent of patients with hip fractures

(40,000 persons each year) die within 1 year after their fractures are incurred (*1,2,7*).

The current cost for acute care of patients with injuries due to osteoporosis reaches $3.8 billion annually, making care of these patients a major factor in national health care costs (*1,2,11*). As demographic changes in the U.S. population lead to a much larger total proportion of older Americans, costs for care of patients with osteoporosis will constitute an even greater percentage of the national health care budget.

Furthermore, the disorder extracts a nonquantifiable price from its sufferers and their families. It can lead to lengthy convalescences, nursing home care, and a loss of independence that may never be recovered. Unfortunately, a vast majority of the American population will be either directly or indirectly affected by osteoporosis.

This proposal elaborates a number of specific ways that our health care and educational institutions can change these prospects. A screening program is proposed that can identify at an early age those most at risk of developing osteoporosis and educate them concerning their particular needs for an adequate diet and physical fitness program. A public health education effort is also proposed to discourage attitudes in our society about the inevitability of this condition and to encourage active preventive efforts based upon adequate intake of dietary calcium and physical exercise. Now is the time to make the appropriate efforts to improve the chances for millions to enjoy a long and healthier life.

Background

Among many other functions, the tissue of the skeleton—bone—serves as an important reserve of calcium and phosphorus, minerals crucial in many metabolic functions. Osteoblasts, osteocytes, and osteoclasts—the cells of bone—maintain skeletal mass in a constant balance of formation and resorption of the mineral matrix. If for any reason resorption exceeds formation, a decrease in mass per unit volume of mineralized bone will result (*2*). This state is known as osteoporosis.

The postmenopausal cessation of estrogen production seems to be a major determining factor in the occurrence of osteoporosis in women. Premenopausal women resorb calcium from the bone at a rate of 25 mg per day, whereas resorption in postmenopausal women increases to 50 mg per day (*5,12*). Since the rate of bone formation does not increase to make up for the increased resorption, postmenopausal women tend to lose their bone matrix as they age. This decrease in bone mass allows fractures to occur easily, usually on the performance of an otherwise normal skeletal maneuver. Osteoporosis most often affects trabecular bone, resulting in compression fractures of the vertebrae, and endosteal bone, resulting in fractures of the proximal femur and humerus and the distal radius.

For some time it was believed that estrogen therapy might be a simple way to prevent the development of osteoporosis in postmenopausal women. Estrogen given to postmenopausal women does prevent loss of bone mass, but it is also true that exogenous estrogen therapy is associated with an increased incidence of endometrial carcinoma (*6,13–16*). However, in persons at a high risk for developing osteoporosis, the benefits of estrogen therapy can outweigh its risks (*1*).

It is becoming increasingly evident that a number of factors affect maintenance of the bone matrix in premenopausal and postmenopausal women, and it is important to consider these factors in order to prevent osteoporosis. These factors include age and menopause, as well as exercise, diet, the use of certain drugs, some disease states, and family background.

Exercise must be added to age and menopause as a determinant of who will develop osteoporosis. A recent study has shown that postmenopausal women who exercise for 1 hour, three times a week, for 1 year, experienced an increase in total body calcium (*8*). Weight-bearing exercise appears to have a positive effect in maintaining calcium balance by inducing a higher rate of bone formation, thus tipping the bone formation and resorption balance away from osteoporosis (*4,8,13,16,17*).

Calcium intake in the diet is closely related to osteoporosis. Studies have shown that women with lifelong adequate levels of calcium intake experience significantly less osteoporosis than those with an inadequate intake of calcium (*11*). It only makes sense that one dietary goal in the prevention of osteoporosis is for calcium intake to equal or exceed calcium excretion. With this goal in mind, researchers have shown that premenopausal and estrogen-treated women must consume 1,000 mg of calcium per day and that postmenopausal women's needs increase to 1,500 mg per day (*1,5–7,9,16*). The current established recommended daily dietary allowance for calcium, as set by the Food and Nutrition Board of the National Research Council, National Academy of Sciences, is 800 mg per day (*18*), actually falling short of the amount needed for balance (*16*). Yet a U.S. Department of Agriculture survey reported that an average of only 450 mg per day of calcium was consumed by women above 45 years of age (*10*). Thus, most women are consuming between one-third and one-half the calcium needed to maintain a positive calcium balance and to prevent the loss of bone mass (*6*).

The calcium-to-phosphorus ratio is another consideration in the dietary prevention of osteoporosis. This ratio should ideally be 1:1. Osteoporosis has developed in

animals when the calcium-to-phosphorus ratio has been less than 1:1 (more phosphorus than calcium). Some research has shown that because of significant changes in the American diet, most people's calcium-to-phosphorus ratio is now close to 1:2. This excessive consumption of phosphorus is thought to induce a mild secondary hyperparathyroidism, with a resulting increased bone resorption (*3*). One significant source of phosphorus is cola soft drinks, and their excessive consumption must be considered when assessing dietary risk for osteoporosis.

The use of some drugs in certain disease states has been shown to increase the risk of osteoporosis and therefore should be considered in its prevention. Commonly used drugs that cause an increase in calcium depletion are corticosteroids, thyroid extracts, isoniazid, tetracycline, furosemide, heparin, and antacids containing aluminum. A history of hyperthyroidism, symptoms of intestinal malabsorption, alcoholism, rheumatoid arthritis, and a history of renal calculi all carry an increased risk of osteoporosis.

A woman's family background and medical history need to be considered as well. A small skeletal frame and northern European, Chinese, or Japanese ethnic origins increase one's risk of developing osteoporosis. A family history of vertebral or hip fracture, or a personal history of oophorectomy before age 45, or gastrectomy also need to be considered when a person's risk of osteoporosis is evaluated (*5–7,11,19*).

Of all the factors that can affect development of osteoporosis, the two most important for its prevention are exercise and adequate calcium intake (*8*). Promotion of these preventive measures would not only save millions of people from the disorder's potentially devastating consequences but would also generally improve diet and physical well-being in a majority of our population. Since osteoporosis is a potential "backbreaker" for millions of Americans, and since its prevention is both economically and physically feasible for most, the failure of health professionals and the general public to address this problem would be ethically remiss and economically unsound.

Proposal

If osteoporosis is to be prevented, then lifestyle and dietary changes must be made by millions. The stakes are quite high in terms of both promoting a healthy existence throughout life and preventing the expenditure of billions of dollars in the future to treat and care for the victims of this disorder. An effort must be made on a number of levels simultaneously to address this problem.

We propose that the following specific steps be taken as the quickest way to have a major impact on this problem in the shortest time. We also propose ways that will begin an ongoing process of reeducation of the general population and health professionals to the possibility of preventing osteoporosis through nutritional and lifestyle changes.

1. A screening program for women of all ages, designed to assess their risk of developing osteoporosis, should begin as soon as possible. This program should provide education and counseling as to what individual women can do to prevent osteoporosis from destroying their bones and their independence.

Accompanying this article is an osteoporosis risk assessment questionnaire designed to give physicians and other health professionals a quick means of assessing a woman's risk of developing osteoporosis in postmenopausal years. This easy-to-complete form gathers organized information about certain areas of a woman's personal history, dietary habits, and lifestyle that all authorities on osteoporosis agree are significant in predicting whether she will be at high risk of developing osteoporosis in later years. The form is designed both to give health care personnel information about osteoporosis risk and to give the woman who is filling out the form some education about the disorder, her likelihood of developing it, and things she can do to prevent it or delay its appearance.

The osteoporosis risk assessment form can be used to screen women in premenopausal and postmenopausal years; however, it is in premenopausal years that preventive measures are most successful. By maintaining an adequate dietary level of calcium and getting exercise at a level adequate to induce bone density buildup, a woman can lay down in early life the bone she needs. Postmenopausal bone mass loss in later years will then be offset by the additional bone laid down earlier, and the fracture risk will consequently be reduced. And if proper nutrition and exercise are made a long-term part of a woman's life as a result of education about osteoporosis in early years, then continued adequate levels of calcium intake and exercise in postmenopausal years may prevent bone loss from becoming a problem at all.

Of course this screening process should include all women. But one quick way to reach a large number of women in the right age group, with maximum effect and minimum effort, would be to institute regular use of the screening process among medical and health professionals working with women of reproductive age. It is during this time that women are most likely to come in contact with the medical establishment and other health professionals and be subject to education about osteoporosis. In addition, pregnancy often entails a change in both nutritional and lifestyle habits. Therefore, this form might well be used by medical and health personnel in prepartum and postpartum medical care of women in

Osteoporosis Risk Assessment Questionnaire

1. How many servings of the following foods do you consume daily? (Please fill in the shaded areas.)

Food	*Serving size*	*Number of servings*	*Calcium (mg) per serving*
Milk	(1 cup = 8 oz)	_____	× 300 = _____
Yogurt	(1 cup)	_____	× 300 = _____
Cheese	(1 slice)	_____	× 200 = _____
Cottage cheese	(½ cup)	_____	× 70 = _____
Ice cream	(1 cup)	_____	× 180 = _____

Daily calcium intake (DCI): _____

2. How many servings of the following foods do you consume weekly? (Please fill in the shaded areas.)

Food	*Serving size*	*Number of servings*	*Calcium (mg) per serving*
Broccoli	(½ cup)	_____	× 65 = _____
Baked Beans	(½ cup)	_____	× 65 = _____
Pizza	(1 slice)	_____	× 100 = _____
Soup (made with milk)	(1 cup)	_____	× 170 = _____
Sardines	(3 oz)	_____	× 375 = _____
Canned salmon	(4 oz)	_____	× 300 = _____
Shrimp	(3 oz)	_____	× 100 = _____

Weekly calcium intake (WCI): _____

DCI + (WCI ÷ 7) = Average daily calcium intake: _____

(Beware of calcium score less than 1,000 mg per day in premenopausal women and less than 1,500 mg per day in postmenopausal women.)

3. Has anyone in your family suffered a hip or vertebral (back) fracture? Yes_____. No_____. Relationship_____.
4. Is your ethnic background northern European, Chinese, or Japanese? Yes_____. No_____.
5. Do you exercise regularly (3 times a week for 30 minutes)? Yes_____. No_____. If yes, what kind of exercise?_____.
6. Do you regularly take antacids? Yes_____. No_____. Brand name:_____.
7. Do you consume carbonated beverages? Yes_____. No_____. Number per day: _____. Type:_____.
7. Do you take any calcium supplements? Yes_____. No_____. Number per day: _____. Type:_____.

Health Providers' Instructions for Osteoporosis Risk Assessment Form

Many medical providers believe that osteoporosis is an unfortunate product of aging. It is important for providers to realize that, with early detection of high-risk individuals, osteoporosis can be prevented in most cases.

Two very important factors in the prevention of osteoporosis are adequate calcium intake and exercise. This form is designed to give you an easy way to assess premenopausal women's risk of developing osteoporosis. It can also be used for postmenopausal women, but it is by no means designed to substitute for a complete history and physical, nor do the questions address all factors that have been linked to development of osteoporosis. Our goal is to identify people at risk for developing osteoporosis and, through education, help them make dietary and lifestyle changes in order to prevent osteoporosis in their later lives.

Questions 1 and 2: A quick dietary assessment of daily calcium intake. Premenopausal calcium needs are 1,000 mg per day and postmenopausal needs are 1,500 mg per day. Adequate dietary intake should be in this range ± 100 mg per day.

Question 3: Many people do not know the term "osteoporosis" but may have a positive history of fractures that could indicate a familial tendency to develop the disorder.

Question 4: Osteoporosis is most often seen in these ethnic groups and in women with small skeletal frames.

Question 5: Exercise is essential for the formation of new boney matrix. Walking, running, and bicycling are the best forms of exercise to induce bone formation and should be performed at least three times a week for a half hour.

Question 6: Aluminum increases calcium excretion. Therefore, anyone who takes an aluminum-containing antacid regularly should be encouraged to switch to one with no aluminum.

Question 7: A calcium-to-phosphorus ratio of 1:1 is needed to avoid calcium depletion. Some research has shown that because of significant changes in the American diet, most people's calcium-to-phosphorus ratio is now close to 1:2. This excessive consumption of phosphorus is thought to induce a mild secondary hyperparathyroidism, with resulting increased bone resorption. One significant source of phosphorus is most carbonated beverages. Excessive consumption of these beverages must be considered when assessing dietary risk for osteoporosis. Encourage patients to check labels for phosphorus content and to substitute skim or whole milk when possible.

their teens, twenties, and thirties. It could readily be incorporated in the medical records of physicians for periodic evaluations of risk levels, as well as used in such public health programs as Women, Infants, and Children nutrition programs and family planning clinics.

2. The recommended daily dietary allowance for calcium intake should be immediately increased to 1,000 mg per day for premenopausal and estrogen-treated women and 1,500 mg per day for those past menopause who are not treated with estrogen. There is virtually no controversy among scientific and medical experts concerning the efficacy of this move as a minimum needed to reduce the risk of osteoporosis in individual women, and such a change could be made and begin to have an impact relatively rapidly. The Department of Health and Human Services should request the Food and Nutrition Board of the National Research Council, National Academy of Sciences, to begin this process immediately.

3. Every day the public is exposed to a bombardment of information via the mass media. Radio, television, and the print media have become major purveyors of education to people in all age groups. Any public health campaign aimed at educating women and health professionals would therefore do well to use the media to raise the consciousness of the entire society.

We propose that the appropriate bureaus of the Department of Health and Human Services and the Department of Agriculture (for example, the Expanded Foods and Nutrition Education Program of the Department of Agriculture's Cooperative Extension Service) begin an ongoing publicity campaign designed to educate the public about osteoporosis and how it can be prevented. (Suggested radio and television public service announcements are available from the authors, as is the suggested text for a basic information leaflet, designed for use in conjunction with media efforts and for general distribution.)

A public education campaign is obviously an intricate part of any measures aimed at preventing osteoporosis, and a wide variety of techniques for getting the message across are available. We are convinced that the issue is of vital interest to nearly all women and that a competent public education effort would meet with great success.

4. The appropriate U.S. Government agencies should be directed to investigate means by which consumption of calcium can safely be increased in the American diet. Specifically, calcium additives to nondairy products should be considered as well as calcium-enriched milk.

5. Finally, we propose that the Secretary of the Department of Health and Human Services do whatever is necessary to establish an organization, governmental or independent, to monitor all aspects of osteoporosis prevention. This organization would:

- Monitor osteoporosis research and sponsor scientific medical meetings with an osteoporosis prevention theme.
- Organize continuing education credit courses for physicians, nurses, dietitians, and other health workers to disseminate information about osteoporosis and its prevention. The first priority would be continuing medical education courses for obstetricians, gynecologists, internists, family practitioners, and other health workers likely to come in contact with women of childbearing age.
- Prepare and offer, to medical and allied health schools, curriculum material designed to incorporate osteoporosis prevention into regularly established course work.
- Maintain a long-term education program with the goal of making osteoporosis prevention a recognized pattern of dietary and lifestyle habits for all American women.
- Approach and involve for-profit organizations (for example, the National Dairy Council) and nonprofit organizations (for example, the National Council on Aging and women's organizations) in all aspects of its public education campaign.

Conclusion

Osteoporosis is a treatable condition but, equally important, a preventable one. It has been demonstrated that simple changes in dietary habits and exercise could ultimately prevent innumerable skeletal injuries. In this proposal, we outline feasible ways for public health officials and health workers to educate the public about prevention of osteoporosis. We feel that the long-term impact of the program would not only greatly better the lives of millions of women but also save countless health care dollars.

It is time to dispel the myth that brittle bones are an inevitable price of aging. The sooner we act, the greater will be the savings in lives and dollars.

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