OVERCOMING THE BARRIER OF LACTOSE INTOLERANCE TO REDUCE HEALTH DISPARITIES

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Federal health goals for the public have focused on reducing health disparities that exist between whites and various racial and ethnic groups. Many of the chronic diseases for which African Americans are at greater risk—hypertension, stroke, colon cancer, and obesity—may be exacerbated by a low intake of calcium and/or other dairy-related nutrients. For example, a low intake of dairy food nutrients, such as calcium, potassium, and magnesium, may contribute to the high risk of hypertension seen in African Americans. The Dietary Approaches to Stop Hypertension (DASH) study demonstrated that a low-fat diet rich in fruits and vegetables (8 to 10 servings) and low-fat dairy foods (3 servings) significantly reduced blood pressure—and was twice as effective in African-American participants. Calcium and dairy food consumption is particularly low among African-American, Hispanic. and Asian populations. Average intakes are near the threshold of 600 to 700 mg/day, below which bone loss and hypertension can result. Although lactose intolerance may be partly to blame for the low calcium intakes due to reduced dairy food consumption by minority populations, culturally determined food preferences and dietary practices learned early in life also play a role. The high incidence figures for primary lactose maldigestion among minority groups grossly overestimates the number who will experience intolerance symptoms after drinking a glass of milk with a meal. Randomized, double-blind, controlled clinical trials have demonstrated that by using a few simple dietary strategies, those who maldigest lactose (have low levels of the lactase enzyme) can easily tolerate a dairy-rich diet that meets calcium intake recommendations. Physicians and other health professionals can help their minority patients and the general public understand how to improve calcium nutrition by overcoming the surmountable barrier of lactose intolerance. At the same time they will be helping to reduce the incidence of calcium-related chronic diseases for which minority populations are at high risk. (*J Natl Med Assoc.* 2002;94:55–66.)

Key words: lactose maldigestion ♦ lactose intolerance ♦ calcium deficiency ♦ ethnicity

Federal health goals for the public have focused on reducing health disparities that exist between whites and various racial and ethnic groups.[1] It is well documented, for example, that African Americans have a greater risk for hypertension, stroke, colon cancer, and obesity than do whites. Although these seemingly disparate diseases are multifactorial, research over the last several years suggests that a low calcium intake and disordered calcium metabolism is a contributing factor in their etiology.[2]

It is widely recognized that the calcium ion

Table 1. Disorders Related to Low Calcium Intake[2]

As a Result of		
Decreased Calcium Reserve	Decreased Food Residue Calcium in Chyme	Adaptive Mechanisms Maintaining Extracellular Ca^{2+}
Osteoporosis	Colon cancer Kidney stones	Hypertension Pre-eclampsia Premenstrual syndrome Obesity Polycystic ovary syndrome (Hyperparathyroidism)

acts as an intracellular second messenger, mediating several diverse biochemical processes (i.e., as muscle contraction, interneuronal synaptic signal transmission, glandular secretion, cell division, and blood clotting). These biochemical functions are well protected by a complex system involving the calcium reserves (the skeleton) and endocrine control, and so are virtually never compromised. Diseases of calcium nutrition deficiency arise when chronic low calcium intakes result in: 1) depletion of the skeletal reserve, 2) a continuous homeostatic adaptive response in an attempt to compensate for low intake; and 3) the physical chemical effects of high calcium levels in the intestinal lumen are diminished.[2] (Table 1)

The health consequences of avoiding dairy foods, the major source of dietary calcium, are particularly serious for African Americans, Hispanics, Asians, and Native American Indians—who are at high risk for calcium-related chronic diseases (Table 2). African Americans for example, have the highest rates of hypertension of all ethnic groups, develop hypertension earlier, and have increased mortality from hypertension-related sequelae (i.e., stroke and cardiovascular and renal disease).[3] A low intake of dairy food nutrients, such as calcium, potassium and magnesium may contribute to an African-American person's high risk of hypertension and stroke.[4–8] The DASH randomized, multicenter controlled feeding study conducted among 459 adults—two thirds of whom were African-American and other racial/ethnic minorities—demonstrated that a combination diet, low in fat and rich in fruits and vegetables (8 to 10 servings/day) and low-fat dairy foods (3 servings/day) significantly reduced blood pressure in those with normal blood pressure and as much as drug monotherapy in those with mild hypertension. The researchers say that a population-wide reduction in systolic or diastolic blood pressure of the magnitude observed with the combination diet has important clinical and public health relevance, as it would reduce incident coronary heart disease by an estimated 15% and stroke by 27%.[9]

A subgroup analysis of the DASH trial found that the combination diet was effective at reducing blood pressure in all groups tested (African Americans and whites, men and women, older and younger, obese and lean, higher and lower income, sedentary and active, hypertensive and normotensive), but was most effective in African Americans with hypertension. The DASH combination diet reduced blood pressure in African Americans with high blood pressure by 13.2/6.2 mm Hg, when compared to a typical Western diet low in dairy products, fruits, and vegetables—which was twice the effect on white hypertensive participants (−6.3/−4.4 mmHg).[10]

Subsequently, the DASH Collaborative Research Group has published the results of additional studies, further confirming the benefits of the DASH eating pattern on additional aspects of cardiovascular risk such as blood homocysteine and lipid levels, and stage 1 isolated systolic hypertension.[11–13] In addition, the American Heart Association 2000 Dietary Guidelines places an increased emphasis on foods and an overall eating pattern to reduce the risk of cardiovascular disease.[14] The American Heart Association guidelines recommend the DASH diet (5 to 9 servings of fruits and vegetables and 2 to 4 servings of dairy products) as a recommended lifestyle approach to reduce and maintain blood pressure, and to maintain an adequate intake of calcium, potassium, and magnesium. The report emphasizes, "The preferred strategy for increasing mineral

Table 2. Minorities' Risk of Calcium Deficiency-Related Diseases[52]

- **Hypertension and Stroke**
  Compared to whites, African Americans develop high blood pressure at an earlier age and it is more severe at any decade of life. Consequently, African Americans have a 1.3 times greater risk of nonfatal stroke, a 1.8 times greater rate of fatal stroke, a 1.5 times greater risk of heart disease death, and a 5 times greater risk of end-stage kidney disease than whites.
- **Colon and Rectal Cancer**
  African Americans are more likely to develop and die from colon and rectal cancer than any other racial and ethnic group in the U.S.
- **Overweight and Obesity**
  African-American and Mexican-American adults have a higher prevalence of overweight and obesity than white adults.
- **Osteoporosis**
  Preliminary data from the National Osteoporosis Risk Assessment indicate that low bone density occurs in 65% of Asian women, 59% of American-Indian women, 55.6% of Hispanic women, 50.5% of white women, and 38% of African-American women. The National Osteoporosis Foundation estimates that 300,000 African-American women have osteoporosis. Additionally, between 80% and 95% of fractures in African-American women over age 64 are due to osteoporosis. Also, African-American women are more likely than white women to die following a hip fracture.

intake is through foods rather than supplements."

Low calcium intakes are recognized as a major public health problem in the United States, with more than 75% of Americans not meeting the current calcium recommendations for their age/gender group.[15] National consumption surveys reveal that the calcium consumption of African Americans and Hispanics is particularly low (Fig. 1). It is not surprising that consumption of dairy foods, which provide 72% of the calcium in the U.S. food supply,[16] is also lower in these ethnic groups when compared to whites (Fig. 2). These intakes are near the threshold of 600 to 700 mg of calcium, below which bone loss and hypertension result.[17]

Although lactose intolerance may be partly to blame for the low calcium and dairy food intakes of African-American, Hispanic, and Asian people, other factors such as culturally determined food preferences and dietary practices learned early in life also play a role. Researchers examining the food preferences and eating attitudes of three generations of women, for example, found that drinking milk (or coffee) with meals is more preferred by white than African-American women.[18] They found that the African-American college-age women's low preference for drinking milk at meals was more similar to that of African-American mothers and grandmothers than to those of white women students their own age.

However, there is evidence that acculturation (the process of adapting to a new society)

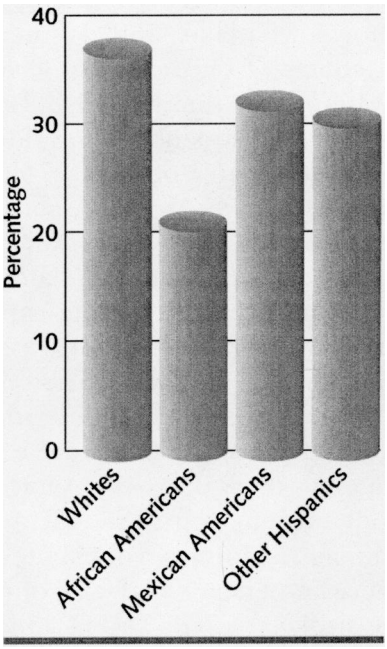

Figure 1. Percentages of Individuals with Diets at or Above 100% of the 1989 Recommended Dietary Allowances (RDAs) for Calcium.[16]

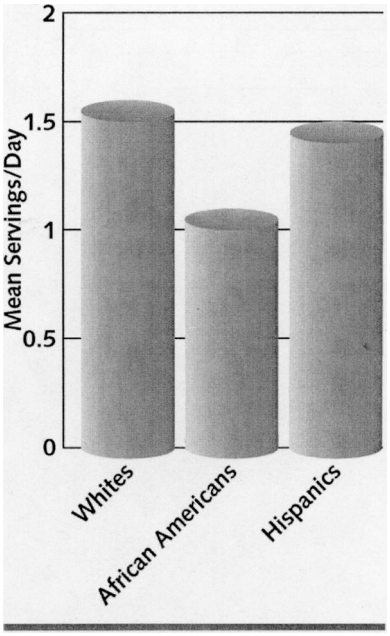

Figure 2. Mean Number of Servings of Dairy Products Consumed/Day[15]. USDA's Food Guide Pyramid recommends 2 to 3 servings of dairy products/day.

of Asian American and Hispanic Americans positively influences dietary patterns of calcium and milk consumption.[19,20] For example, a study of Hispanic Americans reported that acculturation led to moderate increases in milk consumption of 6% to 8%.[20]

It is understandable how an unpleasant experience of gastrointestinal symptoms after drinking milk might create an aversion and avoidance of milk drinking in the future. Data from most studies suggest that individuals with primary lactose deficiency consume less milk than those who digest lactose normally,[21–23] even although avoiding milk may not be a conscious decision[24,25] Horowitz et al.[24] found that although only 5% of the lactose maldigesters he studied reported a history of milk intolerance, they drank significantly less milk (<1 cup/day) than those who digested milk normally (2 cups/day). Newcomer et al.[25] observed a similar phenomenon. Patients diagnosed as lactose maldigesters by the breath hydrogen test were not aware of milk intolerance, yet their intake of milk and calcium was significantly lower than that of lactose digesting subjects.

Yet, consuming dairy foods is an easy way to meet calcium needs.[26] An 8-ounce serving of milk or yogurt or 1 1/2 ounces of cheese contain approximately 300 mg of calcium. A number of nondairy foods, such as salmon with bones and some green leafy vegetables, such as broccoli and kale, also contain calcium, although in smaller amounts[27] (Fig. 3). In addition to calcium content, bioavailability of calcium ranges from 5% (spinach) to more than 50% (bok choy and broccoli), and should be considered when choosing a calcium source (Table 3).[28,29]

A National Institutes of Health Expert Panel recommends dairy foods as the preferred source of calcium, followed by calcium-fortified foods and calcium supplements.[29] Studies in children, adolescents, and adults have shown that increasing dairy food intake improves the intake of several other nutrients.[30–33] Dairy foods provide at least 20% of the daily value of calcium, vitamin D (fortified milk and some yogurts), riboflavin, and phosphorus, and at least 10% of the daily value of protein, potassium, vitamins A and B_{12}, and niacin. In addition, dairy foods contribute 16.2% of the zinc, 15.8% of the magnesium, and 8.7% of the vitamin B_6 to the U.S. food supply.[16] Individuals who choose not to consume dairy foods because of cultural preference, milk allergy, animal rights concerns or other reasons, will need to rely more heavily on calcium-fortified foods and calcium supplements to meet calcium recommendations.

Much is now known about the maldigestion of lactose.[4,34] Controlled clinical trials among lactose maldigesters have helped put the practical significance of this condition into perspective and have fostered the development of several simple strategies that allow those with low lactase activity to consume dairy products without experiencing the unpleasant symptoms of intolerance (Table 4). It is possible for symptomatic lactose maldigesters to achieve adequate calcium intake if they incorporate the

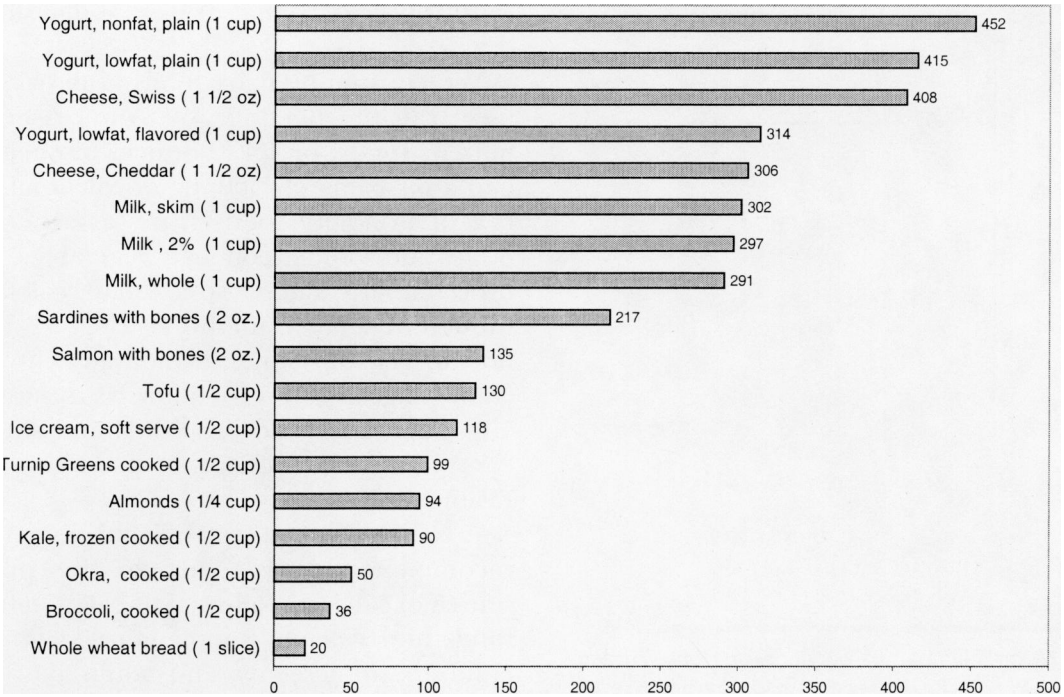

Figure 3. Calcium Contribution of Foods.

dietary management strategies into daily living.[35]

LACTASE NONPERSISTENCE

All young mammals and human infants (except those with a congenital defect) are born with high levels of the enzyme "lactase," which enables them to digest lactose, the primary carbohydrate in milk. Lactase activity declines after weaning in most racial/ethnic groups except most white North Americans and northern Europeans, so that by approximately 3 to 5 years of age, when the child is consuming a variety of foods, lactase levels are low.[36] This condition is called primary lactase nonpersistence, or lactase deficiency. It is genetically determined and is inherited as an autosomal recessive trait. In contrast, lactase persistence is inherited as an autosomal dominant characteristic.[2,37] Secondary lactase deficiency, a temporary condition that can occur at any age, is caused by environmental factors (e.g., infectious diarrheal disease, radiation, certain medications) that injure the intestinal mucosa in which lactase is expressed. Secondary lactase deficiency is reversed upon correction of the underlying cause.

Scientific investigations from many different disciplines, including biochemistry, cultural anthropology, and nutrition have added to our knowledge about lactose digestion. As a result of these studies, we have learned that: (1) the ability to digest lactose in adults is most common in northern Europeans and white American ethnic groups; (2) the trait is genetically transmitted; (3) the activity of the enzyme can not be "induced" by continued exposure to lactose; but (4) adaptation in the colon may improve tolerance to continued milk intake.

LACTOSE INTOLERANCE DEFINED

Limited digestion of lactose can lead to unpleasant gastrointestinal symptoms of varying severity, termed lactose intolerance. As undigested lactose reaches the colon, it is fermented by gas-producing bacteria and may cause bloating, flatulence, abdominal pain and diarrhea. Symptoms result when the amount of

Table 3. Comparison of Sources of Absorbable Calcium With Milk

Food	Serving size* (g)	Calcium Content† (mg)	Fractional Aabsorption‡ (%)	Estimated Absorbable Calcium§ (mg)	Servings Needed to Equal 240 mL Milk (n)
Milk	240	300	32.1	96.3	1.0
Beans					
Pinto	86	44.7	26.7	11.9	8.1
Red	172	40.5	24.4	9.9	9.7
White	110	113	21.8	24.7	3.9
Bok choy	85	79	53.8	42.5	2.3
Broccoli	71	35	61.3	21.5	4.5
Cheddar cheese	42	303	32.1	97.2	1.0
Cheese food	42	241	32.1	77.4	1.2
Chinese cabbage flower leaves	85	239	39.6	94.7	1.0
Chinese mustard greens	85	212	40.2	85.3	1.1
Chinese spinach	85	347	8.36	29	3.3
Fruit punch with calcium citrate malate	240	300	52.0	156	0.62
Kale	85	61	49.3	30.1	3.2
Spinach	85	115	5.1	5.9	16.3
Sweet potatoes	164	44	22.2	9.8	9.8
Rhubarb	120	174	8.54	10.1	9.5
Tofu with calcium	126	258	31.0	80.0	1.2
Yogurt	240	300	32.1	96.3	1.0

*Based on half-cup serving size (≈85 g for green leafy vegetables) except for milk and fruit punch (1 cup or 240 mL) and cheese (1.5 oz).
†From references 4 and 5 (averaged for beans and broccoli processed in different ways) except for the Chinese vegetables, which were analyzed in our laboratory.
‡Adjusted for load by using the equation for milk [fractional absorption = 0.889–0.0964 in load (6)] then adjusted for the ratio of calcium absorption of the test food relative to milk tested at the same load, the absorptive index. The absorptive index was taken from the literature for beans (7), bok choy (8), broccoli (8), Chinese vegetables (9), fruit punch with calcium citrate malate (10), kale (8), sweet potatoes (9), rhubarb (9), tofu (11), and dairy products (12).
§Calculated as calcium content × fractional absorption. All references in this table are included in reference 28. Table reproduced with permission of the *American Journal of Clinical Nutrition*. American Society of Clinical Nutrition.

lactose consumed exceeds the body's ability to break it down into its constituent sugars, glucose, and galactose. Therefore, the term lactose intolerance may be used more precisely by referring to the symptomatic response to a defined lactose load (i.e., tolerant to 12 g of lactose; intolerant to 24 g).

Determination of the presence and severity of symptoms is subjective, and may be influenced by factors other than the presence of lactose. For example, Johnson et al.[38] tested for milk tolerance in a subgroup of 45 African American subjects who had confirmed lactose maldigestion and intolerance to 25 g of aqueous lactose. Subjects were given either 315 mL of lactose-containing milk or lactose-hydrolyzed milk alternately on three different days in a double-blind test. One third of the subjects experienced symptoms of intolerance to both types of milk, indicating that their symptoms were not due to lactose. The authors conclude that social and cultural habits and attitudes also affect tolerance to milk drinking.

Because the symptoms of lactose intolerance are nonspecific (i.e., flatulence, bloating), it is impossible to know without testing if the symptoms are caused by lactose, a learned aversion, or some other gastrointestinal problem. A diagnosis of lactase nonpersistence or lactose maldigestion can be determined definitively by an objective test, such as the breath hydrogen test (Table 5). Lactase deficiency is seldom to-

Table 4. Strategies for Improving Tolerance to Dairy Foods

1. **Adjust the amount of lactose consumed.** Individuals differ according to how much lactose they can tolerate at any one time. Start with less than one cup of milk with food and gradually increase the amount just until symptoms begin to develop.
2. **Drink milk with a meal or snack.** This slows gastric emptying and/or delivery of lactose to the colon, allowing more time for any remaining lactase enzyme to digest lactose.
3. **Choose wisely.** Some dairy foods are better tolerated than others.
   - *Yogurts* with "live, active cultures" are well tolerated.
   - *Whole milk* may be better tolerated than lower fat milk.
   - *Chocolate milk* may be better tolerated than unflavored milk.
   - *Many cheeses,* especially aged cheeses such as cheddar, colby, Swiss, and Parmesan, are low in lactose and generally well tolerated.
   - *Sweet acidophilus milk, yogurt milk, and other fermented dairy foods* are tolerated as least as well as milk.
4. **Try lactose-free or lactose-reduced products.** Lactose-hydrolyzed milk and other dairy foods contain the same nutrients, including calcium, as their regular counterparts. You can also use commercial lactase preparations (capsules, chewable tablets, solutions). Drops of liquid lactase can be added to milk to break down much or all of its lactose. Or, oral lactase tablets can be taken before consuming lactose-containing foods.
5. **Train for tolerance.** Gradually increasing intake of lactose-containing foods improves tolerance to lactose. Continued exposure to lactose may enhance the efficiency of colonic bacteria to metabolize lactose, thereby producing fewer intolerance symptoms.

tal, and those with limited lactose digestion may or may not experience intolerance symptoms. Whether an individual experiences symptoms depends on the level of lactase activity remaining, the amount of lactose consumed, gastrointestinal transit,[39] and the ability of the colon microflora to metabolize lactose.

PREVALENCE OF PRIMARY LACTOSE MALDIGESTION

It is estimated that up to 75% of the world's adult population and approximately 25% of American adults, have a genetically controlled limited ability to digest lactose.[40] In the United States, some degree of primary lactose maldigestion occurs in an estimated 15% (6% to 19%) of whites, 53% of Mexican Americans, 62% to 100% of Native Americans, 80% of African Americans, and 90% of Asian Americans.[41] These population-wide incidence figures for lactose maldigestion were based on studies employing a breath hydrogen test using a challenge dose of 50 g of lactose in water. Although effective for diagnosing lactose maldigestion, this test grossly overestimates the likelihood that an individual will experience

Table 5. The Breath Hydrogen Test

This test has become the "gold standard" or method of choice for diagnosing lactose maldigestion. When lactose (or other dietary sugar) is not completely absorbed, the unabsorbed portion is fermented by colonic bacteria, forming hydrogen—some of which is absorbed into the portal circulation and exhaled in breath. Test protocol:[63]

1. A baseline breath sample is taken from the patient after an overnight fast.
2. Patients are given a 2% aqueous solution of 2 g of lactose per kg of body weight (10–50 g) to drink.
3. Breath samples are taken every 30 minutes for 3 hours. Samples are collected in test tubes and the hydrogen in breath is analyzed by gas chromatography.
4. An increase in breath hydrogen of >10 to 20 ppm above the baseline value is positive for lactose maldigestion.

Hydrogen production is proportional to the lactose dose. When the dose of lactose given is small (10–12 g) the criteria of ≥10 ppm is diagnostic of lactose maldigestion. However patients with a breath hydrogen rise of only 10 ppm are less likely to experience intolerance symptoms than those with a higher rise.

Table 6. Self-Described "Lactose-Intolerant" Individuals and Lactose Maldigesters Can Tolerate the Amount of Lactose in a Serving or More of Milk and Other Dairy Foods

Study	Subjects	Lactose Dose (g) Breath Hydrogen Test	Lactose Digesters	Lactose Maldigesters	Milk Products Tested	Results
Suarez et al.	30 self-described LI racially mixed adults	15 g	30%	70%	One cup of milk (12 g lactose) with breakfast	All tolerant
Suarez et al.	49 self-described LI racially mixed adults	15 g	31%	69%	Two cups of milk/day consumed in divided doses with breakfast and dinner	All tolerant
Suarez et al.	62 female racially mixed adults	15 g	50%	50%	One cup of milk at breakfast; 1 ounce of cheese and 8 ounces of yogurt at lunch; one cup of milk and one ounce of cheese at dinner	All tolerant; increased flatus frequency rated "trivial" in maldigesters

LI, lactose intolerant.

symptoms of intolerance after consuming a glass of milk (12 g of lactose) with a meal.

PRACTICAL SIGNIFICANCE OF LACTOSE MALDIGESTION

Results of double-blind, randomized, crossover trials indicate that most individuals (African Americans, other minorities, and whites) with primary lactase deficiency can tolerate 1 cup (240 mL) of milk with a meal or 2 cups (480 mL) if consumed in divided doses with breakfast and dinner.[42,43] Most recently, the same investigators found that women with limited lactose digestion can eat a dairy-rich diet that includes milk, yogurt, and cheese, supplying approximately 1500 mg of calcium per day, without major impediment[44,45] (Table 6).

MINORITIES BENEFIT FROM INCREASED CALCIUM AND/OR DAIRY FOOD INTAKE

A meta-analysis of 66 randomized, controlled trials of calcium and hypertension found that the effect of dietary calcium on systolic and diastolic blood pressure was twice as large as the effect of calcium supplements.[46] The effect of calcium on blood pressure in the nine trials in which calcium was supplied by dairy foods was very consistent and homogeneous, whereas there was a marked heterogeneity of response in the trials utilizing calcium supplements. It has been suggested that factors tracking with calcium from dietary sources (i.e., other dairy nutrients) in these studies may have been essential in eliciting an optimal and consistent benefit of increased calcium intake.[7]

In a large, prospective cohort study of 34,486 postmenopausal Iowa women, Bostick et al. reported that a high intake of total calcium (whether from food or supplements) was associated with a 30% to 35% reduction in death from ischemic heart disease.[47]

Dwyer et al.[48] demonstrated that calcium supplementation can lower diastolic blood pressure in African-American adolescents with low dietary intakes of calcium. This is a subgroup of the population who consistently consumes suboptimal amounts of dietary minerals and in whom cardiovascular risk factors cluster

early in life. Although the study by Dwyer used calcium supplements to increase calcium intake, a recent study demonstrated that African-American adolescents can adapt to a dairy-rich diet.[49] Although 82% of the African-American teens were lactose maldigesters, both lactose digesters and lactose maldigesters reported no or minimal gastrointestinal symptoms following lactose challenges (0.35 g/kg).[49]

Previous studies have also shown that regular intake of lactose-containing foods can actually improve tolerance to lactose.[50,51] The mechanism by which adaptation occurs is not completely understood. Johnson et al.[50] propose the following mechanisms: (1) The presence of unhydrolyzed lactose in the colon stimulates organic acid production, which lowers the pH inhibiting further fermentation and hydrogen production, (2) undigested lactose may alter the composition of colonic bacteria by reducing the number of gas-forming bacteria in favor of nongas-producing organisms, or (3) lactose in the colon stimulates colonic bacterial fermentation and the removal of end products.

In the DASH trial, African Americans who consumed three servings per day of dairy foods as part of the combination diet experienced a reduction in blood pressure twice that of white participants, but without any symptoms of lactose intolerance. Recognizing that some of the minority participants may be lactose intolerant, DASH nutritionists designed the meal plans using simple dietary strategies to minimize any symptoms. These included offering fluid milk in small portions with meals, low-fat cheese, and yogurt. Lactose digestive aids also were available, if needed. [52]

Diets high in energy, total fat, saturated fat, and cholesterol are associated with an increased risk for obesity, type 2 diabetes, and cardiovascular disease. Therefore, when counseling individuals to increase their dairy food intake, it is important to do so in the context of current recommendations to consume a diet moderate in fat (<30% of calories) and saturated fat (10% or less of calories) and to maintain a healthy body weight. The DASH combination diet, which includes three servings of lowfat dairy foods per day within a total diet that meets current fat and saturated fat guidelines, can serve as a model diet that practitioners can use with clients.

Several studies have demonstrated that increasing intake of calcium using recommended amounts of dairy foods can be accomplished without necessarily increasing calorie or fat intake, body weight, or percent body fat.[53–56] For example, a randomized, placebo-controlled intervention study of adults ages 18 to 70 years demonstrated that calcium intake could be increased to 1500 mg/day with low-fat dairy foods without producing weight gain or an increase in blood lipid levels.[53] A recent study involving older adults aged 55 to 85 years assessed the effect of increasing consumption of skim or 1% milk by 3 cups per day for 12 weeks (without other dietary advice) on blood pressure, body weight, and blood lipid levels.[54] Compared with controls, participants in the milk group increased their intake of several nutrients and had a small increase in body weight (0.6 kg), although it was less than predicted, indicating some compensation for the added energy from milk. Increasing milk intake had no effect on total and low-density lipoprotein cholesterol levels or on the ratio of total cholesterol to high-density lipoprotein cholesterol. Studies in children and adolescents demonstrate that dairy foods can be increased without increasing body weight or dietary fat intake.[55–56]

New research findings indicate that increasing calcium intake, especially from dairy foods, may help control body fat.[57–61] An early indication of this relationship came during the course of a clinical trial investigating the antihypertensive effect of calcium in obese African-American men. Increasing dietary calcium in these men by providing them with 2 cups of yogurt per day for 1 year resulted in a 4.9 kg loss of body fat.[57] Zemel et al.[57] subsequently tested and confirmed in transgenic mice the hypothesis that dietary calcium could reduce fat mass by suppressing adipocyte intracellular Ca^{2+} by suppressing the calcitropic hormone

1,25-$(OH)_2$-D. When transgenic mice expressing the *agouti* gene in adipocytes (model of diet-induced obesity) were fed high-calcium diets varying in the source (i.e., calcium carbonate or nonfat dry milk) for 6 weeks, the high-calcium diets reduced weight gain and fat pad mass by 26% to 39%. When calcium was supplied by replacing 50% of the protein with nonfat dry milk weight gain was significantly less than when calcium was supplied by a calcium supplement. Other studies have since shown associations between increased calcium or dairy food intake and reduced body weight in adults, young women, and preschool children.[59–61] It should be recognized that any positive effect calcium or dairy foods may have on weight can be overridden by a high energy intake. This was demonstrated in a recent study of young women (ages 18–31) in which total calcium or dairy calcium predicted changes in body weight or fat mass only in those consuming less than 1876 kcal/d.[60] Additional clinical trials are needed to confirm the benefits of calcium and dairy foods for maintaining a healthy body weight.

CONCLUSION

Over the last three decades we have learned much about the etiology, prevalence, and factors involved in lactose maldigestion. This information has allowed us to develop effective strategies to manage this condition. Health practitioners play a key role in helping their clients with lactose intolerance understand the importance of calcium and other dairy food nutrients in the diet and the serious consequences of calcium deficiency diseases. A large body of evidence suggests that the intake of calcium and other dairy-related nutrients helps reduce the risk of several chronic diseases, such as hypertension and stroke, colon cancer, and osteoporosis.[62] With the exception of osteoporosis, these are conditions that affect African Americans and other minorities disproportionately. Physicians can help reduce the disease burden and health care costs in minority populations by committing themselves to helping their clients overcome the barrier of lactose intolerance.

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