DOCUMENT RESUME

ED 321 998 SE 051 506

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TITLE Decoding Fad Diets. Nutrition in Health Promotion Series, Number 20.
INSTITUTION Ohio State Univ., Columbus. Dept. of Family Medicine.
SPONS AGENCY Health Resources and Services Administration (DHHS/PHS), Rockville, MD. Bureau of Health Professions.
PUB DATE 85
CONTRACT 240-83-0094
NOTE 43p.; See SE 051 486 for "Comprehensive Guide and Topical Index" to Modules 1-26. See SE 051 487-502 for Modules 1-16, "Primary Care Series" and SE 051 503-512 for "Nutrition in Health Promotion" series.
PUB TYPE Guides - Classroom Use -- Materials (For Learner) (051)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Dietetics; Disease Control; Health Education; Higher Education; *Independent Study; *Medical Education; Medicine; Nutrition; *Nutrition Instruction; *Patient Education; *Preventive Medicine; Science Education; Special Health Problems; Teaching Methods

ABSTRACT

Nutrition is well-recognized as a necessary component of educational programs for physicians. This is to be valued in that of all factors affecting health in the United States, none is more important than nutrition. This can be argued from various perspectives, including health promotion, disease prevention, and therapeutic management. In all cases, serious consideration of nutrition related issues in the practice is seen to be one means to achieve cost-effective medical care. These modules were developed to provide more practical knowledge for health care providers, and in particular primary care physicians. This module is designed to help primary care physicians become critical reviewers of nutritional information. These skills will help the physician to be able to critique nutritional claims and teach patients how to assess fad diets and popular nutritional products. Included are learning goals and objectives, a self-check of achievement with regard to goals, and references for the physician and for the physician to recommend to patients. Appendices include patient handouts concerning avoidance of nutritional quackery, and the dangers of herbal teas. (CW)

The Nutrition in Primary Care Series Contains These Modules:

1. Nutrient Content of Foods, Nutritional Supplements, and Food Fallacies
2. Appraisal of Nutritional Status
3. Nutrient and Drug Interactions
4. Normal Diet: Age of Dependency
5. Normal Diet: Age of Parental Control
6. Normal Diet: Adolescence
7. Normal Diet: Pregnancy and Lactation
8. Normal Diet: Geriatrics
9. Dietary Management in Obesity
10. Dietary Management in Diabetes Mellitus
11. Dietary Management in Hypertension
12. Dietary Management in Hyperlipidemia
13. Dietary Management in Gastrointestinal Diseases
14. Dietary Management for Alcoholic Patients
15. Nutritional Care of Deteriorating Patients
16. An Office Strategy for Nutrition-Related Patient Education and Compliance

The Nutrition in Health Promotion Series Contains These Modules:

17. Individual and Social Factors
18. Metabolic Principles
19. Risk Factors and Disease Prevention
20. Decoding Fad Diets
21. Protecting Bone and Teeth
22. Exercise and Physical Activity
23. Vitamins and Trace Minerals
24. Behaviorial and Neurological Disorders
25. Preventing Hospital and Home Malnutrition
26. Questions About Common Ailments

Faculty Guide (includes comprehensive index for Modules 1-26)

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20 Nutrition in Health Promotion: Decoding Fad Diets

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Contract Number: 240-83-0094

U.S. Department of Health and Human Services
Public Health Service
Health Resources and Services Administration
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A special note of appreciation is extended to persons in family practice residency programs and universities throughout Ohio for reviewing the materials and to the faculty and residents of the Central Ohio Affiliated Family Practice Residency Programs where the materials were piloted:

Grant Hospital, Columbus, Ohio
Riverside Methodist Hospital, Columbus, Ohio
University Hospital, Columbus, Ohio
Mt. Carmel Hospital, Columbus, Ohio

Composition, Camera Work, Reproduction and Binding: Lesher Printers, Fremont, Ohio

Library of Congress Catalog Card Number: 85-62199

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Introduction

Every American is in some way affected by nutrition fallacies. Newspaper ads lure people to purchase products for treatment of self-diagnosed ailments. Magazines and books promote claims that manipulation of the diet and use of "supplements" are essential to health. Supermarkets have "health foods" and "supplements" prominently displayed for their customers' "benefit." And nearly every shopping center contains a health food store with rows of high-priced products and scores of pamphlets which tell the consumer what to buy.

Physicians recognize that nutrition fallacies, fad diets, and bogus nutrition products are commonplace in our society. However, patients often do not have the knowledge to evaluate diets and nutrition products. How can you guide patients away from use of fad diets and nutrition products which are not beneficial? How can you help patients evaluate non-scientific nutrition literature which is used to support nutrition fallacies? The answers to these and other questions are included in this module.

Goal

The goal of this module is to help the primary care physician become a critical reviewer of nutrition information. As a patient advocate, the physician will be able to critique nutritional claims and teach patients how to assess fad diets and popular nutritional products.

Objectives

Upon completion of this module, you will be able to:

1. *Evaluate fad diets and the claims of nutrition products in a scientific manner.*
2. *Inform patients how to determine potential dangers and benefits of fad diets and nutrition supplements.*
3. *Compile a data base of sound sources of diet and nutrition product information for personal and patient education.*
4. *Guide patients away from use of unnecessary nutrition products.*
5. *Teach patients how to make sound decisions when confronted with fad diets and claims.*
6. *Evaluate and apply scientific nutrition literature to clinical practice.*

Identifying Sound, Scientific Literature in Order to Evaluate Nutrition Claims

As a physician, you can help protect your patients from nutrition fallacies by identifying faulty conclusions from the literature and explaining their pitfalls during office visits. Anecdotal evidence and epidemiological research do not determine cause/effect relationships. Controls are needed so that only one variable is changed at a time before cause and effect is a valid conclusion.

Freedom of the press allows publication of any point of view, regardless of how inaccurate or outrageous it might be. Often, misinformation or claims designed to sell a product reach the public via the media. Lay people may not understand how to evaluate evidence to determine if a claim or conclusion has merit. They frequently accept as "truth" that which sounds logical to them. Physicians need to be able to identify sound, scientific evidence if they are to evaluate popular nutrition claims and help patients avoid nutrition fallacies.

Many nutrition fallacies are based upon anecdotal evidence. Such evidence should not be interpreted to prove cause and effect because variables are not controlled. It is appropriate to use anecdotal evidence, such as a series of case reports, to generate hypotheses. However, each hypothesis must be tested by an observational study which utilizes comparison groups. Only after completion of an observational study can an experiment be designed which attempts to identify cause and effect.

Some fad claims are based upon epidemiological studies which attempt to correlate factors between two or more populations. Scientists agree that such studies cannot be used to determine cause-effect relationships because controls are hard to achieve. When populations are compared, one should ask, "What factors are different between the populations in the study?" Differences in genetics, climate, lifestyle, and food intake are examples of variables which can skew the interpretation of epidemiological research.

If populations used in an epidemiological study are as similar as possible, one should ask, "How important is the influence of one variable upon another?" This can be approximated by squaring the correlation coefficient. For example, a correlation coefficient of 0.4 would suggest that 0.16 or 16% of the variation of one factor could be attributed to the other factor; i.e., 84% of the variation would be due to some other factor(s).

When experimental studies are critiqued, one should ask, "How many variables were changed and how were they changed during the study?" One should also ask, "Are the conclusions appropriate?" It is obviously misleading to test one variable experimentally and then apply the conclusions to another untested variable. Yet this kind of error often appears in the scientific literature.

When scientific literature is interpreted, regardless of which type of research is reported, health professionals must ask whether or not results are in conflict with knowledge already known about the subject. If not in conflict, results can be used to extend current knowledge. If results are in conflict, one must consider two possibilities: either reexamination of previous knowledge is necessary, or the authors have made an error in study design or interpretation. Careful review of the assumptions, approach, and interpretation should help determine which of these possibilities is most likely.

Recent articles which promote nutrition fallacies have begun to list references from journals which "support" their claims. Often, the studies cited contain conclusions which have been taken out of context. Some quotations are made from journals which were published a long time ago and ignore more recent research which does not support claims made. Other references cited are published in journals which are not subject to peer review. If the public is to be protected from such shams, the physician must be skilled at identifying faulty conclusions from the literature and explaining their pitfalls to patients.

Why There Are So Many Fad Diets

Most patients have followed one or more fad diets in an effort to achieve quick weight loss. Fad diets attempt to cure a weight problem, but they often do not change eating habits or promote lasting weight control. Understanding why fad diets are popular is a first step in redirecting patients toward healthful weight-control methods.

Bookstore shelves are crowded with books which promise "quick, easy, guaranteed" weight loss. People

try one diet after another in search of "the diet" which will allow them to achieve their goal. There are many reasons why diet books continue their widespread popularity even though little, if any, weight loss is achieved and maintained.

1. *Cultural Pressure.* Many people have a strong cultural value that they must be "thin" to be accepted, successful, or beautiful. Often, this is an emotional issue.
2. *Unrealistic Expectations.* Most people search for a "magic cure" which is relatively easy and promises quick results. They want to believe that easy weight control is possible. "I just haven't found the right diet yet."
3. *Advertising Pressure.* Advertising suggests that famous celebrities have achieved their success and attractive figures by following such plans. Consumers often believe these claims.
4. *Peer Pressure.* Peer pressure may convince people that "everyone goes on diets."
5. *Unrealistic Plans.* Unrealistic plans for weight maintenance result in weight gain once "the diet" is stopped. People become trapped in a vicious cycle as they try diet after diet in an effort to find one which produces lasting results.

Diets are viewed by most people as a temporary change in behavior. They perceive them as a quick and easy approach which allows them to continue to eat whatever appeals to them in unlimited quantities. Fad diets attempt to correct a weight problem, but they are unsuccessful because they do not permanently change eating habits.

Two plausible reasons fad diets may not work include the "set point" theory and the "visualization" theory. The "setpoint" theory suggests that people have an internal mechanism which regulates body weight. Fad diets generally do not effectively lower or maintain weight below the setpoint. Internal mechanisms appear to continuously work to return weight to the predetermined setpoint level. Regular exercise, however, may help lower the setpoint, while a diet of high-fat foods may raise the setpoint.[1]

The "visualization" theory suggests that people must be able to "visualize" themselves at their weight goal. If they do not do this, they will subconsciously find ways to regain weight to achieve the weight which they picture for "themselves." This occurs even if they consciously wish to weigh less.[2] Fad diets usually do not help people learn to visualize themselves at their weight goal.

Most fad diets fail because they are based on gimmicks which defy laws of energy and biochemistry. Some suggest weight can be lost by eating unlimited quantities of certain foods. Others explain the weight loss process using bizarre descriptions of how the human body digests food and stores or loses fat. Such descriptions may sound logical to those who are not familiar with digestion, absorption, and metabolism. Fad diets often fail because they are monotonous, unpalatable, socially unacceptable, and/or cause unpleasant and sometimes harmful side effects.

Diets Which Are Sound

Sound weight-reduction diets are ones which are individualized to a patient's usual way of eating, to lifestyle, and to food preferences. Behavior modification, visualization, diet follow-up, and an exercise program are critical components of successful, permanent-weight-loss diet programs.

Sound weight-reduction diets are ones which do not promise miraculous cures but which are individualized to a patient's usual way of eating, to lifestyle, and to food preferences. A well-planned weight-reduction diet must take into account a patient's physical activity level when calculating the number of calories allowed for the day's intake. Certainly calories ingested must be less than calories expended, or the patient will not lose weight. Sound weight-reduction diets should promote no more than 1-2 pounds of fat loss per week, and in general should not be less than 1000-1200 kcal/day for women nor less than 1200-1500 kcal/day for men. At levels less than these, meeting the RDA for vitamins, minerals, and protein is difficult. Recommendations from the *Guide to Good Eating*[3] are good to keep in mind when planning sound weight-reduction diets. The recommendations in the Guide will provide approximately 1200 kcal/day. It is also wise to remember that weight-reduction diets should contain a minimum of 100 grams of carbohydrate daily in order to prevent ketosis, unless the patient is monitored frequently for various blood tests. Behavior modification, visualization, diet follow-up, and an exercise program are critical components of successful, permanent-weight-loss diet programs.

The physician can ask several questions to determine if a diet is not sound. If the answer is "yes" to any of the

following questions, the diet may not promote permanent weight control and may result in undesirable side effects:

- Does it promote quick, effortless weight loss?
- Does it claim that unlimited quantities of food can be eaten?
- Does it claim that the rate of weight loss can be increased by use of certain "supplements" and/or combinations of foods?
- Does it claim success based solely on anecdotal evidence and testimonials?
- Does it claim that "spot weight reduction" of body parts such as thighs and tummy is possible? Is the term "cellulite" used?
- Does it contain a limited variety of foods? Is the calorie level less than 1000-1200 kcal/day? Does it contain less than 0.8 gm of protein per kg of ideal body weight? Does it provide less than 100 gm of carbohydrate per day?
- Does it emphasize one type of food at the expense of other foods?
- Does it recommend periods of fasting?
- Does it promote use of diuretics or laxatives?
- Does it focus on diet without emphasizing the need for permanent changes in eating (and exercise) habits? Does it fail to include a plan for weight maintenance?
- Does it fail to encourage frequent follow-up counseling sessions with a dietitian or physician trained in nutrition and behavior modification? Does it fail to use weight-control support groups when indicated?
- Does it fail to teach people how to visualize themselves at their weight goal?

It is impossible to keep up with the amount of fad weight-loss diets and diet pills which appear yearly. Over the past several years, diets have generally divided themselves into six basic categories. Table 20-1 has been developed to assist you in classifying old diets, current fad diets, and "yet to be developed" fad diets for weight loss. Without knowing everything about the diet you can identify advantages, possible problems, and fallacies concerning these diets. Table 20-2, in similar format, contains information that you should know concerning over-the-counter diet pills for weight reduction.

It is often appropriate to refer patients for assistance in weight loss to one of several community self-help groups or group diet programs. Table 20-3 provides an identification of the most popular weight-loss groups and offers a critique of each program for assistance in helping you fit patients into a group if appropria -

Redirecting the Patient to Use Sound Weight-Control Plans

Before the patient can make the critical choice of a sound weight-reduction diet over a fad weight-loss diet, a caring relationship between the physician and the patient must be established. Some patients may be skeptical of professional opinions about fad diets. Fad diets should be discredited without insulting the patient's intelligence.

As the physician, you are always in the business of health promotion and prevention of disease by directing patients to assume responsibility for their own health. Nowhere is this more evident than by assisting patients in achieving an appropriate weight for height. From experience you have learned that there are many positive ways (and there are other less positive ways) to approach patients regarding needed weight loss. Because it is essential to obtain the patient's consent and boost motivation to follow a well-planned weight-reduction diet before success can be achieved, the following important points should be remembered:

1. Patients must recognize that you care about them. A good relationship must be built before beliefs about "dieting" should be challenged.
2. Emotional needs of the patient must be met before scientific knowledge can be successfully used to discredit fad dieting.
3. It is helpful for you to identify benefits the patient expects from the fad diet. Alternatives can then be offered which help the patient achieve these benefits by using sound weight-control plans instead of fad diets.
4. The patient should be encouraged to compare the benefits of sound weight-control plans with the drawbacks and dangers of fad diets. Unnecessary

Table 29-1 What the Physician Should Know About Fad Diets

DIET CATEGORY	NAME OF DIET	HOW DIET WORKS	ADVANTAGES	POSSIBLE PROBLEMS	FALLACIES
Fasting	Fasting: The Ultimate Diet Fasting is a Way of Life	Rapid weight loss due to loss of lean body mass and fat	Dieter is encouraged by rapid weight loss of water which may be mistaken for loss of fat.	Hypoglycemia, neutropenia, hyponatremia, hypokalemia, ketosis, dehydration, increased uric acid levels, nausea, dizziness, facigue, alopecia, increased renal loss of phosphate and magnesium, negative nitrogen balance, loss of lean body mass, atrophy of organs such as the liver and heart, impaired cellular immunity, sudden death.[4] Does not educate the dieter how to maintain weight. Return to initial pre-fasting weight is likely once fast is stopped. If used, must be carefully monitored in a hospital setting.	Fasting cleanses the body of impurities. Fasting normalizes metabolism.
Low-protein, low fat, high-carbohydrate diets	Pritikin Diet	Calories are limited automatically since most of intake consists of vegetables, whole grains, and fruits Meat and fish are limited to 16 oz per week Only 10% of calories come from fat	Possible reduction of serum cholesterol, triglyceride, and uric acid levels. Promotes permanent changes in eating habits.	Unpalatable for those who enjoy meat (allows 2-3 oz meat/day). Extreme low fat level is difficult for most Americans to achieve, and is unpalatable for many. Nearly impossible to follow if one eats in restaurants. If protein intake is too low, it may increase risk of infection and result in poor wound healing. Possible negative nitrogen balance. Flatulence; possible iron-deficiency anemia since most iron is obtained from non-heme sources. Possible decreased absorption of trace minerals, calcium, and zinc due to increased intake of phytates.	Claims that the diet prevents degenerative diseases.
Ketogenic diets or low-carbohydrate (100 gm or less), high-protein, high-fat diets	Dr. Atkin's Diet Revolution Stillman's Diet DuPont Diet Air Force Diet Drinking Man's Diet Calories Don't Count Diet Dr. Charlton Frederick's Diet Beacon Hill Diet Scarsdale Diet	Rapid initial weight loss followed by slower but substantial weight loss. Highly effective diet due to low carbohydrate intake and reduced serum insulin level which inhibits lipogenesis	Reduced hunger, palatable, socially acceptable. Should only be used in conjunction with nutrition counseling and behavior modification.	Elevated serum cholesterol and triglyceride levels, ketosis, hyponatremia, hypokalemia, hyperuricemia, dehydration. Specific blood changes in calcium, thiamin, riboflavin, ascorbic acid, folate, and vitamin A. Dizziness, fatigue. Possible renal failure if inadequate fluid intake; bad breath Does not educate the dieter on weight maintenance. Diuresis promotes loss of vitamins and minerals which may not be replaced by the diet.	Claims that the diet promotes production of "fat-mobilizing hormone" which mobilizes fat stores and reduces ketones. Actually the caloric value of ketones produced and excreted in 24 hours rarely exceeds 100 kcal. Claims that unlimited calories can be eaten as long as ketosis is present. Actually caloric intake will probably be limited because of the appetite depressant effect of ketosis.

Table 20-1 What the Physician Should Know About Fad Diets (Continued)

DIET CATEGORY	NAME OF DIET	HOW DIET WORKS	ADVANTAGES	POSSIBLE PROBLEMS	FALLACIES
Liquid protein-sparing modified fast diets	Last Chance Diet	Very-low-calorie intake (600 kcal/day) which uses a liquid protein drink, Prolinn	Rapid weight loss during first few days. Patients like the fact that they do not have to make food choices or think about portion sizes.	Product contains low-quality protein which causes unacceptable danger. Protein-calorie malnutrition, cardiac muscle atrophy, arrythmias, cellular immune deficiency, severe ketosis, gout, hypokalemia, dehydration, vomiting, dizziness, diarrhea, muscle cramps, hypotension, psychological symptoms, alopecia, skin dryness, weakness, and fatigue have been reported.[5] One report of sudden death even though patient was receiving medical supervision.[5] Product is deficient in many nutrients. Monotonous, high attrition rate. Refeeding after use of low-quality liquid protein formulas results in redistribution of nutrients, sodium and water retention, increased catecholamine production, arrythmias, and the possibility of sudden death.	
	Cambridge Diet	Very-low-calorie (330 kcal/day) and very-low-carbohydrate intake promotes rapid loss of water in addition to loss of fat and protein. Consists of a powdered mix which is added to water. Use of Cambridge Diet or any high-quality protein liquid diet should be undertaken only under medical supervision. Periodic biochemical and ECG monitoring is needed.	Patients like the fact that they do not have to make food choices or think about portion sizes. Product is easy to mix Contains high-quality protein. Rapid weight loss during first few days. May decrease hunger, serum insulin, blood pressure, cholesterol, triglycerides, and serum glucose.	Nitrogen balance may not be attained until the 5th or 6th week of the diet or may not ever be attained in some individuals.[5] Severe protein losses are possible in some people, even though protein is of high quality.[6] Does not educate dieter on proper eating practices. Monotonous, high attrition rate. "Diet counselors" who sell the diet have not had formal nutrition training and may provide misinformation. Many diet participants do not seek medical supervision, as recommended by the company. Total compliance with the plan could result in moderate ketosis and fluid and electrolyte depletion.[5] Constipation, diarrhea in lactose-intolerant people, and alterations in menstrual cycle are common	Claims that use of such weight-control products is "the answer" to being overweight and will solve future weight-control problems. Claims that if one needs to lose only a few pounds it is OK to use this or a similar product for a few days.

Table 20-1 What the Physician Should Know About Fad Diets (Continued)

DIET CATEGORY	NAME OF DIET	HOW DIET WORKS	ADVANTAGES	POSSIBLE PROBLEMS	FALLACIES
One- or two-food diets	Skim Milk-Banana Diet Steak-Tomato Diet Egg-Wine Diet Fiber Diet Fruit Diet Kempner Rice Diet Zen Macrobiotic Diet Strawberry and Cream Diet Pumpkin-Carrot Diet Hot Dog Diet Egg and Orange Diet	If weight loss occurs, it is probably due to reduced caloric intake as a result of boredom, monotony, and an unpalatable meal plan.	None	Nutritionally incomplete; usually low in protein, vitamins, and minerals Boring, monotonous diet which does not educate the dieter on proper eating practices Death by malnutrition if followed long-term. High attrition rate. Health food supplements recommended by some of the diets are expensive.	Claims that refined sugar and refined flour are unhealthy and should be avoided. Actually, these foods may be eaten as long as excessive amounts are not used Some of these diets suggest that fiber lowers the number of calories one receives from food eaten. Claims that use of a high-fiber supplement will promote early satiety by increasing gastric distention Claims that certain foods, nutrients, or health food supplements have newly discovered, magical properties which promote weight loss Promotional materials often suggest that physicians are unaware of or unwilling to use these "breakthroughs." Kempner Rice Diet may be erroneously considered beneficial for the kidneys, blood pressure, and heart function.
Trick Your Body's Metabolism Diets or "Magic Ingredient" diets	Hilton Head Metabolism Diet Starch Blockers Fructose Diet Mannan Human Choronic Gonadatropin (HCG) K-28 Powder I Love N. Diet Fat-Off Diet Grapefruit Diet or Magic Mayo Diet	If weight loss occurs, it is due to reduced calorie intake. Health food supplements have no effect on promoting weight loss other than a short-term placebo effect.	None	Nutritionally incomplete resulting in possible protein, vitamin, and mineral deficiencies Some are "crash diets." Such diets are usually ineffective. If effective, would be hazardous to health because of nutrient inadequacy, nausea, vomiting, or diarrhea. Attrition rate is high. Does not educate dieter on eating properly for life-long weight maintenance. Any weight lost is usually temporary.	Implies that a particular food combination and/or health food supplement or enzyme will "melt off" or "emulsify" unwanted fat Frequently uses the meaningless term "cellulite" for unwanted fat Claims that the diet and/or supplement will inhibit food intake, remove toxic substances from the body and increase the metabolic rate, resulting in large amounts of quick weight loss. Promotional materials often suggest that physicians are unaware of or unwilling to use these "breakthroughs." Claims that grapefruit is a catalyst for burning fat

Table 20-1 What the Physician Should Know About Fad Diets (Continued)

DIET CATEGORY	NAME OF DIET	HOW DIET WORKS	ADVANTAGES	POSSIBLE PROBLEMS	FALLACIES
	Enzyme Catalyst Diet	Same as above	None	Same as above	Claims that raw fruits, vegetables, seeds, and plant juices provide the dieter with enzymes which trigger mitochondrial function, "melt accumulated fat," and allow fat to be washed out of the body. Actually, any enzymes in foods are digested to amino acids and play no enzymatic role once absorbed
	Lecithin, B_6, Vinegar, Kelp	Same as above	None	Same as above	Claims that lecithin emulsifies fat, B_6 metabolizes fat, and that vinegar flushes fat out of the body. Claims that vinegar is a good potassium source Actually, there are only 5 mg of potassium in 1 tsp of vinegar Claims that iodine in kelp causes the thyroid gland to produce more thyroxin and speed up metabolism
	Lipogene-GH Diet	Same as above	None	Same as above	Growth hormone dissolves fat and "cellulite" while you sleep. Actually the lipogene-GH tablets are amino acids. The body would have no way of knowing the difference between Lipogene-GH amino acids and those from steak or tofu.
	Body Clock Diet	Same as above	None	Same as above	Claims that people can lose weight while continuing to eat their usual foods if they eat earlier in the day.
	Dolly Parton Diet	Same as above	None	Same as above	Claims that food combinations recommended by this diet require more calories to digest than they actually contain. This is impossible!

Table 20-1 What the Physician Should Know About Fad Diets (Continued)

DIET CATEGORY	NAME OF DIET	HOW DIET WORKS	ADVANTAGES	POSSIBLE PROBLEMS	FALLACIES
	Beverly Hill's Diet	Same as above	None	In addition to the problems listed above, adherence to this diet could result in severe diarrhea, weakness, shock, hypotension, gout, and renal stones. Strenuous exercise could result in hypokalemia, dehydration, and cardiac arrythmias	Claims that undigested food gets stuck in the body and causes fat to be made Claims that sesame seeds are a good source of calcium and that fruit requires no digestive enzymes because they contain all enzymes needed for digestion. Claims that being overweight is caused by the combination of foods eaten. This is based on Shelton's 30-year-old food-combining theories. Claims that digestive enzymes for protein and carbohydrate cannot work at the same time, therefore carbohydrate and protein should not be eaten in the same meal. Claims that unlimited intake of french fries will not produce weight gain as long as fresh pineapple is eaten the next day.

Table 20-2 Information Physicians Need to Help Patients Evaluate Weight-Reducing Aids

WEIGHT-REDUCING AID	*CLAIM*	*CRITIQUE*
Weight-reducing candies such as Aydes	If taken before a meal, they curb the appetite by raising the blood sugar and dulling the taste buds.	Those that contain about 25 kcal per candy have little effect on blood sugar levels. Directions often suggest dieters should drink a hot beverage while eating the candy. Any short-term satiety is probably due to the beverage, not the candy. See "Anesthetic-containing diet pills" for comments about benzocaine which is an ingredient in some candies.
Phenylpropanolamine-containing diet pills such as Appedrine, Dexatrim, Dex-a-Diet, Permathene-12, Prolamine, Super Ordinex	Easy weight loss without hunger.	Works as an appetite suppressant for 2 to 3 days; then a tolerance to it develops and it is no longer effective. Rebound appetite may occur once tolerance is established, resulting in greater food intake and weight gain. Such products often contain caffeine. Side effects include hypertension and CNS effects; also may interfere with glucose tolerance in those who have diabetes. Should not be used by people diagnosed with hypertension, thyroid disease, depression, nervousness, or by those who are under age 12, pregnant, or breastfeeding.
Fiber-containing diet pills such as Glucomannan, grapefruit pill, Super Mannan	These products "swell up" inside the stomach and decrease hunger.	The pills are very small; combined with even large amounts of water they could not fill the stomach enough to cause satiety. No scientific evidence supports this claim.
Anesthetic-containing diet pills such as Slim Line (also contains fiber and sugar)	They work by anesthetizing the taste buds and decreasing the flavor of food, helping one eat less.	Usually contain benzocaine or lidocaine, which have no effect on appetite or food consumption.
Sugar-containing diet pills such as Slim Line, Slim Fast	They curb the appetite by raising the blood sugar.	Elevation in blood glucose is usually minimal. If blood glucose is raised significantly, rebound hypoglycemia may occur and stimulate the appetite.

Table 20-3 Information Physicians Can Use to Help Patients Evaluate Diet Programs

PROGRAM	*CRITIQUE*
Diet Center	This program emphasizes quick weight loss. The diet provides approximately 1000 kcal/day and is combined with daily counseling, if desired by the client. People are encouraged to take a Diet Center Supplement four times a day. The supplement contains B-vitamins (at megadose levels), protein, and sugar and is supposed to raise the blood sugar to a level which decreases appetite. No scientific evidence indicates that such a supplement is effective other than to provide a short-term placebo effect. The expense of the supplement is probably not justified. This type of program tends to teach people that weight control is a temporary effort rather than a life-long change in eating habits. This program is more expensive than weekly visits to a registered dietitian for weight-control counseling.
Nutri-System	Clients who follow this program eat Nutri-System's prepackaged meals to control their caloric intake. Food preparation and menu planning are done for clients, thus they do not learn how to make wise food choices. This is a major drawback which "sets the client up" for rebound weight gain once the program is discontinued. Weekly counseling is provided for an additional fee. This program is more expensive than weekly visits to a registered dietitian for weight-control counseling.
Overeaters Anonymous	People who belong to this organization view overeating as an addiction which cannot be cured. Meetings are modeled after Alcoholics Anonymous and may appeal only to those who see themselves as "compulsive eaters." Low-calorie diets may be give to members, but the majority of time is spent discussing ways to control eating behaviors. Members may not learn how to make wise food choices. There is no set fee.
TOPS (Taking Off Pounds Sensibly)	Members of this women's organization attend weekly meetings to receive group support and set weight-loss goals. Quality of group sessions varies depending upon the skills of the leader. People may be "turned off" by weekly weigh-ins which are not kept confidential. Those who do not lose weight may be "put on the spot" and embarrassed. Members frequently admit that they avoid eating and drinking the day prior to a meeting so they lose weight. It is not uncommon for groups to go out for dessert after each meeting to celebrate by overeating! Unfortunately, this approach does not promote change in eating habits.
Weight Watchers, Inc.	This organization offers several diet plans which are based upon the diabetic diet exchange lists. Many health professionals recommend this program. Safe weight loss is encouraged. Members attend weekly meetings to obtain group support, recipes, and weight-loss tips. Weight maintenance diets are provided when weight goals are reached. The company sells a variety of lower calorie foods, cookbooks, and magazines which members may be encouraged to buy. Cost of the program varies depending upon the number of products purchased by the client.

cost, long-range ineffectiveness, and potential harm to health are factors which may help convince the patient.

5. Patience and reinforcement of weight loss during several office visits will probably be necessary.
6. A confrontation with the patient should be avoided if at all possible when trying to change erroneous beliefs.
7. Some patients will be skeptical of professional opinions about fad diets. The public has been led to believe that physicians discredit fad diets because they conspire to withhold "the key" for weight loss. These are the most difficult patients to work with and require more effort before they trust your opinion.[7]

The material in Appendix A may help even the most skeptical of patients to consider the merits and possible problems of fad diets. This handout should be of value to your patients in educating them to decide for themselves whether or not what they read or hear regarding specific nutrition and food claims is or is not valid.

Fad Diets and Adolescent Girls — An Example

Use of fad diets is of particular concern among adolescents. Physicians can be instrumental in guiding adolescent patients away from fad diets toward use of healthful weight-control measures. Development of sound attitudes about the pitfalls of fad diets can benefit adolescents throughout their lives.

As a result of "thin is in" peer pressure, as many as one in three teenage girls is on a "diet." Often, one crash diet after another will be tried as girls search for an easy, magical route to achieve their perceptions of "ideal weight." Fad diets are used by overfat teenagers as well as those who are not significantly overfat but are preoccupied with their body image.

Adolescence is a period of growth and is not the appropriate time for restrictive caloric intake. While it is difficult to objectively determine damage to health caused by teenage fad diets, inadequate intake of nutrients and calories cannot promote optimum development. At least 1600 kcal/day should be eaten by girls who are actively growing and have not yet reached menarche.

For overfat teens, the goal should be to prevent additional weight gain and allow them to "grow into" their weight (for example, a 5'1", 140 pound, 10-year-old can achieve a more desirable level of fatness by maintaining weight at 140 pounds while growing to 5'5" at 14 years of age). Girls who have reached their adult height should eat at least 1200 kcal/day.

Prevention of obesity or overfatness in teens may best be accomplished by regular aerobic exercise rather than diet.[8] This is especially true for children who are so inactive that overfatness occurs even though food intake is normal.[9]

Diet recommendations should be limited to use of lean meats, low-fat dairy products, fruits, vegetables, breads, and cereals. Frequent use of calorie-dense foods (desserts, soda pop, chips, high-fat foods) which provide few vitamins and minerals should be discouraged. Lower calorie alternatives which appeal to teens include sugar-free soda pop, beverages sweetened with aspartame (Nutra-Sweet), frozen pudding bars, frozen gelatin pops, unbuttered popcorn, and angel food cake.

Exercise provides several benefits for weight control. With exercise, food intake may decrease or increase slightly (but usually not enough to offset the energy expenditure of exercise). Metabolic rate increases during exercise and results in greater caloric expenditure. As regular exercise increases the percentage of lean body mass, metabolic rate is elevated. Exercise also may regulate fat cell size and delay or inhibit increases in fat cell numbers during adolescent growth.[10,11] Yet another benefit of exercise is its ability to lower the body's setpoint (the theoretical control mechanism which regulates body weight and fat). The following guidelines may be helpful when recommending an exercise program for adolescents[8]:

- Exercise should be fun, vigorous, and focused on activities that can be easily practiced throughout life so that the habit of regular exercise is developed.
- Frequency and duration of exercise are more important than the speed at which it is done. One-half hour of aerobic exercise done 3-4 times a week (or more often) is desirable.
- Walking, bicycling, and swimming are good exercises for those who are out of condition.
- Group exercises such as aerobic dance may appeal to some. Groups which meet 2-3 times a week for workouts which include flexibility, warm-up, aerobic, and cool-down exercises are effective.

Helping Patients Avoid Nutrition Quackery

It is helpful if the physician understands why patients, including adolescents, believe nutrition misinformation. Once a trusting relationship is established, the physician can reinforce positive behaviors and encourage the patient to select nutrition therapies that are based upon scientific evidence and which can be practiced for a lifetime.

There are several reasons nutrition misinformation is prevalent. Well-meaning people believe they help others when they give testimonials explaining their "success" using "nutritional therapies."

People may be encouraged to self-diagnose and treat "conditions" or potential illnesses. "Diseases" may be invented which explain minor aches, pains, and symptoms. Magical cures often are more reassuring than scientific facts. Justification for use of "nutrition products" may contain a few facts woven together with much nonsense, all of which may sound surprisingly logical.

Some may not recognize that many minor ailments improve with time, regardless of the treatment (or lack of treatment) used. They often assume that "the remedy" caused the cure when actually they would have recuperated without treatment. Lack of understanding of the placebo effect compounds this problem. Some believe, "Just because it didn't work for you doesn't mean that it might not work for me."[12]

Promoters of nutrition misinformation appeal to personal concerns and make every effort to meet customers' needs. The media often perpetuate nutrition fallacies. Media personnel and non-medical persons seldom challenge the credentials of self-proclaimed experts or demand that claims be subject to peer review. Also, when results of scientific studies are reported, these persons may misinterpret, twist, or exaggerate claims.

Patients' beliefs about nutrition and use of nutrition "supplements" are deep-seated and difficult to change. The most effective method is a common-sense approach which takes into account the patient's beliefs about nutrition and dieting.

Once a trusting relationship between patient and physician is established, the physician can encourage attitude change while reinforcing positive behaviors. Confrontation of an undesirable practice may make the patient even more resistant to change. See the section, "Redirecting the Patient to Use Sound Weight-Control Plans" for more ideas, and Appendix A for a useful patient handout.

Evaluating Claims About Nutrition Products

Answers to key questions are useful when evaluating claims made about nutrition products. Claims such as "richest source of a nutrient," "overcomes a deficient diet," "natural and organic," "aids in digestion," "it works for me," or "has no toxic side effects" should be red flags to physicians and patients that the product may not be legitimate.

Advertisements and labels for nutrition supplements and products make claims which often seem quite logical. However, each product should be evaluated according to the following questions to determine if claims are legitimate.

1. *Is the product really a good source of nutrients?*
   Even though a supplement is a rich source of nutrients, it may not contribute significantly to the overall nutriture of a person. Determine how much of the product one would have to take to replace a food source which is rich in the same nutrient. For example, proponents of bee pollen claim it contains more protein than beef, eggs, or cheese. Information obtained from product literature suggests one would have to take approximately eight tablespoons of bee pollen to provide the same amount of protein found in one ounce of cheese. Two tablespoons is the seller's recommended dose per day. This is hardly a significant contribution to protein intake (and is an expensive protein source)!
2. *Are nutrients provided by the product actually deficient in the user's diet?*
   Once an adequate intake has been achieved, additional nutrients are unnecessary and do not participate in their usual functions. For example, excess proteins (amino acids) are burned for energy or stored as fat; vitamins taken in excess will produce a pharmacologic action.
3. *What words are used to describe the product?*
   Many products are labeled "natural" or "organic."

These terms have no real meaning. The human body cannot tell the difference between a natural or synthetic source of a nutrient. Organic products supposedly have been grown in soil which has not been exposed to pesticides and herbicides. There are no laws which govern use of the term "organic," and products labeled as such are often from the same fields as products not labeled "organic." The cost of "organic" products may be 2 to 6 times that of a similar "non-organic" product.

4. *Does the product claim its nutrients are more potent than those from other food sources?*

The body recognizes nutrients by their chemical structure. For example, in general there is only one chemical formula for each vitamin which the body recognizes and can use. It is not possible to create more potent forms of vitamins, minerals, protein, and other nutrients. Product labels which claim "high potency" benefits are meaningless and mislead the consumer. In addition, some products are inactive, although advertisements may say they function as active substances. Some products are even made up of substances which are falsely advertised to be essential to humans. While it is true that there are different forms of some substances (calcium, for example, as calcium phosphate, calcium carbonate, and calcium gluconate) many advertisements do not differentiate between these forms nor indicate they are absorbed to various degrees.

5. *Do claims make sense when compared to mechanisms of human digestion, absorption, and metabolism?*

Many fad products, if they were effective, would have to distort or contradict laws of biochemistry which regulate utilization of food in humans. Literature of one "digestive aid" claims that people should use the product when they overeat to "supplement" the body's digestive secretions. Health professionals know that people produce more digestive enzymes than are needed, even if they have eaten too much. Enzymes taken by mouth are digested (like any protein) and have no enzymatic activity. Such a digestive supplement would be of no use.

6. *What kind of evidence is propagated to justify use of fad products?*

Fad products usually rely on anecdotal information, testimonials, and uncontrolled studies to support use of the products. Some companies include impressive reference lists with citations from respected professional journals in their product literature. Unfortunately, many of these studies have been taken out of context or have been used to make premature conclusions from insufficient data.

7. *What is the potential for harm?*

Undesirable effects from use of fad products vary. Some products cause no physical problems, but they may encourage self-diagnosis and treatment of known medical problems. Other products cause significant side effects. For example, lecithin (used by maturing adults to improve memory) can cause gastrointestinal distress, dizziness, anorexia, depression, and other symptoms. Potential for provoking such side effects underscores the importance of asking questions about use of nutritional supplements and products when interviewing patients.

Table 20-4, Nutritional Supplements — Fact or Fiction, includes information which will help you evaluate several popular nutrition supplements.

Little Known Dangers of Herbal Teas

The physician should be familiar with the potential dangers of herbal teas. There are no regulations which ban the sale of potentially dangerous herbal products. Physicians should advise patients to avoid herbal teas unless ingredients are listed, and to drink only those which are safe.

Popularity of some herbal teas should be cause for concern among health professionals. Health food stores and some supermarkets sell a wide variety of herbs and herbal teas, including some which can be dangerous or cause undesirable side-effects. Unfortunately, the public believes that all herbal teas are wholesome. Actually, there are no regulations which ban the sale of potentially dangerous herbal products.

Companies are not required to list herbal tea ingredients, and many do not. There are no standards of quality, and various samples of the same herb mixture may contain different quantities of ingredients. The best advice a physician can offer is to suggest patients buy only those herb products which list all ingredients. People should avoid products which contain herbs listed in the patient handout (Appendix B).

The literature reports several cases of illness resulting from use of herbal tea. One 65-year-old man developed reversible agranulocytosis after taking a Chinese herbal tea "cure" for arthritis. When the tea was analyzed it contained phenylbutazone, phenacetin, aminopyrine, and mercuric sulfide.[25] A young woman developed ir-

Table 20-4 Nutrition Supplements — Fact or Fiction

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
Alfalfa powder or tablets[13]	Contains the proper balance of nutrients. Contains natural estrogens which cure circulatory problems. Relieves symptoms of diabetes and arthritis.	Greatly overpriced. The same nutrients are found in less expensive foods. May produce a hypocholesterolemic effect due to saponins which reduce intestinal absorption of cholesterol; additional research is needed in this area. No scientific evidence supports use for diabetes or arthritis.	Encourages self-diagnosis and treatment of medical problems. No long-term studies are available on toxicity of alfalfa in humans.
Bee pollen[14]	The only "perfect food." Provides youth, health, and vitality. Provides energy for athletes. Contains all essential nutrients. A general "cure all."	Greatly overpriced. The same nutrients are found in less expensive foods. No scientific studies support claims that its use relieves illness, provides special health benefits, or enhances athletic performance. All evidence is anecdotal.	May trigger gout or renal stones (due to nucleic acid content) in susceptible persons. Allergen potential can trigger systemic reactions or anaphylactic shock.
Bone meal powder or tablets[13]	Prevents bone fractures.	Contains greater than 1000 mg calcium per teaspoon. Made from ground bones of inspected, slaughtered animals.	May contain arsenic and lead. Content of bone meal is variable, depending on diet and environment of animals.
Brewer's yeast[13]	A "health" food	Provides B-complex vitamins, nucleic acids, selenium, and chromium. Chromium is present in the organic form. May improve glucose tolerance and lower serum cholesterol; additional research is needed in this area.	May trigger gout or renal stones (due to nucleic acid content) in susceptible persons.
Carob powder[13]	A healthier alternative to chocolate. A "diet" food	A substitute for cocoa. Does not contain the stimulant, theobromine, found in cocoa. It is higher in calories than cocoa.	People may assume that a food made with carob is a low-calorie food.
Cranberry juice[13]	Reduces risk of urinary tract infection	In theory, it contains a precursor of hippuric acid which is a strong anti-bacterial agent in urine. Actually, effective levels of hippuric acid cannot be achieved In palatable quantities, it does not consistently lower and sustain urinary pH.	Unpalatable and high in calories if used in large quantities.

Table 20-4 Nutrition Supplements — Fact or Fiction (Continued)

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
DHEA (dehydroepi-androsterone)[15]	Enhances sex life. Promotes longevity. Helps with weight loss Prevents cancer and heart disease. Cures diabetes.	A precursor of sex hormones made by the human body. DHEA prevents obesity and promotes weight loss in rats. Prevents the development of certain cancers in mice. Helps control diabetes in mice. May be useful as a drug someday but more research is needed. No research shows that DHEA has the same effects on humans as it does on rats and mice. Supplements usually contain insignificant levels of DHEA. Most products do not have the actual content of DHEA listed.	Has not been systematically tested in humans. Can alter levels of sex hormones Has toxic side effects. Supplements which contain high levels of DHEA may be dangerous for pregnant women. Long-term effects are unknown.
Digestive aids	Supplements the body's secretions. Aids in the utilization of food. Relieves digestive distress. Needed when one overeats or when rumbling and flatulence occur one hour after eating (indicates food is not being digested properly). Prevents proteins from putrefying in the intestine, starches from fermenting, and toxin production.	Contains pancreatic enzymes, pepsin, bile, and/or hydrochloric acid. Most people do not need such a supplement since the body produces more than is needed. In cases of malabsorption due to pancreatic enzyme deficiency, more appropriate prescription supplements are available. Rumbling and flatulence do not indicate that food is being improperly digested. Few people have difficulty digesting protein and starch. Toxins are not formed from these nutrients.	Encourages self-diagnosis and treatment of medical problems.
Dried cruciferous vegetables with beta carotene	Decreases risk of cancer by inhibiting carcinogens. Those who have poor eating habits or do not like vegetables should take this supplement.	Contains dried cabbage, broccoli, cauliflower, brussels sprouts, and beta-carotene. An expensive source of these vegetables. Based on the National Academy of Sciences' report, "Diet, Nutrition and Cancer," cause and effect relationships between food and cancer are impossible to establish. If this minimizes risk, the quantity needed to do so is unknown.	Implies that everyone should take these tablets to prevent cancer.
Fructose[2,13,16]	Promotes weight loss Natural replacement for sugar. Should be used instead of sugar in the diet for diabetes.	Does not improve blood glucose levels in diabetes when blood sugars are poorly controlled or when obesity is present. Provides a flatter blood glucose response than sucrose when used in controlled diabetes. No scientific evidence to support the role of fructose as a weight-reduction aid.	It is not calorie-free. Many "dietetic" foods made with fructose contain as many calories as similar products made with sucrose. The public assumes incorrectly that they are low-calorie foods. A large dose (70-100 gms) can cause abdominal pain, diarrhea, and increased serum uric acid levels.

Table 20-4 Nutrition Supplements — Fact or Fiction (Continued)

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
Gerovital H-3[14]	Effective against arthritis, atherosclerosis, angina, deafness, neuritis, Parkinson's disease, depression, Alzheimer's disease, senility, and impotence. Stimulates hair growth. Re-pigments gray hair.	Many uncontrolled studies have been done, but double-blind, controlled studies do not show improvement in mental or physical status of the elderly.	Sensitivity reactions to the ingredient, procaine, may occur.
Ginseng[13,14]	A tonic for digestive troubles; a stimulant and aphrodisiac. Increases resistance to infection and disease. Protects against air pollution and radiation. Increases stamina, relieves stress, lengthens life, normalizes blood sugar, and lowers blood cholesterol. No side effects.	All evidence is anecdotal. Much is unknown about the herb, its harmful effects, and its interactions with other substances. Is not on FDA's list of "generally recognized as safe" ingredients.	Ginseng Abuse Syndrome is possible. As little as 3 grams result in hypertension, insomnia, nervousness, feelings of depersonalization, confusion, depression, skin eruptions, edema, and diarrhea. Abrupt withdrawl may result in hypotensive crisis. May have an estrogen-like effect on the vaginal mucosa, producing vaginal bleeding; can also cause mastalgia with diffuse mammary nodules in post-menopausal women.
Glucomannan[16]	Used by the Japanese to promote weight control. Decreases food absorption by stimulating transport through the gastrointestinal tract.	An extract from the konjac root. No scientific studies document its effectiveness. All information is anecdotal.	An expensive weight-loss gimmick which results in frustration when failure to lose weight occurs. If it works, it would cause severe diarrhea.
Herbal preparations[14]	A general "cure all." Combinations of certain herbs are more effective than single herbs.	Quality control is poor and products may be contaminated with weeds and other agents. Many products are labeled incorrectly. No scientific evidence supports the claim that some herbs are synergistic.	May contain agents which cause allergic reactions and cardiovascular toxicity. May contain stimulants, carcinogens, teratogens, and poisons. Chinese herbal products have been found to contain lead and arsenic. Should not be used during pregnancy. (See Patient Handout, Appendix B.)

Table 20-4 Nutrition Supplements — Fact or Fiction (Continued)

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
Honey[13,16]	It is more nutritious than sugar. It is a natural sugar which provides quick energy. It should be used instead of sugar in the diet for diabetes.	Contains a mixture of glucose and fructose with only traces of other nutrients. Although honey has more vitamins and minerals than table sugar, these quantities are not nutritionally significant in the amounts usually eaten. No scientific evidence supports the claim that it is a quicker energy food than other carbohydrates.	Diabetics who ingest honey are, essentially, consuming sugar, which may result in poor blood-sugar control. Infants under one year of age are susceptible to botulism if fed honey.
Lactobacillus acidophilus tablets and powder[13,14]	Maintains a good "balance" of bacteria in the intestine. Inhibits toxin-producing bacteria in the colon. Used for "detoxification." Maximizes food absorption. Is a "natural" antibiotic. Sweetens the breath. Stimulates the immune system. Can be digested by lactose-intolerant people.	No in-vivo research in animals or man has been conducted. In theory, the Lactobacillus bacteria create an acid environment in the bowel by producing lactic acid from lactose. Some bacteria cannot live in an acid environment. Effectiveness is questionable. If taken without milk products the Lactobacillus bacteria may not survive. Sweet acidophilus milk may be useful for lactose-intolerant people. A more economical alternative is Lact-Aid, a powdered lactase enzyme.	May decrease the metabolic activity of fecal microflora, associated with a higher incidence of bowel cancer.
Lecithin and choline[13,16]	Cures or prevents arthritis, gallstones, heart disease, nervous disorders, and skin problems. Improves memory. Lowers blood cholesterol. Aids the digestion and absorption of fat. Promotes weight loss	Widespread in the food supply and can be made by the body. Supplements are not needed and become merely an additional energy source. Commercial lecithin contains only 20-30% lecithin It is an FDA-approved food additive used as a stabilizer and emulsifier. No scientific evidence exists that lecithin supplements promote weight loss. Humans may be unable to absorb intact lecithin, explaining why it appears to be of no benefit when taken orally. Lecithin may increase levels of high-density lipoproteins.[17] Use of lecithin may improve tardive dyskinesis and Huntington's Chorea[18]	Can produce acute gastrointestinal distress, diarrhea, sweating, salivation, dizziness, anorexia, depression, supersensitivity of dopamine receptors, a fish-like body odor, and disturbance of the choline-dopamine-serotonin balance.

Table 20-4 Nutrition Supplements — Fact or Fiction (Continued)

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
Liver tablets	An excellent source of vitamins and iron. Helps build red blood cells.	Contains dried liver An expensive source of vitamins and iron. For example, it takes as many as 10 tablets to provide the nutrition value of one ounce of fresh liver.	Encourages self-diagnosis and treatment of medical problems.
Protein powders, liquids[16] and tablets[16]	The more protein eaten, the more nutritious the diet Protein improves physical performance, promotes weight loss, and is not fattening. Certain amino acids taken in tablet form control pain.	Products may be of high or low quality (in terms of amino acid content). Once the body's protein needs are met, additional protein is of no value in building muscles, improving performance, or promoting weight loss. Excess protein is converted to fat. An excessive intake of protein can contribute to weight gain. No amino acid, taken alone or in combination, provides curative powers or pain relief.	Excessive protein intake can result in dehydration and increased loss of calcium which can trigger gout or renal stones in susceptible persons.
Seaweed (Kelp)[13] (Also see Spirulina)	Contains large quantities of high-quality protein as well as many other nutrients. Cures constipation and mucous colitis; prevents atherosclerotic heart disease. Promotes weight loss. Protects against radiation sickness. A "natural" source of iodine.	Most seaweeds are not good sources of protein. Names of seaweeds include agar-agar, algae, carrageenan, dulse, Iceland moss, Irish moss, kelp, laver, rockweed, and sea lettuce. Claims for curative properties of seaweed have not been substantiated by scientific studies. The human body cannot distinguish between "natural" iodine and other sources of iodine	Taken in excessive amounts can result in iodine toxicity.
Spirulina[13,14]	Promotes weight loss by decreasing appetite, a "natural" diet pill. Contains vitamins which are more potent than other sources of vitamins. Cures hypoglycemia, hay-fever, diabetes, anemia, liver disease, and ulcers. Provides quick energy. Contains all nutrients needed to support human life. A good source of vitamin B_{12}.	Contains good quality protein, but is greatly overpriced. Few people can afford to eat nutritionally significant amounts. (The amount of protein in $0.70 worth of peanuts would cost $10-23 if purchased as spirulina). Most of the vitamin B_{12} is in an analog form which has no vitamin activity in man. No scientific evidence exists to suggest that it is useful for treatment of any condition other than that it may have a hypocholesterolemic effect.[19] Safe consumption has not been adequately tested. Does not provide quick energy One vitamin source is not more potent than another vitamin source.	Advertisements may not indicate the source of the product; some sources are toxic, resulting in nausea, vomiting, and anorexia. Some may also trigger gout or renal stones (due to nucleic acid content) in susceptible persons. Vitamin B_{12} analogs may be harmful

Table 20-4 Nutrition Supplements — Fact or Fiction (Continued)

PRODUCT	*CLAIMS*	*FACTS*	*CONCERNS*
Starch blockers	Promotes weight loss by inhibiting the enzyme which digests carbohydrate. Encourages unlimited intake of starch.	Now classified as a drug by FDA and banned from sale. Scientific studies show that starch blockers do not reduce absorption of carbohydrate if taken prior to meals.[20] Conflicting evidence exists regarding the effectiveness of starch blockers taken during meals.[20,21] Starch blockers may not work in vivo because: (a) pre-incubation of the enzyme inhibitor with amylase is not possible;[22] (b) the pancreas secretes much more amylase than is needed for digestion of starch;[20] (c) gastric acid may inactivate the starch blocker;[23] and (d) starch may be hydrolyzed by an alternative route which is not affected by the starch blocker.[24]	Side effects may include nausea, vomiting, diarrhea, stomach pain, and flatulence. At least 30 hospitalizations have resulted from use of starch blockers.
Superoxide Dismutase (SOD)[13,16]	Reverses aging and degeneration. Prevents cancer. Lessens the effects of air pollution.	SOD is an enzyme found in cells of all oxygen breathing animals. It protects cells from free radicals that damage DNA. Scientists do not understand the complete picture and claims for its use are premature. Parenteral use of certain forms of SOD looks promising, but more research is needed.	Potential side effects are unknown.

regular menstrual bleeding due to reduced serum clotting factors. The cause was linked to heavy intake of an herbal tea which contained natural coumarins. While several other factors could have contributed to her problem, use of the tea probably had a major effect.[26]

Use of herbal teas in the clear liquid diet for management of acute diarrhea should be discouraged since several herbs can aggravate diarrhea. Patients with perplexing symptoms should be questioned about their consumption of herbal teas. If heavy usage has occurred, it may be of value to have the product analyzed to determine the presence of pharmacologic substances which could trigger the problems. Table 20-5 includes a summary of some pharmacologic effects caused by herbs.

Summary

Use of fad diets and nutrition supplements can be harmful to health and, at the very least, in many cases, they are a waste of money. Americans spend millions of dollars each year on the false belief that they are attaining a higher degree of health by use of such diets and products. Physicians can be influential in helping patients make wise decisions when they are confronted with nutrition claims. The prosperity of nutrition quackery can be reduced significantly if consumers, through their physicians, learn how to better evaluate diet and nutrition products.

Table 20-5 Pharmacologic Actions of Commonly Used Herbs

HERBS AND PHARMACOLOGIC ACTIONS	ADDITIONAL TOXIC EFFECTS
Abortifacients Claw's root Devil's root Pennyroyal	Can induce spontaneous abortion in pregnant women.
Allergenic Agents Chamomile Goldenrod Marigold St John's Wort Yarrow	Chamomile may trigger rhinitis, skin reactions, or anaphylactic shock in persons allergic to ragweed, asters, chrysanthemums, or other members of this plant family. Persons allergic to chamomile should avoid all herbs listed in this category. St John's Wort may trigger delayed hypersensitivity reactions.
Anti-cholinergic Agents Burdock root and seeds Catnip Horsetail Hydrangia Jimson weed Juniper Lobelia Shave grass Wormwood	Burdock produces severe symptoms with as little as 1/2 cup of tea Shave grass and Horsetail contain nicotine and thiaminase When eaten by animals, bizarre CNS symptoms and a syndrome similar to beriberi have resulted. Acute neurotoxicity.
Carcinogens Sassafrass	Sassafrass contains safrol, a potent carcinogen, banned from use in food by the FDA
Cardiovascular Toxicity Ginseng Licorice root	Ginseng can cause hypertension and edema. Large amounts of licorice can cause edema, hypokalemia, hypertension, and congestive heart failure
Cathartics Aloe leaves Buckthorn bark Dock root Ginseng Senna	These herbs can cause severe diarrhea. Use of senna has resulted in death in Africa.
Coumarins Melilot Tonka beans Woodruff	Contain natural coumarins which can interfere with normal blood-clotting mechanisms.
Diuretics Buchu Dandelion Juniper Quack grass	Buchu, quack grass, and dandelion produce a mild diuretic effect and are considered harmless. Juniper is a diuretic which can irritate the GI tract
Estrogen Activity Ginseng	Ginseng may cause swollen and painful breasts. Mandrake is often sold as ginseng and contains a hallucinogen Reserpine is also sold as ginseng and can lower blood pressure
Hepatotoxins Comfrey Sassafrass	Comfrey contains several substances that are potentially toxic to the liver. Side effects take several years to appear. Habitual use of comfrey tea, especially if made from the root, has potential for serious health hazard and should be discouraged.[29] Sassafrass inhibits certain liver microsomal enzymes. Secondary toxicity could develop if drugs usually metabolized by these enzymes are given [30]
Toxins Foxglove Indian tobacco Inkberry Mistletoe Pennyroyal Pokeweed	Foxglove and pokeweed can cause death. Indian tobacco contains a CNS stimulant and can cause sweating, vomiting, paralysis, hypothermia, coma, and death. Inkberry can cause gastroenteritis, diminished respiration, and death, especially in children. Mistletoe can cause gastroenteritis.

Many herbal teas are rich in tannins which can bind, inactivate, or delay absorption of nutrients and certain drugs. Excessive use of any herbal tea should be discouraged.

For additional information: Tyler, V.L. *The Honest Herbal. A Sensible Guide to the Use of Herbs and Related Remedies.* Philadelphia: George F. Stickley Co., 1982.

Evaluation

To become a patient advocate in the area of nutrition products and fad diets requires that you be familiar with the environment in which patients are making nutritional decisions. To raise your level of awareness of your patient's "nutrition environment," do the following exercises, then discuss them with fellow residents, faculty, and available nutrition specialists.

1. Get to know your surroundings. Check the yellow pages of your phone directory for the presence of health food centers and diet and weight-loss clinics in your area. Visit some of these centers and clinics. Remember, if a center or clinic is in your practice area, it means there is a market for its services. Also visit supermarkets in your area. Many supermarkets now contain diet and health food sections. As you visit these centers, clinics, and stores, ask the following questions:
   A. What types of claims are being made for products and services offered?
   B. Are the services and/or products being offered of value?
   C. Are the services and/or products being offered priced appropriately?
   D. Would you, in general, classify the environment in which your patients live as one which encourages nutrition faddism?
2. Visit your local bookstores, magazine stands, and supermarkets. Buy and read some of the "diet" books being promoted. Look for references to diets in popular magazines. Assess the quality and quantity of nutrition information available to your patients via the popular media.
3. Prepare a display for your office waiting room, presenting your own set of nutrition do's and don'ts. Include a recommended diet book and diet article list and other information which may be used in patient education.

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   Contains timely, sound articles about topics related to nutrition.
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   Uses a question and answer format to present information about weight control and the folly of food fads in addition to other topics.
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    Uses a question and answer format to present information about teenage nutrition problems, realistic weight control, "natural" and "organic" foods, "how to spot a nutrition quack," and "where to get reliable advice."
11. Stare, F.J.: *Dear Dr. Stare: What Should I Eat? A Guide to Sensible Nutrition.* Philadelphia: George F. Stickley Co., 1982.
    Guides the reader through a maze of health and nutrition information.
12. Tyler, V.L.: *The Honest Herbal. A Sensible Guide to the Use of Herbs and Related Remedies.* Philadelphia: George F. Stickley Co., 1982.
    Uses scientific documentation to support or dismiss herbalist's claims in clear, non-technical language. Helps the reader decide whether an herb is potentially useful, of no value, or potentially hazardous.
13. *Tufts University Diet and Nutrition Letter.* Newsletter issued monthly by Tufts University Diet and Nutrition Letter, 322 West 57th St., Box 2465, Boulder, CO 80322.
    Contains timely, sound articles about topics related to nutrition.
14. Popular magazines are often a source of nutrition information for the public. The American Council on Science and Health scored many magazines on the reliability of their articles on nutrition.

Following are the results (1982):

Magazine	*Accuracy on Nutrition*
50 Plus	100%
Parents	97%
Redbook	97%
Reader's Digest	95%
Good Housekeeping	93%
Glamour	80%
Vogue	79%
Woman's Day	74%
Ms	73%
Seventeen	71%
Family Circle	59%
McCall's	57%
Ladies' Home Journal	50%
Mademoiselle	46%
Cosmopolitan	37%
Harper's Bazaar	29%
Organic Gardening	25%
Prevention	10%

A similar study conducted in 1984 confirmed the above findings and also included other popular magazines. American Health, Self, and Consumer's Research were rated as providing excellent nutrition information with extensive nutrition coverage.

Appendix A

PATIENT HANDOUT

How to Avoid Costly Nutrition Quackery "Rip-Offs"

Every American is in some way affected by nutrition quackery. Newspaper ads, magazines, and books promote claims that manipulation of the diet and use of "supplements" will improve health. Nutrition claims are often misleading. Many "supplements" and "diets" are of little or no value and may even be harmful. People need to ask questions before they select a nutrition product or diet. The following questions will help you make wise decisions.

1. Is the evidence based upon a story (personal experience) rather than on scientific studies?
2. Has it been proven safe? Don't assume that all nutrition supplements, herbs, and diets are safe.
3. What is the motive of the promoter? If profit is the only motive, "Watch Out!"
4. What kind of claims are made? Are they vague and misleading? Are they based upon testimonials and case histories? The quack's position is "Prove I'm wrong" instead of "Here is scientific proof that I'm right."
5. Do experts in the field use it? Would an expert encourage a relative to use the product or diet?
6. Does your doctor think the claim makes sense?
7. Does it claim that a nutrient, food group, or supplement is the "key" to rapid weight loss? Does it blame certain foods for causing problems? If so, then look elsewhere.
8. Is it a revolutionary idea? This trick has been used for years to mislead the public.
9. Does it claim 100% success? No product or diet which is sound will do so.
10. Do promoters claim persecution by the medical profession? This is used as a sympathy-getting tactic and should immediately tip off the consumer that "something is fishy."

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Little Known D.. gers of Herbal Teas

Herbal teas are a blend .. herbs, spices, and aromatic ingredients such as flow.. buds and citrus peel. They have gained widespread acceptance as caffeine-free alternatives to coffee and tea. Herbal teas blended with matte or black tea, however, are not caffeine-free.

Unfortunately, there are no regulations which ban the sale of herbal teas that are potentially dangerous. Companies are not required to list herbal tea ingredients, and many do not. There are no standards of quality, and various samples of the same herb mixture may contain different quantities of ingredients.

"Natural" products such as herbal teas can contain harmful substances which act like drugs when consumed. While some herbal teas are harmless, those which contain the following herbs should not be used.

Herb	*Problem*
Aloe leaves	Can cause severe diarrhea.
Buckthorn bark	Can cause severe diarrhea.
Burdock root and seeds	Can affect the nervous system and cause anxiety, delirium, disorientation, and seizures.
Catnip	Can affect the nervous system.
Chamomile	Can cause inflammation of the nose and skin reactions in those who are allergic to ragweed, asters, chrysanthemums, or other members of this plant family; in severe cases, can result in life-threatening anaphylactic shock.
Claw's root	Can induce spontaneous abortion in pregnant women.
Comfrey	Can damage the liver and cause serious health problems; side effects take several years to occur.
Devil's root	Can induce spontaneous abortion in pregnant women.
Dock root	Can cause severe diarrhea.
Foxglove	Poisonous.
Ginseng	Can cause high blood pressure, edema, insomnia, nervousness, contusion, depression, skin eruptions, and diarrhea, in addition to other side effects.
Goldenrod	Can trigger allergic reactions in those allergic to this plant.
Horsetail	Can cause bizarre central nervous system symptoms and a syndrome similar to one caused by thiamin deficiency.
Hydrangea	Can affect the nervous system.
Indian tobacco	Can cause sweating, vomiting, paralysis, hypothermia, coma, and death.
Inkberry	Poisonous; can cause inflammation of the stomach, decreased respirations, and death (especially in children).
Jimson weed	Can affect the nervous system.
Juniper	Can cause increased urination and irritate the stomach and intestine; also can affect the nervous system.
Licorice root	Can cause water retention, low levels of potassium in the blood, high blood pressure, and congestive heart failure.
Lobelia	Can affect the nervous system.
Mandrake	Often sold as ginseng; can cause hallucinations.
Marigold	Causes same problems as chamomile.
Melilot	Can interfere with normal clotting of the blood.
Mistletoe	Poisonous; can cause inflammation of the stomach.
Pennyroyal	Can induce spontaneous abortion in pregnant women.
Pokeweed	Poisonous.
Reserpine	Often sold as ginseng; can cause low blood pressure.
Sassafrass	Contains a potent carcinogen, safrol.
Senna leaves	Can cause severe diarrhea.
Shave grass	Causes symptoms similar to those of horsetail.
St. John's Wort	Causes same problems as chamomile.
Tonka beans	Can interfere with normal clotting of the blood.
Woodruff	Can interfere with normal clotting of the blood.

Wormwood	Can affect the nervous system.
Yarrow	Causes same problems as chamomile.

Many herbal teas are rich in tannins which can bind, inactivate, or delay absorption of nutrients and certain drugs. Excessive use of any herbal tea is not wise.

For additional information: Tyler, V.L.: *The Honest Herbal. A Sensible Guide to the Use of Herbs and Related Remedies.* Philadelphia: George F. Stickley Co., 1982.

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a page number followed by a "t" indicates a table; an "f" refers to a figure.

Some Abbreviations Used in the Nutrition in Primary Care Series

ATP	adenosine triphosphate
c	cup
cc	cubic centimeter
CNS	central nervous system
FDA	Food and Drug Administration
gm	gram
IBW	ideal body weight
IU	International Units
kcal	kilocalorie
kg	kilogram
lb	pound
lg	large
MCV	mean corpuscular volume
MDR	minimum daily requirement
med	medium
μg	microgram
mEq	milliequivalent
mg	milligram
MJ	megajoule
ml	milliliter
oz	ounce
RDA	Recommended Dietary Allowances
RE	retinol equivalents
sl	slice
sm	small
Tbsp	Tablespoon
TPN	total parenteral nutrition
tsp	teaspoon
USDA	United States Department of Agriculture

DOCUMENT RESUME

ED 321 999 SE 051 507

AUTHOR Roehrig, Karla L.
TITLE Protecting Bone and Teeth. Nutrition in Health Promotion Series, Number 21.
INSTITUTION Ohio State Univ., Columbus. Dept. of Family Medicine.
SPONS AGENCY Health Resources and Services Administration (DHHS/PHS), Rockville, MD. Bureau of Health Professions.
PUB DATE 85
CONTRACT 240-83-0094
NOTE 30p.; See SE 051 486 for "Comprehensive Guide and Topical Index" to Modules 1-26. See SE 051 487-502 for Modules 1-16, "Primary Care Series" and SE 051 503-512 for "Nutrition in Health Promotion" series.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Dental Health; *Dietetics; Disease Control; Health Education; Higher Education; *Independent Study; *Medical Education; Medicine; Nutrition; *Nutrition Instruction; Physiology; Preventive Medicine; Science Education; *Skeletal System; Special Health Problems; Teaching Methods
IDENTIFIERS *Osteoporosis

ABSTRACT

Nutrition is well-recognized as a necessary component of educational programs for physicians. This is to be valued in that of all factors affecting health in the United States, none is more important than nutrition. This can be argued from various perspectives, including health promotion, disease prevention, and therapeutic management. In all cases, serious consideration of nutrition related issues in the practice is seen to be one means to achieve cost-effective medical care. These modules were developed to provide more practical knowledge for health care providers, and in particular primary care physicians. This module is designed to encourage the primary care physician to stress to patients that osteoporosis is avoidable and to provide instruction on how patients can change their dietary habits. Answers are provided to commonly asked questions regarding bone and tooth development, the prevention of disease, and the role of nutrition in the maintenance of healthy bones and teeth. Included are learning goals and objectives, a self-check of achievement with regard to goals, references, and lists of resources for patients and physicians. (CW)

The Nutrition in Primary Care Series Contains These Modules:

1. Nutrient Content of Foods, Nutritional Supplements, and Food Fallacies
2. Appraisal of Nutritional Status
3. Nutrient and Drug Interactions
4. Normal Diet: Age of Dependency
5. Normal Diet: Age of Parental Control
6. Normal Diet: Adolescence
7. Normal Diet: Pregnancy and Lactation
8. Normal Diet: Geriatrics
9. Dietary Management in Obesity
10. Dietary Management in Diabetes Mellitus
11. Dietary Management in Hypertension
12. Dietary Management in Hyperlipidemia
13. Dietary Management in Gastrointestinal Diseases
14. Dietary Management for Alcoholic Patients
15. Nutritional Care of Deteriorating Patients
16. An Office Strategy for Nutrition-Related Patient Education and Compliance

The Nutrition in Health Promotion Series Contains These Modules:

17. Individual and Social Factors
18. Metabolic Principles
19. Risk Factors and Disease Prevention
20. Decoding Fad Diets
21. Protecting Bone and Teeth
22. Exercise and Physical Activity
23. Vitamins and Trace Minerals
24. Behaviorial and Neurological Disorders
25. Preventing Hospital and Home Malnutrition
26. Questions About Common Ailments

Faculty Guide (includes comprehensive index for Modules 1-26)

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21 Nutrition in Health Promotion: Protecting Bone and Teeth

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Contract Number: 240-83-0094

U.S. Department of Health and Human Services
Public Health Service
Health Resources and Services Administration
Bureau of Health Professions
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A special note of appreciation is extended to persons in family practice residency programs and universities throughout Ohio for reviewing the materials and to the faculty and residents of the Central Ohio Affiliated Family Practice Residency Programs where the materials were piloted:

Grant Hospital, Columbus, Ohio
Riverside Methodist Hospital, Columbus, Ohio
University Hospital, Columbus, Ohio
Mt. Carmel Hospital, Columbus, Ohio

Composition, Camera Work, Reproduction and Binding: Lesher Printers, Fremont, Ohio

Library of Congress Catalog Card Number: 85-62199

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Introduction

Osteoporosis is a severe, often crippling, disease of old age that can deny your patients a happy, productive life in their later years. As many as 30,000 premature deaths per year in the U.S. are due to the primary or secondary effects of osteoporosis. The annual cost has been estimated to be $3.8 billion, a figure which is likely to climb substantially as the result of rapid increases in the geriatric population.[1]

Although relatively little can be done to reverse osteoporosis once there is an onset of fractures, there can be a great deal accomplished by focusing on the preventive measures effective against this debilitating disease.

For a review, sections on the processes which regulate bone metabolism have been included. Throughout this module, an attempt has been made to relate the clinical processes to the underlying physiological and biochemical processes involved in bone metabolism.

Goal

The goal of this module is to encourage the primary care physician to stress to patients that osteoporosis is avoidable; however, measures such as adequate daily calcium intake, exercise, and rational drug use need to be instituted as a matter of daily habit early in life rather than as a short-term treatment once a problem has been diagnosed. Answers will be provided to commonly asked questions regarding bone and teeth development, prevention of osteoporosis and dental caries, and the role of nutrition/diet in maintenance of healthy bones and teeth.

Objectives

Upon completion of this module, you will be able to:

1. *Discuss normal metabolism and pathological processes of bones and teeth.*
2. *Identify which population groups are at greatest risk for osteoporosis.*
3. *Recognize the need for calcium at various stages of the life cycle and distinguish between the needs of males and females.*
4. *Determine when preventive measures should be started to preserve teeth and bones.*
5. *Identify which dietary, drug, and exercise measures are most effective in maintaining teeth and bones.*
6. *Educate patients as to the factors which contribute to the good health of bones and teeth.*
7. *Counsel patients as to how to obtain the proper amount of calcium in the diet.*
8. *Determine which drugs, diseases, and treatment regimens exacerbate problems with bones and teeth.*

Definition of Osteoporosis and the Population at Risk.

Osteoporosis is the loss of bone mass which results in an increased number of fractures, primarily of the spine, hips, and forearms.

Osteoporosis is the most common skeletal disorder in the world and is characterized by a lowered bone mass, with the remaining bone normally mineralized. Although the osteoporotic process may be slowed or stopped, the existent damage is irreversible. This malady, osteopenia, is one of four subcategories of the loss of bone mass; the other three subcategories are osteomalacia, endocrinopathies, and marrow packing disorders, some of which are reversible.

The decrease in bone mass due to osteoporosis leads to an increased number of fractures, with the spine, hips, and forearms being most susceptible. Spinal compression fractures after such minor trauma as stepping down from a step, coughing, or receiving an enthusiastic hug are common. Different subgroups of osteoporotic individuals may have greater or lesser incidence of fractures at various bone sites.

Osteoporosis not only has an extreme economic impact, but it also can affect the overall general health of its victims. The same factors which maintain good bone health are also responsible for maintenance of sound teeth.

In the U.S. alone, osteoporosis is implicated in nearly 200,000 hip fractures and 100,000 wrist fractures per year, affecting predominantly women, in particular about 15-25% of all postmenopausal women. In the spine, the lower thoracic and upper lumbar regions are most affected. In addition to being painful and temporarily debilitating, these types of fractures can have long-term consequences (Table 21-1).

The lowered thoracic and abdominal volume may lower appetite and decrease lung volume, thereby impairing ability to exercise. The yearly costs in the U.S. from the acute problems of osteoporosis alone are staggering, in the order of billions of dollars.[2] This figure does not include requirements for chronic care, long-term disability, or lowered quality of life.

Table 21-1. Consequences of Osteoporosis

1. Reduced stature
2. Dowager's hump
3. Alteration of rib position leading to
   a. Lowered thoracic volume
   b. Lowered abdominal volume

Although osteoporosis does not include strictly dental problems such as peridontal disease, the same factors which help to maintain strong bones also affect the soundness of teeth. The calcified tissues in teeth are the enamel, dentin, and cementum. These tissues are more influenced by external factors during the developmental period than after the teeth have erupted. When bones of the jaw deteriorate, however, teeth may loosen and eventually be lost. Thus, throughout this discussion it should be borne in mind that the discussion also applies to teeth. Because of the pervasiveness of osteoporosis, it is important to understand the mechanisms for the development of the disease and the preventive measures which may be taken to reduce or eliminate the problem.

Susceptibility to osteoporosis may be related to peak bone mass which is attained at approximately age 35 in both sexes.

Bone mineral mass peaks at roughly age 35 for both sexes and declines at a greater rate for females than for males; it is particularly accelerated after menopause. The major determinant for osteoporosis in old age may be the peak bone mass attained early in adult life.[3] Therefore, measures aimed at preventing osteoporosis should be directed not only at the older segments of the population but also at children and young adults who have not yet attained peak bone mass. Factors affecting peak bone mass will be discussed in various sections of this module.

Bone Composition and Structure

Bones are 65% mineral, with a calcium and phosphorus crystal type called hydroxyapatite being the major component. There are two

types of bone in the skeleton, tubular and cancellous, and it is the cancellous type which is subject to osteoporosis.

Bone is composed of minerals, water, and an organic matrix consisting of 95% collagen and 5% extracellular fluid and mucoprotein. The mineral component of bone (65% of total weight) is composed mostly of hydroxyapatite, $CA_{10}(PO_4)_6(OH)_2$; 30-40% amorphous calcium phosphate; and small amounts of other crystalline types like octacalcium phosphate, $CA_8H_2(PO_4)\bullet H_20_5$. Of the approximately 600 gm of phosphorus in the adult human, 85% of it is in the skeleton. Teeth contain similar types of crystals, but the percentages of each type vary in the three kinds of calcified tissue of the teeth.

The skeleton has two kinds of bone—tubular and cancellous. Tubular bone has a cortex and a few underlying trabeculae (bone spicules or the fibrous framework) and is found predominantly in the appendicular skeleton. Cancellous or spongy bone, on the other hand, has a thin cortex: numerous trabeculae provide support. Cancellous bone is found mostly in the axial skeleton in the spine, in the head and neck of the femur, and in the distal radius. It is the cancellous bone which is preferentially subject to osteoporosis. Radiologists can quantitate the degree of bone loss by the Singh index, which is based upon the disappearance of trabeculae from the neck and head of the femur.[4] However, up to 30% bone loss may occur before overt losses can be detected radiographically.

Tooth formation begins *in utero,* with calcification beginning at 5 months of gestation. The final stages of tooth development occur in the early twenties with the eruption of the wisdom teeth.

A number of factors can influence the health of a tooth long before the tooth actually erupts above the gum line. The tooth buds form *in utero* at 4-6 weeks of gestation. Calcification of the teeth begins at 5 months of gestation. After birth, the permanent teeth begin to calcify as early as 4-6 months of age, even though the eruption of these teeth does not occur until approximately 6 years of age; the process continues until the early twenties with the eruption of the wisdom teeth.

Proper tooth development requires adequate dietary intake of calcium, phosphorus, protein, and other essential minerals. Vitamin A deficiency *in utero* may result in inadequately developed tooth enamel, a circumstance which leaves teeth more susceptible to decay later. Vitamin D deficiency delays tooth eruption and results in pitted, thin, or absent tooth enamel. Vitamin C deficiency impairs collagen formation and compromises the health of the gums.

Tooth decay (dental caries) occurs when bacteria metabolize food stuck to the surfaces of the teeth producing organic acids which destroy the tooth enamel. A newly erupted tooth has the greatest susceptibility to development of caries. The frequency of caries can be reduced by

1. brushing teeth after eating and using floss daily,
2. avoiding sugar-containing snacks unless tooth brushing follows promptly,
3. avoiding sticky foods such as caramels which hold carbohydrate-containing foods next to the teeth,
4. rinsing the mouth with warm water if brushing cannot be accomplished immediately,
5. drinking fluoridated water or using a fluoridated rinse with the advice of a dentist, and
6. having regular dental check-ups and professional tooth cleaning.

Another problem that can affect teeth in young children is the "nursing bottle" syndrome. Persons who put their children to bed with a bottle of milk or fruit juice may encounter this problem which leads to massive decay of the upper front teeth. As the child falls asleep, saliva production ceases and the milk or juice pools around the front top teeth. Bacterial growth with resultant acid production then occurs, promoting caries in the upper teeth. The lower teeth, protected by the tongue, are seldom involved. The practice of putting infants to bed with a bottle should be discouraged. Further, soft drinks or other high-sugar drinks should not constitute part of a diet for an infant.

Osteoblasts are involved in bone formation; osteoclasts are active in bone resorption; and osteocytes are resting bone cells embedded in the mineral matrix.

In order to understand the factors that result in formation and maintenance of strong, fracture-resistant

bones, it is first necessary to examine processes involved in metabolic bone formation. An excellent two-part review has appeared recently.[5,6] The process will be examined only briefly here.

The major functioning cells of bone (osteoblasts, osteoclasts, and osteocytes) originate from a common mesenchymal stem cell. Their functions are summarized in Table 21-2.

Together osteoblasts and osteoclasts constitute 95% of the bone cells. Osteoblasts have several important roles in bone formation. Procollagen is synthesized and undergoes hydroxylation and glycosylation in the osteoblasts. After secretion from the osteoblasts, procollagen is attacked by a protease to form collagen which is then formed into fibrils stabilized by intra- and intermolecular crosslinks. Mineralization can then occur. Osteoblasts are also responsible for synthesizing other proteins important to the bone matrix, such as a calcium-binding protein, osteocalcin (whose synthesis is vitamin K- and vitamin D-dependent), and osteonectin (a phosphoprotein capable of crosslinking collagen and calcium). As new bone matrix is built, the osteoblasts become embedded in the bone and become resting cells or osteocytes. The final type of cells important to bone strength are the osteoclasts; these are involved in bone resorption. They are multinucleated cells which secrete proteolytic enzymes and organic acids (citrate and lactate) which are involved in the breakdown of existing bone. Teeth, of course, have the added insult of organic acids, such as those produced by bacteria in plaque, which erode the teeth from the surface.

Bone synthesis and remodelling are constant processes.

Through cell processes, communication among bone cells is maintained. There are two modes of osteogenesis: endochondral, wherein new bone develops from previously formed cartilage; and membranous, wherein new bone arises from connective tissue rather than cartilage. A reasonably constant bone mass is maintained by carefully balancing the relative activities of osteoblasts and osteoclasts. It is important to remember that bone is a living tissue which is constantly synthesized and remodelled.

Regulation of Bone Formation and Remodelling

A number of regulatory factors are involved in the overall control of bone formation and remodelling. The types of factors involved are listed in Table 21-3. Mechanisms must also exist to mediate effects of exercise and stress on bone. How these are mediated, however, is not at all clear.

One of the body's very crucial needs is to maintain serum calcium levels within a narrow range. As the major pool of calcium, bones play an active role in the maintenance of serum calcium levels.

Although bone growth and remodelling are important to structural integrity, the larger and more important role is that of providing calcium homeostasis.

Serum calcium levels are tightly maintained between 9 and 11 mg% (4.5-5.5 mEq/l) and excursions in either direction result in death. Therefore, it is necessary for the body to have a multiplicity of acute and chronic regula-

Table 21-2. Formation and Degradation of Bone

Cell Type	Function	Involvement
Osteoblasts	Bone formation	Synthesize procollagen Synthesize bone matrix proteins
Osteocytes	Resting cells	Osteoblasts which have become embedded in bone matrix
Osteoclasts	Bone degradation	Secrete proteolytic enzymes Secrete organic acids

Table 21-3. Regulators of Bone Formation and Remodelling	
I.	Factors in calcium homeostasis
	1. Parathyroid hormone
	2. Calcitonin
	3. Vitamin D
	4. Intracellular calcium regulators
II.	Hormones involved in nutrient homeostasis
	1. Insulin
	2. Growth hormone
	3. Thyroxine
	4. Sex steroids
	5. Glucocorticoids
III.	Factors which operate locally
	1. Prostaglandins
	2. Osteoclast-activating factor
	3. Bone-derived growth factor

tory mechanisms to ensure that bone, which is the major pool of body calcium (99% or 1200-1400 gm in a typical adult human), is maintained at a reasonably constant level. Half of the calcium in blood is present as "free" calcium (1mM), and half is bound to small molecules or plasma proteins. Calcium plays a role in muscle contraction, nerve conduction, and hormone secretion by coupling an appropriate stimulus with calcium mobilization in the secreting cell and intracellular communication; therefore, it is necessary that regulation of changes in the mineral composition of bone be intimately connected to the physiological processes in the rest of the body.

Because maintenance of stable calcium levels is so crucial to life, it seems reasonable that a number of regulatory processes and tissues should be involved in the overall control of calcium metabolism. Intake and excretion of calcium contribute to overall calcium balance, and there is considerable turnover of calcium throughout the body (calcium in extracellular fluid turns over between 40 and 50 times a day). In liver and heart the turnover is six times a day; in skeletal muscle the turnover is twice a year. While 50-60 gm of calcium in bone is readily exchangeable, the total bone turnover of calcium is on the order of 3%/year. Clearly, if the turnover process is not balanced, a significant loss of bone minerals can occur, even in as short a period as 10 years. An overall description of the regulation of calcium levels is shown in Table 21-4.

Table 21-4. Factors Regulating Serum Calcium		
Factors	Tissue	Effect*
Intake Versus Excretion		
Intestinal uptake	Intestine	+
Fecal excretion	Intestine	–
Renal excretion	Kidney	–
Diarrhea	Intestine	–
Dietary phytate	Intestine	–
Vitamins and Hormones		
Parathyroid hormone	Parathyroid	+
Calcitonin	Parafollicular cells of thyroid gland	–
Vitamin D	Liver, skin, intestine, and kidney	+
Bone Remodelling		
Osteoblasts	Bone	–
Osteoclasts	Bone	+

*+indicates a rise in serum calcium, –indicates a fall

Effects of Parathyroid Hormone

Parathyroid hormone raises serum calcium levels by elevating bone resorption, renal reabsorption of calcium, and synthesis of 1,25 dihydroxycholecalciferol.

Parathyroid hormone is responsible for maintaining adequate levels of serum calcium. The hormone is released from the parathyroid glands as the precursor hormone, proparathyroid hormone (proPTH, 94aa) or parathyroid hormone (PTH). Additional proteolytic modification of PTH takes place in various peripheral tissues. Release of PTH is stimulated by a fall in calcium or a rise in the antagonistic hormone, calcitonin, which will be discussed later. PTH functions by several mechanisms: it stimulates bone resorption, reabsorption of calcium in the renal tubules, and synthesis of dihydroxycholecalciferol [$1,25(OH)_2D_3$] which evaluates intestinal absorption of calcium and phosphate and itself stimulates bone resorption.

The effects of PTH on the kidney are likely mediated via adenylate cyclase-cyclic AMP but, in addition, require the presence of calcium. PTH has a very rapid

Table 21-5. Summary of the Roles of Parathyroid Hormone, Calcitonin, and Vitamin D on Bone Remodelling and Growth

Factor	Action	Direction
Parathyroid hormone	Bone resorption	+
	Renal Ca++ resorption	+
	1,25 $(OH)_2D_3$	+
	Osteoclast acid production	+
	Osteoblast collagen synthesis	–
	Renal phosphate excretion	+
	Osteoclast number	+
Calcitonin	Osteoclast number	–
	Organic acid synthesis	–
	Renal phosphate excretion	+
	Renal calcium excretion	+
Vitamin D	Intestinal calcium uptake	+
	Mobilization of bone calcium	+

effect in enhancing phosphaturia. In individuals with PTH-secreting tumors, there is a rise in blood calcium which cannot be effectively treated by diet. Treatment issues will be discussed later. The role of PTH is summarized in Table 21-5.

Effects of Calcitonin

Calcitonin is responsible for lowering serum calcium by stimulating bone growth, and calcium and phosphate excretion.

Calcitonin, which lowers serum calcium levels, is secreted from the parafollicular cells of the thyroid gland and is known as thyrocalcitonin in older literature. Support of the notion that calcitonin plays a role in overall calcium metabolism comes from the observation that people with calcitonin-secreting tumors have hyperplastic parathyroid glands. Further, calcitonin levels are affected by dietary calcium intake; the levels rise when a calcium-rich meal is fed after a fast. Young animals are apparently more sensitive to calcitonin than older animals, making it tempting to speculate that calcitonin insensitivity may play a role of osteoporosis. Calcitonin rapidly decreases the number of osteoclasts and the amounts of lactate and citrate produced by the osteocytes. It also increases the ability of the osteoblasts to synthesize collagen matrix necessary for mineralization. Paradoxically, calcitonin lowers the actual number of osteoblasts. This may explain why calcitonin is effective in Paget's disease, a pathologic bone resorption condition, for only a short period of time. Like PTH, calcitonin elevates urinary phosphate excretion and also increases calcium excretion. This is consistent with its lowering plasma calcium, but this part of its action counteracts its contribution to bone mineralization. The role of calcitonin is summarized in Table 21-5.

Effects of Vitamin D

Vitamin D has become a required nutrient because of our lifestyle. It is converted to its active form in a series of reactions to 1,25 dihydroxycholecalciferol [1,25$(OH)_2D_3$].

Vitamin D has been said to be a hormone which our lifestyle has made into a vitamin. Under conditions of adequate exposure to sunlight, vitamin D can be completely synthesized endogenously, travel to a target tissue via the bloodstream, and exert its actions in minute quantities—all of the qualifications of a hormone. The Recommended Dietary Allowance for vitamin D is shown in Table 21-6.

Table 21-6 Calcium, Phosphorus, and Vitamin D Recommended Dietary Allowances

	Age (yr)	Calcium (mg)	Phosphorus (mg)	Vitamin D* (μg)
Infants	0.0-0.5	360	240	10
	0.5-1.0	540	360	10
Children	1-3	800	800	10
	4-6	800	800	10
	7-10	800	800	10
Males	11-14	1200	1200	10
	15-18	1200	1200	10
	19-22	800	800	7.5
	23-50	800	800	5
	51+	800	800	5
Females	11-14	1200	1200	10
	15-18	1200	1200	10
	19-22	800	800	7.5
	23-50	800	800	5
	51+	800	800	5
Pregnant		+400	+400	+5
Lactating		+400	+400	+5

* As cholecalciferol — 10 μg cholecalciferol = 400 I.U. of vitamin D.

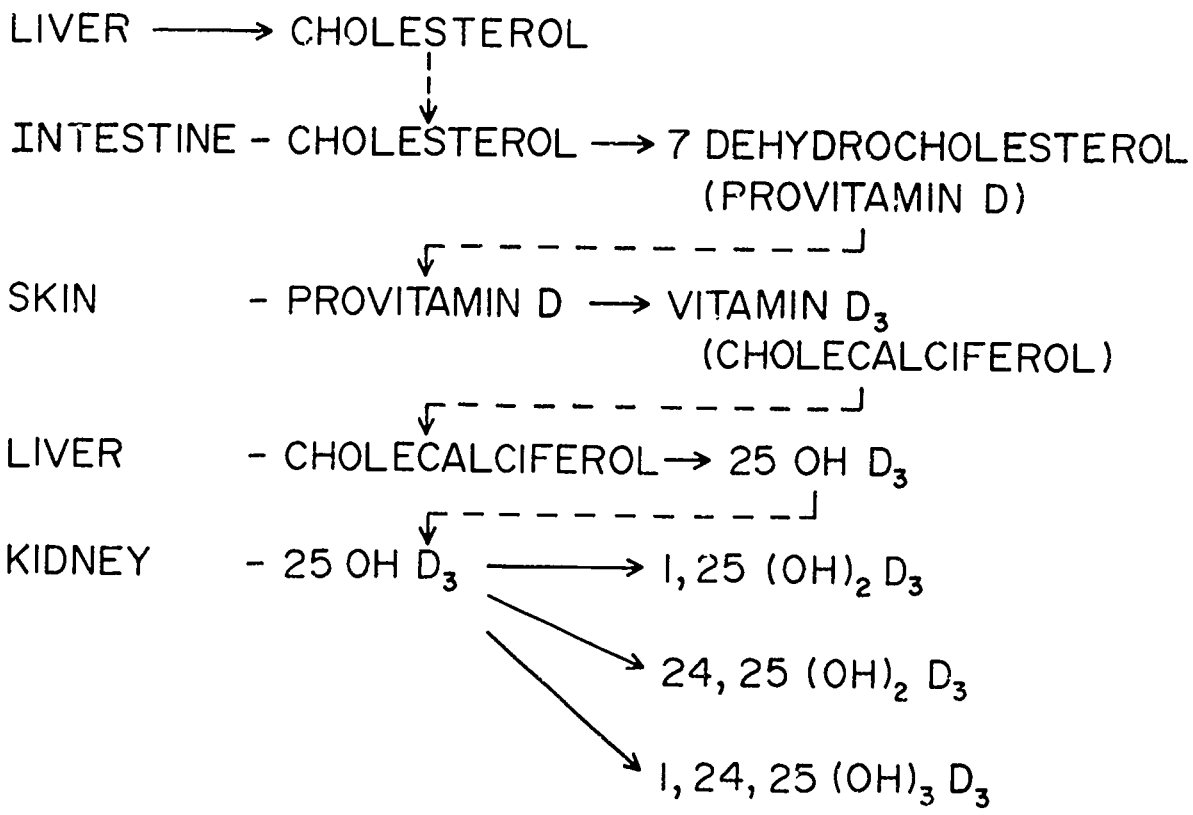
Adapted from Food Science and Nutrition Board, National Academy of Sciences—National Research Council. *Recommended Dietary Allowances*, Revised 1980.

Vitamin D is an excellent example of the interaction of a variety of tissues and regulatory mechanisms. The synthetic scheme for the active form of vitamin D is shown in Figure 21-1. Disease in any of the tissues involved in the synthesis and conversions of vitamin D should be expected to contribute to osteoporosis. For example, renal disease can prevent adequate formation of 1,25 $(OH)_2D_3$ or other metabolites, and diarrhea may prevent adequate calcium absorption, even in the presence of sufficient vitamin D. High plasma calcium concentrations inhibit the 1-hydroxylase enzyme, and PTH may be required for the synthesis of the 1-hydroxylase. Another vitamin D metabolite is also formed by the kidney — 24,25 dihydroxycholecalciferol. Only the 1,25 form stimulates uptake of calcium by the intestine, but both forms can stimulate mobilization of bone calcium. It is possible that the 24,25 hydroxylated form may be involved in feedback inhibition of PTH secretion. When there is adequate calcium, hydroxylation in the 24 position dominates; when calcium reserves are low, the 1 position is preferentially hydroxylated. There is a third metabolite, 1,24,25 $(OH)_3D_3$, whose role is still unclear. It may be a form of the vitamin marked for excretion by the liver. The role of vitamin D is summarized in Table 21-5.

Rickets in children and osteomalacia in adults can be prevented by adequate vitamin D and phosphate, or by 1,25 dihydroxycholecalciferol [1,25$(OH)_2D_3$]. Use of certain anticonvulsants or antibiotics may increase the risk of rickets.

Without adequate vitamin D, bone mineralization is incomplete, causing rickets in children or osteomalacia in adults. There is hypocalcemia and often secondary hyperparathyroidism. Bone matrix and cartilage syn-

Figure 21-1 Synthesis of Vitamin D and Its Metabolites



theses are normal at first but eventually slow greatly in the absence of mineralization. Teeth which are formed during a period of rickets are abnormally calcified, leading to a greater incidence of caries in later life. Fortunately, vitamin D deficiency rickets is now rare in Western societies. There are, however, vitamin D-resistant forms of rickets which may respond to a combined treatment of vitamin D and phosphate supplementation or to the addition of 1,25 $(OH)_2D_3$. This may be accomplished with Calciferol, available in 50,000 USP unit tablets or 500,000 USP/cc in oil injections. This compound should not be given to patients with hypercalcemia or evidence of vitamin D toxicity, such as weakness, headache, vomiting, muscle or bone pain, loss of appetite, hypertension, or cardiac arrhythmias. Several types of phosphate supplements are available, but they may cause vomiting or diarrhea. In some cases, such as in children or adults receiving certain anticonvulsant drugs (e.g., phenytoin) osteomalacia may develop as the result of stimulation of the enzyme system responsible for vitamin D breakdown. These drugs should be used in the lowest effective dosages possible and for the shortest time periods needed to produce therapeutic effects. Certain antibiotics, such as tetracycline, may tie up calcium in the gastrointestinal tract. Chronic renal disease may also precipitate bone loss as a consequence of failure to hydroxylate $25(OH)D_3$ to $1,25(OH)_2D_3$ in the kidney. There may be build-ups of the $25(OH)D_3$ form or other vitamin D metabolites which themselves may interfere with normal calcium homeostasis. Likewise, liver disorders may result in a lack of sufficient hydroxylation in the 25 position to form the 25(OH) intermediate. There are some conditions which may be confused with rickets.[7] Usually, however, there is some method for differentiating other disorders from rickets (see Table 21-7).

Table 21-7. Conditions that May Be Confused with Rickets

Condition	Differentiation from rickets
Intrinsic bone disease	
Achondroplasia	Normal serum chemistries Radiological determination
Metaphyseal chondroplasia	
(Jansen type)	Hypercalcemia
(Schmid type)	No hypercalcemia
Genetic mucopolysaccharidoses	
Morquio's syndrome	Urinary mucopolysaccharide
Hurler's syndrome	Urinary mucopolysaccharide
Hormonal disorders	
Syndromes involving pituitary, thyroid, adrenals, gonads	Growth plates well-defined
Hyperparathyroidism	Chronic elevated PTH, late childhood, normal or accelerated growth; hips and ankles more affected than knees or wrists; long-bone bowing uncommon
Vitamin C deficiency	Fractures in metaphysis produce a zone of compressed, disorganized calcified cartilage resembling healed rickets
Metaphyseal defects	
Hypophosphatasia	Prominent cupping deformity Phosphorylethanolamine in urine
Osteogenesis imperfecta	Defective formation of primary and secondary spongiosa
Osteopetrosis	Bone-in-bone appearance of radiographs; less space for bone marrow
Localized disorders	
Blount's disease	No widening of growth plate at proximal end of tibia
Trauma, Radiation, Frostbite, Myelodysplasia	Sometimes difficult to differentiate from rickets; examine multiple bone sites

Adapted from Reference 7.

Effects of Insulin

Insulin insufficiency leads to generalized growth retardation. Bone demineralization may occur in diabetic metabolic acidosis.

Another group of hormones which affects bone metabolism are those hormones which ordinarily regulate nutrient homeostasis.[6] Among these are insulin, growth hormone, thyroid hormone, the sex steroids, and glucocorticoids. Some of the actions of these hormones on bone may be secondary or tertiary to their impact on other target tissues, and certainly many of their interactions with bone are not well understood. For example, in insulin deficiency in children, there is generalized growth retardation, but it is not clear whether the effect is one of generalized nutrient deficiency or whether there are more direct actions on bone cells. Since insulin is known to alter intracellular calcium pools in some cells, it is also possible that insulin could affect bone calcium distribution in a direct way. Bone demineralization may occur during periods of metabolic acidosis in diabetics. The goal for such patients should be to prevent ketosis and acidosis by maintaining good blood glucose control. (See the Guide Index for other modules which outline dietary strategies for the diabetic.)

Effects of Growth Hormone

Growth hormone is necessary for bone growth, and insufficiency leads to reduced stature and perhaps to sexual immaturity. Excesses are equally detrimental, producing gigantism in the young and acromegaly in adults.

Effects of growth hormone on bone are direct, producing dose responses in bone growth. Lack of the hormone during developmental periods leads to a failure to achieve full stature (dwarfism), while excesses during this period result in abnormal excess growth (gigantism). Pituitary dwarfism is the result of the failure of the pituitary to produce growth hormone, either as part of an overall lack of hormones from the pituitary (panhypopituitarism) or as a particular deficiency of growth hormone (sexual ateliotic dwarfism). Those with panhypopituitarism will not mature sexually and will show signs of hypothyroidism and adrenal insufficiency. Lack of only growth hormone, however, impairs attainment of full stature and not sexual maturity. After fusion of the epiphyseal plates, additional bone growth is limited to areas of responsive cartilage such as the jaw, hands, and feet, leading to the characteristic deformities of acromegaly. The effects of growth hormone on bone are apparently mostly on calcification and chondrogenesis without speeding up the bone maturation process and the fusion of the epiphyseal plates. It is generally believed that growth hormone exerts its actions on bone via the somatomedins, among which is insulin-like growth factor I.

Effects of Thyroid Hormone

Hypothyroidism slows bone turnover while hyperthyroidism increases bone turnover and leads to negative calcium and phosphate balances.

Thyroid hormone appears to have dramatic interactions with bone. In hypothyroidism bone turnover is slowed, while in hyperthyroidism it is increased. During development, hypothyroidism leads to impairment of skeletal growth. Bone resorption by osteoclasts has been shown to occur *in vitro* in response to thyroid hormone. There are associated increases in serum calcium and a decrease in PTH and 1,25 $(OH)_2D_3$, as would be expected. Cartilage growth may be stimulated. Unlike growth hormone, thyroid hormone promotes bone maturation. Excesses of thyroid hormone lead to negative calcium and phosphate balances and to decreased absorption from the intestine. Hyperthyroid patients should be monitored closely to determine that they are receiving adequate dietary calcium.

Effects of Sex Hormone

Androgens and estrogens are involved in bone maturation and fusion of the epiphyseal plates.

Clearly, the sex steroids (androgen and estrogens) must also be involved in skeletal maturation and maintenance. Skeletal size of males is usually greater than

females, while the female skeleton provides a necessary reserve of calcium to support pregnancy and lactation. Further, in postmenopausal women there is a dramatic loss of bone mass which can be slowed by estrogen supplementation (discussed in greater detail in the section "Treatment of Osteoporosis").

Premature secretion of androgens or estrogens results in early fusion of the epiphyseal plates. The mechanisms of action of these hormones are unknown. It has been postulated that part of the androgen effect is due secondarily to increased muscle mass, which seems to favor increased bone mass. Other effects may be mediated by changes in calcium absorption from the intestine, alterations in 1,25 $(OH)_2D_3$ synthesis, or stimulation of calcitonin secretion in order to inhibit bone resorption. Androgens have been used to promote bone healing in aging patients, but their effects are short-term. Besides producing virilism in female patients, androgens may cause hepatic dysfunction. Estrogen will be discussed later in this module.

Effects of Glucocorticoids

Glucocorticoid effects on bone are beneficial at physiological concentrations but detrimental at high concentrations.

The effects of glucocorticoids depend upon their concentrations; i.e., whether they are present in physiological or pharmacological amounts. In excess, the glucocorticoids diminish calcium and phosphate uptake from the intestine and increase their excretion from the kidney. There is increased bone turnover and a precipitous drop in the number of osteoblasts at sites of new bone formation resulting in glucocorticoid-induced osteoporosis. Patients receiving glucocorticoid therapy for adult respiratory distress syndrome, organ transplants, or neoplastic diseases may all experience increased bone turnover as a result of the high glucocorticoid levels. At normal concentrations, however, the glucocorticoids have beneficial effects on skeletal growth. At normal concentrations, there is actually a period of stimulation of bone collagen synthesis by glucocorticoids in bone cultures. Glucocorticoid effects may be mediated by regulation of differentiation of the various types of bone cells. Patients receiving drugs such as prednisone may need to follow a low-sodium, low-simple-carbohydrate diet and try to avoid gaining weight. When pharmacological doses are necessary for a long course of therapy, calcium supplementation may to be in order.

Effects of Paracrine Factors

Bone itself produces factors which, acting locally, alter its own metabolism.

The final group of hormones/factors which help to regulate bone formation and turnover may operate in a paracrine rather than a hormonal fashion. Prostaglandins (PGE series) are potent stimulators of bone resorption. In some bone tumors, there is an elevated production of prostaglandins, which leads to hypercalcemia and considerable resorption in the region of the tumor.

Factors in blood cells may play a role in the regulation of bone metabolism. One of these is the osteoclast-activating factor derived from proliferating lymphocytes. *In vitro* it stimulates bone resorption and inhibits collagen synthesis. This may account for the hypercalcemia associated with such diseases as myeloma. Mithramycin IV (Mithracin), an antineoplastic agent, may be considered for treating such patients in a hospital setting. With such treatment, calcium balance may return to normal rather quickly. Treatment by low dietary calcium is not recommended.

Since bone remodelling occurs in response to mechanical stress, a local phenomenon, local factors must exist to mediate the changes. These factors may be related also to the somatomedins. One factor, bone growth factor II, has been reported to stimulate synthesis of new cells and matrix in cartilage cultures.[6] Although these factors may be derived from other tissues as well, current data seem to indicate that they can arise from cells in the bone. A great deal of additional research must occur before the roles of these factors are clarified.

Clearly, bone growth and remodelling is a complicated process involving not only bone tissue itself but also many other body tissues. Impairment in any of these other tissues may be expected to cause anomalies in the turnover of bone. If a severe enough imbalance is created, then osteoporosis will be the ultimate result.

Risk Factors For Osteoporosis

Although osteoporosis may be a natural consequence of aging, the degree of osteoporosis is a function of peak bone mass attained in early adulthood.

Much of the osteoporosis commonly seen is age-related, but must it be an inevitable part of the aging process? Evidence indicates that bone loss, particularly in women, begins in the third decade of life, although increased fracture risk may not become apparent until ages 60-70. If bone loss occurs as early as age 30, perhaps there are some preventive measures which can be employed to delay the onset of loss or to avoid it entirely. It is generally believed that the degree of subsequent bone loss is a function of peak bone mass attained in early adulthood. Prudence would seem to indicate that actions should be taken to ensure reaching the genetically determined maximum bone mass. The ideal time to discuss the prevention of osteoporosis with female patients is during the yearly female exam.

Postmenopausal women of western European extraction most often develop osteoporosis. Also at risk are women who have had an oophorectomy at an early age, women who have excessive alcohol intake, cigarette smokers, and those who lead a sedentary life style.

Seemingly at greatest risk of osteoporosis are postmenopausal, fair-complexioned women of western European descent. Approximately 15% of the postmenopausal women in the U.S. will develop osteoporosis. The incidence in black women is very much lower.[8] These data would seem to indicate a genetic component for the disease which is separate from nutritional considerations. There does, however, seem to be a correlation of development of osteoporosis with lowered calcium intake. National dietary surveys have indicated that 66% of U.S. women have calcium intakes below the RDA in the years when peak bone mass is attained, and that 75% of older women have inadequate calcium intakes. Blacks generally have lower calcium intakes than whites. In comparing osteoporotic and non-osteoporotic women of the same ages, the osteoporotic groups had lower calcium intakes during a period of time prior to the diagnosis of osteoporosis. Retrospective studies have indicated that excessive alcohol intake, cigarette smoking, and sedentary lifestyles are associated directly or indirectly with osteoporosis in later life.[9] While no causality can be implied by these studies, it is not difficult to suppose, for example, that excess alcohol could cause liver or intestinal damage, which in turn might interfere with vitamin D metabolism and calcium uptake. Other factors known to be capable of precipitating osteoporosis are the chronic use of anticonvulsant drugs, such as phenytoin, and long-term antacid abuse leading to hypophosphatemia.

Prevention of Osteoporosis

Dietary Calcium

Dietary calcium is best supplied by dairy products; but for reasons of economics, food preferences, or intolerances, it may be difficult for many people to obtain an adequate amount of calcium from dietary sources.

The best ways to prevent osteoporosis and to treat the disease, once it is evident, are controversial. A number of studies indicate life-long patterns of less-than-adequate calcium intake resulting in osteoporosis. In general, men consume nearly twice as much calcium as women, and women have the added drain on their calcium supplies of pregnancy and lactation.[10] The recommended dietary allowances for calcium, phosphate, and vitamin D for different age groups are given in Table 21-6. During pregnancy, there is elevated calcium absorption and perhaps even positive calcium balance, with the additional calcium being deposited in the mother's bones. During lactation, there is an additional requirement for calcium and phosphorus because of the losses of these constituents to the milk. Calcium balance during periods of lactation is usually negative.

Intake of calcium is also a function of economic level, since foods that contain the largest amounts of calcium tend to be those which are more expensive. Concerns about calorie intake, ethnic eating patterns, or food intolerance may prevent some individuals from receiving adequate calcium. Food choices of various ethnic groups were discussed in Module 1, Nutrient Content of Foods, Nutritional Supplements, and Food Fallacies.

In older people there may be a loss of appetite or strong food dislikes which can impinge on food choices.

Many older people think milk is only for babies, others may think dairy products are "harmful" because of the cholesterol content. Still others think that cheese causes constipation. Lactose intolerance can contribute to lowered intakes of high-calcium dairy products, but lactose intolerance is found most often in oriental and black populations who are not at particular risk for osteoporosis. Even in lactose-intolerant persons, adequate calcium can be obtained by ingestion of fermented dairy products. The calcium contents of some common foods are shown in Table 21-8. Pasteurization or homogenization of milk does not lower the availability of calcium. Calcium availability is reduced in foods with high oxalate levels (soybeans, kale, etc.) and in foods

Table 21-8. Calcium Content of Common Foods

ITEM	SERVING SIZE	CALCIUM CONTENT (mg)
Milk, skim, whole, 2%	8 oz	300
Milkshake, homemade	8 oz	360
Milk, malted	8 oz	345
Milk, chocolate or buttermilk	8 oz	285
Swiss cheese	2 oz	550
Cheddar cheese	2 oz	410
Colby cheese	2 oz	390
Processed American cheese	2 oz	350
Cottage cheese	½ cup	75
Yogurt, plain, lowfat	8 oz	415
Ice cream	1 cup	170
Pudding	½ cup	135
Pizza, with cheese	1 medium piece	145
Macaroni and cheese	1 cup	360
Sardines, canned	2 oz	170
Salmon, canned, with bones	2 oz	150
Oysters, raw	7 - 9	115
Collards, raw	½ cup	180
Mustard greens or kale, raw	½ cup	100
Blackstrap molasses	1 Tbsp	135
Dried beans, cooked	1 cup	90

Adapted from Module 8, Normal Diet: Geriatrics.

with high phosphate levels, such as unpolished rice and bran. A general rule of thumb is to divide the amount of calcium in foods from these sources by 2 to get the quantity of calcium actually available for absorption.

Dietary Phosphorus

In animal studies, the Ca/P ratio has been found to be important to normal growth and maintenance of the skeleton. It has been suggested that a Ca/P ratio of 1, or a little greater, should be optimal in humans.

Along with dietary calcium intake, phosphorus intake must be taken into consideration. In animals it has been shown that excess phosphorus or low amounts of dietary calcium relative to phosphorus result in skeletal defects. In humans, however, there is little evidence that this is the case and even some evidence that calcium balance may be improved by elevated phosphorus intakes. There is an inverse relationship between dietary phosphorus and urinary calcium. This results in elevated PTH and increased bone resorption. It has been suggested that a Ca/P ratio of 1, or a little greater, would be ideal, but this is difficult to achieve by dietary means alone. In the U.S., consumption of phosphate is rising. Cola drinks contain large amounts of phosphate (12-20 mg%). Phosphates, including orthophosphate (for acidification), and di- and polyphosphates are frequently used as food additives.[4] Dairy products have only marginally more calcium than phosphate. Processed cheese, on the other hand, actually has more phosphate than calcium. Meat which is rich in phosphorus is consumed 31% more now than 20 years ago, while dairy product consumption is down 37%. It has been shown[11] that lacto-ovo vegetarians have a greater bone mass than omnivores. Since meat is high in phosphates and since this type of vegetarian uses dairy products having a Ca/P ratio of about 1, this lends credence to the hypothesis that a balance between calcium and phosphate is beneficial. Most of the dietary phosphorus is absorbed as free phosphate. With normal intakes of phosphorus, absorption efficiency is 60-70%; this may be lowered when a significant amount of dietary phosphate is obtained from cereals and seeds which contain phytate, an organic ester of phosphate which is not readily digestible (see also the section "Drugs and Calcium Absorption").

Age and Calcium Absorption

In young people who are still growing, the efficiency of dietary calcium absorption is 75%, but it drops to 30-60% in adults.

Calcium absorption declines with age, so an additional complicating factor is involved. In actively growing children, about 75% of the available dietary calcium is absorbed; in adults on a normal diet, this figure may drop to 30-60%. Thus, even in calcium-adequate diets there may be a reduced uptake of available calcium. Some of the reduction in absorption may be due to reduced circulating levels of $1,25(OH)_2D_3$. It has been postulated that there is a mild, compensatory parathyroid-mediated bone loss with aging. Other hypotheses suggest that overall bone loss is a function of imbalance between formation and resorption of bone caused by physical inactivity or steroid deficiency.

Another contributing factor to decreased calcium absorption may be the amount of dietary fiber. Although believed to have beneficial effects on lowering serum lipid levels and preventing gastrointestinal tract problems, fiber can effectively bind minerals such as calcium. For a review, see the recent work by Heany et al.[10] Long-term studies have not been performed to determine whether the fiber content of diets might have serious consequences for calcium balance. The apparent mechanism for the bone loss would dictate the most efficacious treatment. Total vegetarians may have lowered bone mass (as opposed to lacto-ovo vegetarians who have been shown to have elevated bone mass),[11] and may refuse calcium supplements as "unnatural." Their rigid exclusion of dairy products from the diet may be extended to their children as well. These patients should be counseled about the short- and long-term hazards of these dietary practices, both for themselves and especially for their children. Fortunately, it is relatively easy for an adolescent to meet the RDA for calcium because foods such as cheese pizza, cheeseburgers, yogurt, milkshakes, etc. find high acceptability in this age group.

Drugs and Calcium Absorption

Laxatives and antacid abuse are common causes of poor calcium absorption.

There are a number of commonly used prescription and over-the-counter preparations which may interfere with calcium uptake or metabolism. As mentioned previously, antacid (aluminum hydroxide-containing antacids such as Maalox, Mylanta, Amphojel, and Gelusil) abuse may lead to phosphorus depletion, which in turn could precipitate osteomalacia. The condition is reversible when the abuse ceases and phosphorus is repleted. Heavy antacid use may be the result of self-medication, but it is also seen in patients with ulcers or in those receiving glucocorticoid when it is administered to reduce the risk of ulcers.[12] The practice of taking these antacids shortly after eating undoubtedly reduces phosphorus availability. Furthermore, much of the dietary phosphorus may be present as phytate, which is available only after hydrolysis. The activity of the intestinal enzyme (phytase) responsible for this reaction is believed to be dependent upon vitamin D. Other drugs, such as cellulose phosphate, an ion exchange resin, bind calcium itself. Similar findings have been reported for cholestyramine resins. Long-term use of colestipol, a bile acid sequestrant, may also change serum calcium levels, perhaps by altering vitamin D absorption. Since calcium is more readily absorbed in an acidic rather than in an alkaline environment, patients with achlorhydria also have lowered calcium absorption.

Laxative abuse may limit calcium absorption, perhaps by decreasing transit time of nutrients in the gut. Phenolphthalein, a common laxative, has been reported to be associated with osteomalacia.[12] Drugs which have a toxic effect on the mucosal cell lining would all be expected to have effects of varying severity on calcium and phosphate uptake, depending upon the degree of damage to the mucosal lining. The drugs which interfere with calcium absorption are summarized in Table 21-9. For patients receiving these treatments, adequate calcium intake should be ensured. If dietary intake is inadequate, then supplements should be used.

Calcium can have an adverse effect on the absorption of certain drugs as well. One of the most notable cases is tetracycline, which combines with calcium to form a nonabsorbable complex. Further, use of tetracycline during the last half of pregnancy, infancy, and childhood (to age 8) may result in a child's having permanently mottled teeth that are extremely susceptible to decay. Some antibiotics such as penicillin, chloramphenicol, and neomycin, however, actually increase absorption of dietary calcium.

Table 21-9. Drugs Which Interfere With Calcium Absorption

Aluminum-containing antacids	
	Maalox
	Mylanta
	Amphojel
	Gelusil
Exchange resins	
	Cellulose phosphate
	Cholestyramine
	Colestipol
Anticonvulsants	
	Phenytoin
Antibiotics	
	Tetracycline
Laxatives	
	Phenophthalein

Treatment of Osteoporosis

Calcium Supplementation

Calcium from several types of supplements is readily available, but calcium carbonate supplements provide the highest percentage of calcium, by weight.

The easiest way to provide additional calcium, besides rational food choices, is by exogenous supplementation. Not all supplements provide the same amount of calcium by weight. The amount of calcium in various preparations is shown in Table 21-10.

Calcium carbonate provides the highest percentage of calcium per weight of pill. This may be an important consideration when there is a need to provide considerable supplemental calcium. All of the preparations are about equally absorbable and comparable to the absorption of calcium from milk. Dairy products have the advantage, however, of having an optimal ratio of Ca/P. These supplements should be taken throughout the day along with a small amount of milk or yogurt, both of which contain vitamin D and lactose which promote the absorption of calcium from the gastrointestinal tract.

Table 21-10. Calcium Content of Common Supplements

Preparation	% of Calcium (by wt)	Note
Calcium carbonate	40%	Contained in antacids such as Tums
Calcium phosphate	31%	See bone meal
Calcium lactate	13%	Poor absorption
Calcium gluconate	9%	Poor absorption
Bone meal	31%	Contains other elements and may be contaminated with toxic metals
Dolamite	22%	Ingredient in several antacids; could be contaminated with toxic metals

At levels of calcium ingestion of greater than 2.5 gm/day, there may be calcification of soft tissues, hypercalciuria, hypercalcemia, and formation of urinary calculi.

Calcium does not appear to be toxic in the concentrations likely to be ingested, but it is possible to consume enough to produce side effects. These include hypercalcemia; hypercalciuria; calcification of the soft tissues, including the kidney and artery walls; formation of urinary calculi; and supression of bone remodelling. Under normal circumstances, these would not be a problem until consumption is greater than 2.5 gm/day. In patients on chronic renal dialysis, however, normal calcium homeostasis is greatly impaired; so strict attention must be paid to calcium balance. Vitamin D may be given to enhance calcium utilization. Another group of patients at risk are those with ulcers who drink large quantities of milk and consume similarly large quantities of antacids. not a recommended treatment modality. They may develop milk alkali syndrome which presents itself as hypercalcemia and alkalosis.

Fluoride Supplementation

Treatment of osteoporosis with combined fluoride and calcium therapy has proved beneficial.

Fluoride use has been suggested because it stimulates bone formation and has been reported to increase bone mass in osteoporotic patients.[13] Fluoride is incorporated into bone as a substitute for the hydroxyl groups in hydroxyapatite. Levels of 50mg NaF/day, plus 1 gm of calcium as calcium carbonate, have been used therapeutically. Some clinicians recommend lower doses for better tolerance. Sodium fluoride is available as a prescription. Ongoing studies and various biases do not allow us to recommend one standard dose at this time. Further, some epidemiological evidence[14] supports the notion that adequate fluoride intake reduces the incidence of osteoporosis. Since fluoride alone may cause defective bone mineralization, it has been suggested that calcium supplementation be an integral part of fluoride therapy. In some cases, fluoride therapy has been associated with rheumatic symptoms (joint pain and swelling), gastrointestinal symptoms (nausea, vomiting, blood loss anemia, and ulcers), or combinations of both. The amount of fluoride which is absorbable depends upon the degree of hardness of the local water supply. Hard water leads to the formation of insoluble calcium-fluoride complexes, thereby lowering fluoride absorption. Supplemental fluoride is currently recommended only in the therapy of osteoporosis, not in prevention. The average diet contains 0.2 - 0.6 mg fluoride/day.[14] Diets high in seafoods or tea provide additional amounts. Fluoridated water is the best source of fluoride and is completely safe in the amounts currently added to the water supply.

Fluoridated water consumed during the period before tooth eruption provides the greatest protection against dental caries.

It has long been known that fluoride consumed during tooth development provides protection against dental caries once the teeth have erupted. Fluoride concentrations in the water of greater than 1 ppm produce this protective effect. Excessive fluoride (greater than 3 ppm in water) consumed during periods of tooth development, however, results in a mottled appearance of the tooth enamel. Topical fluoride applied after the teeth have erupted is less effective. Since developed teeth have limited ability to repair themselves and virtually no communication with systemic circulation, the environment of the mouth is more important in considering any potential effects of topical or ingested fluoride. It may be possible, however, that fluoride interferes with the metabolism of the oral bacteria rendering them less cariogenic.

Vitamin D Supplementation

If vitamin D is used in the treatment of osteoporosis, it should be done with caution because of the potential toxic effects.

Vitamin D status obviously impacts on osteoporosis treatment. Dietary sources of the vitamin are found naturally in oily fish, eggs, liver, and fortified products such as milk, which is required by law to have 10μg/qt (400 IU/qt). The average daily intake in the U.S. is between 4 and 6μg. Studies of the vitamin D status in the older segments of the population are sketchy.[15] Requirements in the elderly have not been clearly defined. Some studies have been unable to show a beneficial effect of vitamin D supplementation on reducing osteoporotic fractures. Vitamin D is stored in fatty tissue and can build up to toxic levels, resulting in elevated serum calcium and nephrocalcinosis. This led investigators to suggest that since vitamin D supplements could result in toxic doses and since hypercalcemia and hypercalciuria have been observed with vitamin D supplementation, vitamin D should not be used therapeutically.[10] Other practitioners include vitamin D (400-800 IU/day) in a combined treatment regimen with fluoride (0.1 mg/kg bodyweight) and calcium (1500 mg/day).[16] If a vitamin D supplement is used, it would seem wise to use a dose similar to the RDA, which is 400 IU/day.

Estrogen Supplementation

Estrogen therapy for osteoporosis should be used only with caution and is most effective immediately after the onset of menopause.

Estrogen therapy begun soon after the onset of menopause slows bone loss; therapy begun later is less effective. It has been reported that 1,25 $(OH)_2D_3$ and calcitonin are increased in estrogen therapy. Estrogen may act on osteoclastic precursors in bone by raising the threshhold for PTH sensitivity. As summarized by Saville,[17] studies reported that 0.625 mg/day of conjugated equine estrogen, 1 mg/day of estradiol-17B, or 0.15 mg/day ethynyl estradiol are effective and minimize side effects. Estrogen therapy itself carries some additional risks.[18] One of these is a 3-7 times greater risk of endometrial cancer. Use of progestins in a cyclic treatment (at least for 10 days/month) for patients with an intact uterus may ameliorate some of the risk of estrogen use.

Use of estrogen therapy entails some special precautions: patients must be closely monitored for symptoms of breast and uterine cancer, and the smallest doses of estrogen possible should be used. The finding that additional calcium (1 gm/day) compensates for the lack of estrogen[17] makes the use of estrogen supplementation a matter for considerable deliberation. Women undergoing oophorectomy at early ages would be candidates for estrogen therapy, as would thin, white women with multiple risk factors present for osteoporosis. All women receiving or contemplating the use of estrogen should be counseled about the relative risks involved with estrogen use.

Exercise is an important component of maintenance of healthy bones. Patients should be encouraged to continue moderate exercise throughout their lives.

Finally, the effects of exercise must be considered. It has long been known that bone mass decreases with immobilization. This has been further substantiated by

investigations into the effects of weightlessness in space-flight studies.[19,20] Exercise may not only slow bone loss rates but may actually increase bone mass, providing there is adequate dietary calcium available. There does seem to be an optimal level of exercise. A recent report[21] has indicated that women joggers who trained with sufficient intensity to become amenorrheic also suffered bone demineralization, even though the average age of the women was only 25. It seems appropriate to counsel patients that walking and swimming in amounts that promote cardiovascular fitness are desirable. Even bed-ridden patients should be encouraged to do whatever isometric exercises are possible, taking into account their particular physical limitations.

Summary

Osteoporosis is the loss of bone mass resulting in increased fracture risk, particularly of the wrist, hip, and spine. Postmenopausal, white women of European extraction are at the greatest risk. Since the degree of risk is related to the peak bone mass attained early in adulthoood, the most effective measures are aimed at providing adequate calcium nutriture and plenty of exercise during this time period. Once osteoporosis is evident, there is little chance of reversal. Calcium supplementation alone or with combinations of fluoride and/or vitamin D have been used with some success. Estrogen therapy, which entails some additional risks, may also be used. Exercise is very important in arresting further bone loss in this population group. A chart of appropriate follow-up questions for different patient age groups is included to aid in monitoring information exchange with the patient (Table 21-11).

Table 21-11. Patient Information Exchange for Optimal Bone and Teeth Health

	Patient Age (Years)								
Exam types	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	>80
Questions	Well Baby School	School Employment	Employment Pap Smears Insurance	Employment Pap Smears Insurance	Employment Pap Smears Insurance	Employment Pap Smears Insurance	Employment Pap Smears Insurance	Pap Smears Routine	Pap Smears Routine
1. Fluoridated H_2O	X	X	X	X	X	X			
2. Topical fluoride		X	X	X	X	X	X		
3. Calcium intake	X	X	X	X	X	X	X	X	X
4. Exercise	X	X	X	X	X	X	X	X	X
5. Weight advice	X	X	X	X	X	X	X	X	X
6. Laxative abuse		X	X		X	X	X	X	X
7. Antacid abuse				X	X	X	X	X	X
8. Stature (ht.)	X	X	X	X	X	X	X	X	
9. Estrogen supplements					X	X			
10. Fractures					X	X	X	X	X
11. Vitamin status (dietary and supplements, especially vitamin D)	X	X	X	X	X	X	X	X	X
12. Glucose tolerance (diabetes)				X	X	X	X	X	X

Evaluation

Evaluation in this module is approached factually. Awareness of the problems associated with the maintenance of healthy bones and teeth is the key to successfully managing this component of your patients' health. Answer the following questions, and check your answers by referring to the appropriate section.

1. When should measures be initiated to prevent or retard the effects of osteoporosis?
2. What type of bone is affected by osteoporosis, and where is this bone found?
3. If a child is seen with massive decay of the upper front teeth, to what may the problem be attributed?
4. How is vitamin D related to bone growth and development?
5. What are the risk factors for osteoporosis?
6. What steps can be taken to prevent osteoporosis?
7. How can osteoporosis be treated?

If you have competed the above questions and wish to further test the knowledge you obtained from the module, do the following:

1. Select a patient from your practice who is at risk for osteoporosis.
2. Design a preventive and/or treatment plan for the patient. Include in your own plan both the medical management of the patient and what patient education you would conduct.
3. Present your patient and your plan to fellow physicians, faculty, and nutrition specialists. Discuss its strengths and weaknesses.

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Resources for Patients

Administration on Aging
Office of Human Development
U.S. Dept. of Health and Human Services
Washington, D.C. 20201

American Dietetic Association
Publication Department
620 N. Michigan Ave.
Chicago, Illinois 60611

American Medical Association
535 N. Dearborn St.
Chicago, Illinois 60610

Building Sound Bones and Muscles
O.E. Allen, Editor
Library of Health (1980)
Time-Life Books
Alexandria, VA 22310

Extension Service/Home Economics
U.S. Dept. of Agriculture
Washington, D.C. 20250
(or see your local county extension agent)

Pamphlet Series on Calcium
National Dairy Council (1984)
6300 N. River Rd.
Rosemont, Illinois 60018

J. Brody
"Calcium, the Vital Mineral"
Family Circle 3/6, 62-65, 1984.

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Triad Publishing Co. (1984)
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a page number followed by a "t" indicates a table, an "f" refers to a figure.

Some Abbreviations Used in the Nutrition in Primary Care Series

ATP	adenosine triphosphate
c	cup
cc	cubic centimeter
CNS	central nervous system
FDA	Food and Drug Administration
gm	gram
IBW	ideal body weight
IU	International Units
kcal	kilocalorie
kg	kilogram
lb	pound
lg	large
MCV	mean corpuscular volume
MDR	minimum daily requirement
med	medium
μg	microgram
mEq	milliequivalent
mg	milligram
MJ	megajoule
ml	milliliter
oz	ounce
RDA	Recommended Dietary Allowances
RE	retinol equivalents
sl	slice
sm	small
Tbsp	Tablespoon
TPN	total parenteral nutrition
tsp	teaspoon
USDA	United States Department of Agriculture