

## Review

# The Myth of Increased Lactose Intolerance in African-Americans

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In the United States, approximately three fourths of African-Americans have the potential for symptoms of lactose intolerance because lactose digestion depends on the presence of the enzyme lactase-phlorizin hydrolase which is reduced by up to 90–95% in individuals with lactase nonpersistence. The 'African-American diet' is more likely to be low in a variety of vitamins and minerals, including calcium. African-Americans consume low amounts of dairy foods and do not meet recommended intakes of a variety of vitamins and minerals, including calcium. Low intake of calcium and other nutrients put African-Americans at an increased risk for chronic diseases. The 2005 Dietary Guidelines recommend consuming three servings of dairy foods per day to ensure adequate calcium intake, among other nutrients, and the National Medical Association has recently published a similar recommendation of three to four servings of dairy per day for the African-American population. Research has shown that lactose maldigesters, including African-American maldigesters, can consume at least one cup (8 oz) of milk without experiencing symptoms, and that tolerance can be improved by consuming the milk with a meal, choosing yogurt or hard cheeses, or using products that aid in the digestion of lactose such as lactase supplements or lactose-reduced milks.

### Key teaching points:

- African-Americans are at high risk for a number of chronic diseases that may be ameliorated by adequate calcium intake.
- Lactose maldigesters, including African-American maldigesters, can consume one cup (8 oz) of milk in one meal setting without experiencing symptoms.
- Lactose intolerance can be limited by drinking milk with meals.
- Yogurts and hard cheeses are well tolerated.
- African-Americans, like other Americans, should not avoid consumption of dairy products due to concerns about lactose intolerance.

## INTRODUCTION

The risk for a number of chronic diseases is elevated among African-Americans. The debate over the cause of this elevated risk continues as additional data accumulate regarding unique genetic, social and environmental factors affecting African-Americans. Hypertension, heart disease and other illnesses affect African-Americans at a rate which is higher than the average for the US population [1]. As a group, African-Americans consume a diet that is lower in recommended nutrients and meet fewer of the national recommendations than the average American. In comparison to national recommendations, the African-American diet is

more likely to be low in vitamins and minerals, including calcium, and higher in fat [2,3]. Additionally, the food pattern in the African-American diet includes more meat and fats, while being lower in fruits, vegetables and dairy foods [4,5]. This pattern is markedly different than the recent recommendations of the Dietary Guidelines Committee, and the advice of numerous other nutrition guidelines. The increased consumption of fruits, vegetables and low fat dairy foods are among the most common recommendations currently being promoted to improve the American diet [6].

Adequate calcium in the US diet is typically associated with the consumption of 3 or more servings of dairy foods per day [7]. Dairy foods are, of course, an excellent source of calcium

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(along with several other nutrients) and provide about 73% of the calcium in the US diet [8]. One perceived barrier to the consumption of dairy foods among African-Americans is the potential for lactose intolerance. Approximately three fourths of African-Americans are lactose maldigesters, and thus have the potential for symptoms of lactose intolerance [9,10]. Primary acquired hypolactasia, more commonly referred to as lactase nonpersistence (LNP), is estimated to affect approximately 75% of the world's population. In LNP there is a 90–95% reduction in activity of the enzyme lactase-phlorizin hydrolase (LPH) which is synthesized in enterocytes controlled by the LPH gene on chromosome 2 [11]. Alternatively, congenital lactase deficiency, where lactase is completely absent at birth, does exist, however this condition is very rare. Recently, some special interest groups have suggested that national recommendations to include three servings of dairy foods in the diets of all Americans are racially biased because of the high incidence of lactose intolerance among African-Americans. In contrast, the National Medical Association (the nation's oldest and largest medical association that represents physicians of African descent in the US and Caribbean with over 30,000 members) has recently reviewed the scientific literature on health risks, diets and dairy foods in relation to the African-American population and concludes that African-Americans should consume a minimum of 3 to 4 servings of dairy foods per day in order to improve their diets, especially in relation to adequate calcium consumption [12]. We, therefore, are reviewing the literature to determine if evidence exists to support the hypothesis that African-Americans experience increased intolerance to lactose and thus should limit dairy foods that are high in lactose.

## **DEFINING LACTOSE INTOLERANCE**

Lactose intolerance is the reduced ability to digest lactose due to decreased lactase activity in the small intestine [13]. There is substantial research evaluating tolerance to lactose among lactose maldigesters, and numerous reviews have been published evaluating these studies [11,13,14,15]. These studies evaluated a variety of ethnic groups including Asian-Americans and Hispanic-Americans and may or may not include African-Americans as subjects. Typically, most studies have selected subjects based on estimates of maldigestion, using breath hydrogen, blood glucose, or other clinical tests, rather than race or ethnic background. However, it is clear from blinded experimental trials that most, if not all, lactose maldigesters can consume at least one 8 ounce glass of milk [16,17,18] without experiencing physiologic symptoms. Tolerance is further improved when milk is consumed with a meal, such that stomach emptying and intestinal transit are slowed, facilitating gastrointestinal digestion of lactose [19,20]. In addition, tolerance is dose-dependent. When more than one glass

of milk is consumed in the fasting state, symptoms of intolerance exceed baseline symptoms. These symptoms are most likely to be excessive flatulence and stomach discomfort. Acute diarrhea occurs much less frequently. Since many dairy foods, including hard cheeses, ice cream, yogurts, cottage cheese and even soft cheeses, contain reduced amounts of lactose, these foods present less potential for symptoms of intolerance [21,22]. Yogurt does not necessarily have a reduced amount of lactose when compared with the same volume of milk. However, the improved tolerance to lactose observed with yogurt is likely due to autodigestion of lactose in the intestine by the starter culture bacteria in the yogurt [22]. Finally, tolerance is also improved with repeated exposure to lactose in the diet, presumably due to colon microbial adaptation which enhances fermentation and reduces gas production [23,24].

## **STUDIES OF LACTOSE INTOLERANCE IN AFRICAN-AMERICANS**

What about African-Americans? Do they experience increased symptoms of lactose intolerance? Does lactose intolerance among African-Americans prevent them from consuming moderate amounts of milk in a mixed diet? In 1966, Bayless and Rosensweig studied 20 African-American and 20 Caucasian prisoners for LNP and intolerance [25]. As confirmed by subsequent studies, approximately 70% of the African-Americans were LNP based on a lactase assay of mucosal biopsy samples and a blood glucose assay for maldigestion. In this study, lactose in a water solution was administered orally in very high doses. Each subject received a large dose of lactose based on body size (50 gm/sq m of body surface). Some doses were the equivalent of up to 1¾ quarts of milk. Subjects almost uniformly experienced symptoms of intolerance to this dose of lactose. However, the authors note that 'six subjects had to drink a quart of milk at one time before these symptoms developed' and 'amounts less than one or two glasses of milk, as in cereal or coffee were well tolerated'. Since only one non African-American maldigester was studied, this report does not provide direct comparisons of tolerance between African-Americans and Caucasians. However, the study does provide some evidence for the dose-response relationship between lactose consumption and tolerance at levels (1–2 cups of milk) that are similar to studies of non African-American maldigesters [26].

More directly pertinent to this review, in 1971, Paige et al [27] addressed the question of the ability of African-American children to consume a moderate amount of milk: the half pint quantity served in schools. This observational study was conducted on two different school days and researchers categorized children as either milk drinkers or non-milk drinkers. After passing through the food line and consuming their food, the students surrendered their meal trays and researchers weighed the amount of milk remaining in the container. A milk

drinker was defined as one who consumed 50% or more of their milk by weight and a non-milk drinker was one who consumed less than 50% of their milk. Researchers found that a greater proportion of African-American children failed to consume 50% of the milk served (20% of African-American children vs. 10% of Caucasian children) and concluded that milk rejection among African-American children was significantly higher than Caucasian children. Maldigestion was determined using blood glucose. Lactose intolerance symptoms were measured using a lactose load of 50 gm/sq m body surface, an amount much higher than a standard 8 oz portion of milk containing 12 gm lactose. It does appear from this study that the African-American children who were maldigesters appear more likely to be non-drinkers. Given that only five Caucasian children were maldigesters, the data is insufficient to determine if African-American maldigesters experienced greater or lesser symptoms of intolerance.

Marrs reported on the milk drinking habits of the elderly in 1978 [28]. The investigators provided 240 ml of milk, as part of a meal, in a congregate dining situation. Participants self-selected the type of milk: whole, skim, chocolate and buttermilk as well as alternate beverages such as coffee and water. Following the meal, participants completed a questionnaire regarding the type of milk they preferred, milk acceptability and perceived milk tolerance. Seventy-five/81 Hispanics, 123/139 African-Americans and 109/117 'Anglos' reported that they drank the milk and were symptom-free. Two of the Hispanics, 7 of the African-Americans and 1 'Anglo' drank the milk and reported some symptoms. Six Hispanics, 2 African-Americans and 3 'Anglos' did not drink the milk because of symptoms. Clearly, the vast majority of African-Americans tolerated one glass of milk in this study. Interestingly, only 1.4% of the African-Americans listed 'symptoms' as their reason for avoiding milk, compared with 6.6% of Hispanics and 2.5% of 'Anglos'. Participants could also select 'dislike' as their reason for avoiding milk. Five percent of African-Americans selected this response in comparison to 8.8% and 3.4% of Hispanic-Americans and Caucasians, respectively.

Rorick and Scrimshaw [29] reported on tolerance among the elderly to 240 ml (8 ounces) of milk vs. lactose-free milk. The researchers found no differences in symptomatic response under double-blind conditions to the lactose-containing and lactose-free milks. Using the breath collection technique for lactose tolerance testing, 23 maldigesters were identified in the study. Five had symptoms following both treatments; two had symptoms exclusively after the lactose-free treatment and none had symptoms exclusively following the lactose treatment. Only 5 of the 23 were African-American and the authors did not delineate the specific responses for these five subjects. None-the-less, the lack of response to the lactose challenge by all subjects, including the 5 African-American subjects, suggests African-Americans are not different in their response.

Johnson et al [30] studied adolescent and young adult African-Americans to evaluate lactose digestion in a group of

subjects who claimed to be lactose intolerant. One hundred and sixty-four subjects, who were 12 to 40 years of age and claimed they experienced some gastrointestinal symptoms after consuming a cup of milk, participated. Hence, the population selected was biased toward a subgroup of African-Americans who might experience symptoms. Stage 1 involved a lactose challenge test of 25 g lactose suspended in 200–300 ml water. Breath samples were collected and analyzed using gas chromatography. As breath samples were collected, subjects also reported gastrointestinal symptoms. Only 58% (95/164) were determined to be maldigesters. Eighty-two of the 95 (86%) maldigesters reported some symptoms following the 25 g challenge.

In stage 2 of the investigation [30], only those individuals who had an increase in hydrogen concentration of >20 parts per million (ppm) or more (maldigesters) were invited to participate. Forty-five subjects chose to participate in this double-blind, crossover test for milk intolerance. Subjects were offered a lactose-containing or lactose-free dairy drink on 3 different days. The lactose challenge test, breath samples, and symptoms record were repeated as in stage 1. In stage 2, 30 subjects reported symptoms when they consumed the lactose-containing beverage and 15 reported symptoms when they consumed either beverage. Thus, 15/45 subjects experienced no symptoms following the consumption of 25 g of lactose. The authors concluded that factors other than lactose are also important in determining symptomatic response among individuals who believe that they are milk intolerant. No comparisons to non African-American populations were made, but the relative incidence of symptoms following this dose (equivalent to drinking two 8 ounce glasses of milk on an empty stomach) is consistent with the incidence observed in non African-American maldigesters.

In a follow up study, Johnson et al [31] challenged 25 African-American maldigesters who were found to be intolerant to lactose-containing milk via double-blind crossover study with increasing amounts of lactose. The lactose in low-fat milk was hydrolyzed using lactase, and the hydrolyzed milk was mixed proportionately with untreated low-fat milk to produce milks containing varying amounts of lactose. There was no requirement for overnight fast in this study and subjects received the milk in the morning hours of each weekday. Subjects were asked to record their symptoms and keep a daily food record. Initially subjects received a milk drink containing 5 g lactose. If a subject did not report experiencing symptoms from a certain dose of lactose for a period of 2–4 days, the lactose content of the milk was increased by 1 g by changing the proportion of lactose-hydrolyzed and untreated milk. The amount of lactose was increased until a dose was reached that produced gastrointestinal symptoms. Then, the subject was given the same lactose dose over a period of days until the symptoms became negligible. Over the 6–12 week period of the study, 17 (77%) of the 22 who completed the study tolerated 12 g or more of lactose. Of these subjects who were able

to tolerate 12 g lactose or more, 10 had hydrogen concentrations  $\geq 20$  ppm. This is consistent with data in other populations of maldigesters who claim intolerance [16] demonstrating a high likelihood of tolerance to lactose when it is consumed in normal serving size amounts. Again, no direct comparison of racial groups or random sampling of the population was made. But, the data indicate substantial tolerance in this African-American group, similar to other maldigesters who claim intolerance.

In 1999, Klesges et al [3] reported on the milk drinking habits of 32,144 Air Force recruits. Regardless of race or maldigestion status, only 17% reported consuming three or more servings of milk per day. Slightly more than half reported consuming less than one serving per day. Milk consumption was positively associated with fruit and vegetable consumption. The most interesting finding relative to this review was that the self-reported incidence of milk-related gastric distress was similar between African-American and Asian recruits. Additionally, a significant trend of experiencing distress was observed for African-Americans. Caucasians in this study reported lower gastric distress than both African-Americans and Asians. Perceived milk intolerance was highest among older African-American women (51.4%), second only to older Asian men (60.4%).

In a study to determine adaptability to a dairy-rich diet, a lactose challenge test was administered twice to a group of 17 African-American girls, aged 11 to 15 [32]. The girls were participants in a 21-day calcium metabolism study in which all subjects lived in a supervised environment for the duration of the study and consumed  $1,211 \pm 76$  mg calcium per day. The subjects consumed approximately four servings of dairy foods daily containing an estimated 33 g lactose/day. Prior to the study the subjects consumed approximately 17 g lactose per day. On the first day of the intervention subjects were challenged with 0.35 g lactose/kg body weight which was presented as 1% milk. Breath samples were collected at baseline, following milk consumption, and hourly for 8 hours. This lactose challenge process was repeated on day 21 of the intervention. Symptoms were recorded hourly using a self-reported record sheet. Subjects were asked to rate symptoms (abdominal pain, bloating, flatulence, diarrhea/loose stools, and headache) a score of 0 to 5 depending on severity of symptoms.

The breath samples were analyzed for carbon dioxide and hydrogen concentrations. Girls who had an increase of  $\geq 20$  ppm of breath hydrogen were classified as having lactose maldigestion [32]. Fourteen of the 17 subjects who participated in the lactose challenge were classified as lactose maldigesters. From the time the test was administered on the first day of the study to the second administration on day 21, there was a significant decrease in the amount of hydrogen produced, suggesting colonic adaptation to lactose throughout the 21-day intervention. Most importantly, it was noted that during both challenges, and during the 21 day period on the high dairy diet, subjects reported minimal or no gastrointestinal symptoms.

Thus, this African-American population could consume a dairy rich diet, and meet adolescent calcium needs, without symptoms of intolerance.

## CONCLUSIONS

Direct comparisons of the relative tolerance to lactose from African-Americans as compared to other lactose maldigesters are not available. However, the information presented here demonstrates that African-American maldigesters, like all maldigesters, experience symptoms in a dose-response fashion. Further, there is a range of symptoms that appear in a given population fed the same dose of lactose. Milk consumed in a mixed meal, and in single portion sizes (8 ounces of milk containing approximately 12 g lactose) is unlikely to cause symptoms of intolerance among African-Americans. Additionally, Suarez et al [18] demonstrated that an 8 ounce portion of milk can be consumed twice per day, as compared with once per day, with no additive effect on symptoms, even in people who claim severe lactose intolerance. Other strategies for consuming lactose containing foods while avoiding or minimizing intolerance symptoms include utilizing products that aid in the digestion of lactose, and choosing yogurt or hard cheeses [14]. The literature on African-Americans, though limited, reflects the findings in the overall body of literature on lactose intolerance in maldigesters. Thus, there is little reason to believe that African-Americans are especially lactose intolerant. African-Americans should not avoid dairy products due to concerns about lactose intolerance and should follow dietary recommendations from the 2005 Dietary Guidelines and the National Medical Association.

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