Edentulism and nutritional status in a biracial sample of well-functioning, community-dwelling elderly: the Health, Aging, and Body Composition Study1–3

Jung Sun Lee, Robert J Weyant, Patricia Corby, Stephen B Kritchevsky, Tamara B Harris, Ronica Rooks, Susan M Rubin, and Anne B Newman

ABSTRACT
Background: Edentulism may affect dietary intake in older adults, but the relation between edentulism and nutritional status is not completely understood.
Objective: The present study examined whether edentulism is associated with nutritional status and whether there is an interaction between race and edentulism on nutritional status among well-functioning, community-dwelling elderly.
Design: The study cohort included 3075 elderly aged 70–79 y (52% women, 42% black) in the Health, Aging, and Body Composition Study. Dietary intake, anthropometric variables, weight change, and serum albumin and lipid concentrations were compared between edentate and dentate participants by the use of multiple linear and logistic regressions.
Results: Edentulism was not associated with total energy or food intake but was associated with the food groups consumed, particularly fat, micronutrients, and hard-to-chew foods. Edentulism was more strongly linked to dietary intake in whites than in blacks. Unlike black edentate elderly, white edentate elderly consumed significantly lower energy-adjusted amounts of vitamin A and β-carotene, higher amounts of energy-adjusted total and saturated fat and cholesterol, and higher percentages of energy from fat than did white dentate elderly. Anthropometry and biochemical indexes were not significantly different by edentulism status in both races. Edentulism was associated with weight gains of >5% in 1 y in both races.
Conclusions: Edentulism was associated with differences in the nutritional status of well-functioning, community-dwelling elderly, more so in whites than blacks. Edentate elders may benefit from dental, medical, and nutrition interventions targeted to addressing these findings.

KEY WORDS Edentulism, nutritional status, well-functioning community-dwelling elderly, socioeconomic status, racial-ethnic differences, Health ABC Study

INTRODUCTION
Despite a steady decline in the rate of complete tooth loss over the past several decades, more than one-third (33.1%) of those aged ≥65 y are edentulous (1–3). Because such a large segment of the elderly is edentulous, the effect of edentulism on nutritional and health status is an important but overlooked public health issue for the elderly (4).

Edentulism can substantially affect oral and general health as well as overall quality of life, including enjoyment of food and overall nutrition (5). Some evidence suggests that impaired oral health status, particularly edentulism, may affect dietary intake. The loss of all teeth, even with dentures, reduces masticating efficiency and affects food taste, food preferences, and food consumption patterns (6–12). Edentulism may also be associated with suboptimal intakes of various nutrients (13, 14), which prevents edentate individuals from meeting current dietary recommendations (15, 16). Several studies have shown that edentate elderly consume fewer fruit and vegetables; less dietary fiber, carotene, calcium, and protein; and more cholesterol and saturated fat than do their dentate counterparts (8, 13, 14, 17–23). Furthermore, these alterations in dietary intake have been suspected to increase the risk of significant weight loss (24, 25) and possibly of selected systemic diseases such as cancer and cardiovascular disease (26–28).

Most previous research was conducted among frail elderly who were institutionalized or hospitalized or white, community-dwelling elderly with higher economic and educational attainments (8, 17, 25, 26, 29–31). Little is known about the relation between edentulism and nutritional status in other elderly populations, including minority elderly. The inclusion of minority participants is important because these persons have both a higher burden of oral health problems than do white elderly populations (1, 32) and cultural differences in food patterns (33).

The purpose of the present study was to examine whether edentulism is associated with nutritional status as measured by nutrient intake, food consumption patterns, anthropometric indexes, weight change, and biochemical indexes in a biracial,
well-functioning sample from the Health, Aging, and Body Composition (Health ABC) Study. We hypothesized that edentate elderly persons would have nutrient and food group intakes that were lower than dietary recommendations and higher weights and body mass indexes, greater weight changes, and poorer serum albumin and lipid concentrations than would dentate elderly persons. We also hypothesized that these proposed differences between edentate and dentate elderly would be similar between blacks and whites.

SUBJECTS AND METHODS

Study population

The Health ABC Study is a longitudinal study designed to help us understand how changes in body composition relate to the incidence of disability. To be eligible for the study, elderly persons had to be free of difficulties with activities of daily living and lower-extremity functional limitations, defined as difficulty walking 0.4 km (0.25 mi) or climbing 10 steps without resting. Participants were recruited from a random sample of Medicare beneficiaries in designated zip codes in and around Pittsburgh and Memphis, which represent northeast and south regions of the United States, respectively. Different sociodemographic characteristics (for example, participants in Memphis were less educated and had lower family incomes than did those in Pittsburgh; 34) and dietary intakes by region were carefully considered in study design and implementation. The study cohort consisted of 3075 white and black (42%) men and women (52%) aged 70–79 y. All measurements used for this study were collected at baseline, except nutrient intake and food consumption pattern, which were collected at the first follow-up examination. All procedures were in accordance with the ethical standards of the institutional review boards of the participating institutions, who approved the protocol and informed consent forms.

Oral health

Basic oral health questions were included in the baseline health assessment in 1997. Edentulism was determined by self-reported information regarding whether a participant had any remaining natural teeth. Participants were also asked whether they wore dentures and whether they had chewing pain.

Nutrient intake

A modified Block 98 food-frequency questionnaire (FFQ) was administered by a trained dietary interviewer at the first annual follow-up examination to estimate individual participant’s usual nutrient and food group intakes. The FFQ, developed and modified by Block Dietary Data Systems (Berkeley, CA) for the Health ABC Study, was based on age-appropriate intake data from the third National Health and Nutrition Examination Survey. The food lists were based on the survey 24-h dietary recall data for those aged >65 y, either non-Hispanic white or black, and residing in either the Northeast or the South. A total of 108 food items were included. All interviews were periodically monitored throughout the study to ensure the quality and consistency of data collection procedures. Wood blocks, real food models, and flash cards were used to help participants estimate portion size. Nutrient and food group intakes and numbers of servings of the food guide pyramid food groups were estimated by Block Dietary Data Systems by using the food guide pyramid–recommended serving sizes.

We focused the analysis on energy and 15 nutrients selected on the basis of previous research to reflect concerns related to edentulism (8, 17–23, 26, 29, 30) and deficient intakes in the elderly (35, 36). Intakes of protein, vitamin A, vitamin C, vitamin E, thiamine, riboflavin, vitamin B-6, folate, niacin, iron, magnesium, and zinc were compared with recommended dietary allowances (37–39). The calcium and fiber intakes of the participants were compared with the adequate intake recommendation (40, 41).

Food consumption pattern

Percentages of energy from major nutrients (carbohydrate, fat, and protein) and from sweets and desserts were compared with recommendations (42) for edentate and dentate elderly. Daily servings of 5 food groups (vegetables, meat and protein, grains, and dairy products) and the daily intake frequency of fruit and fats, oils, and sweets were compared with the food guide pyramid serving recommendations to assess compliance with dietary guidelines appropriate for sex, age, and energy requirement (43).

The daily intake frequency of hard- or easy-to-chew foods was also compared between edentate and dentate elderly. Hard- or easy-to-chew food items were selected on the basis of previous research determining masticating ability and perceived chewing ability (6, 7, 18, 20, 23) and availability in the FFQ. Hard-to-chew foods included raw apples or pears, carrots, mixed vegetables, coleslaw, cold cereal without milk, green salad, nuts and seeds, fried chicken, and beef. The texture of some hard-to-chew food can be modified by using different cooking methods. We were not, however, able to separate out some of the soft dishes (such as pot roast) made with beef given the nature of the food group category in the FFQ. For the purpose of creating a conservative hard-to-chew food score, we included the beef group in the score. Easy-to-chew foods included applesauce, canned fruit cocktail, canned pears, canned peaches, bananas, cooked cereals, cottage cheese, yogurts, puddings, and liquid nutrient supplements.

Anthropometry and weight change

Baseline weight and standing height measurements were used in this analysis. Weight was measured in kilograms with the use of a standard balance beam scale. Standing height was measured in centimeters with the use of a stadiometer (Harpenden; Holtain Ltd, Crosswell, United Kingdom). Weight change between baseline and 1 y was classified into 3 groups: 1) loss (loss of >5% of baseline body weight), 2) stable (±5% weight change), and 3) gain (gain of >5% of baseline body weight).

Biochemical indexes

Fasting blood was collected from participants at the baseline clinic visit through venipuncture with the use of standard protocols. Serum albumin and serum lipids (total cholesterol, LDL cholesterol, HDL cholesterol, and triacylglycerols) were selected for this analysis. Serum lipid concentrations were compared with the National Cholesterol Education Program Adult Treatment Panel II guidelines (42).
Controlling variables

Edentulism, nutrient and food intakes, anthropometry, and biochemical indexes vary by sociodemographic, economic, health behavioral, and medical conditions (5, 17, 36, 44–46). To examine whether edentulism was independently associated with nutritional status, we controlled for these potential confounding variables.

Sociodemographic and economic characteristics included age, sex, education, living alone, study site, and family income. Education status was categorized into 2 groups according to the highest educational level attained: less than high school (<12 y) or more. Questions on marital status and household size were used to create a two-category "living alone" variable as follows: living alone and living with others, including spouse. Study site included 2 categories: Pittsburgh or Memphis. Family income during the past year was classified into 2 groups: <$10 000 or more.

Health behavioral characteristics included smoking and drinking status. Smoking status was categorized as never smoker, former smoker, and current smoker. Similarly, drinking status was categorized as never drinker, former drinker, and current drinker. Self-reported health status was controlled as a dichotomous variable to reflect how ill a person felt (fair or poor compared with others).

Self-reported chewing pain was controlled as a dichotomous variable for examining the relation between edentulism and dietary intake. However, denture use was not controlled for because edentulism was strongly interwoven with denture use. Most edentate elderly wore dentures (90%), whereas only 40% of dentate elderly wore dentures. The effect of edentulism on nutritional status cannot be adequately assessed while statistically controlling for denture use. Because the Health ABC cohort was well-functioning at baseline, cognitive function and physical performance known to be related with nutritional health in other cohorts were not included in the analyses.

Analytic sample

The present study included 3068 participants with edentulism information at baseline. However, because the FFQ data were collected 1 y later, only 88% of the original Health ABC participants had this data. Of 362 participants who did not complete the FFQ, 77 did not attend the exam (36 were deceased, 4 were withdrawn, and 37 were missed), and these participants were more likely to be edentulous, black, poor, and less educated. Similarly, weight change was calculated for 89% of the participants whose weight was measured both at baseline and 1 y later. Family income during the past year was completed by 88% (2701) of the participants. Sociodemographic characteristics between those with income data and those without it were similar except for sex, living alone, and drinking history, which were already included as potential confounders in our analysis. Nutrient intake between those with income data and those without it were not significantly different.

For each analysis, persons missing values for specific variables were omitted from that analysis; thus, the analytic sample for various measures varied slightly in total number, ie, n = 2360 for nutrient intake and food consumption pattern, n = 2670 for anthropometry, n = 2376 for weight changes, and n = 2656 for biochemical indexes.

Statistical analyses

Differences in means and proportions of covariates by edentulism were analyzed by using t tests and chi-square tests, respectively. Multiple linear regression procedures were used to compare adjusted means of energy and energy-adjusted nutrient and food group intakes, anthropometry, and biochemical indexes between edentate and dentate elderly with control for confounding variables. Logistic regression procedures were used to assess whether edentate elderly were less likely to meet two-thirds of dietary recommendations and dietary fat and fiber recommendations than were dentate elderly. It was also used to examine whether edentate elderly were more likely to have weight changes than were dentate elderly. There were significant interactions between race and edentulism on intakes of dietary fats (total fat, saturated fat, and cholesterol), several micronutrients (vitamin A, B-carotene, and phosphorus), and the meat group; thus, analyses for these variables were stratified by race. There were no significant interactions between sex and edentulism or among sex, race, and edentulism. All statistical analyses were conducted by using SAS 8.01 (SAS Institute Inc, Cary, NC: 47). Statistical significance was set at P < 0.05.

RESULTS

Baseline sociodemographic, economic, and health characteristics of edentate and dentate Health ABC participants are presented in Table 1. Twenty-one percent of the Health ABC participants were edentulous. Most of the edentate participants wore dentures and were more likely to report chewing pain, poor appetite (poor or very poor desire to eat during the past month), and poorer health status than were dentate elderly. This was the case for both white and black participants. In both whites and blacks, edentate elderly reported lower educational status and were more likely to have a smoking history than were dentate elderly.

The prevalence of edentulism and oral health characteristics, however, differed by race. Blacks were twice as likely as whites to be edentulous (30.0% compared with 15.9%) and were more likely to report chewing pain and poor appetite. Overall educational and economic attainments were lower in blacks than in whites. Even after control for other significant factors, including sex, education, family income, smoking history, living alone, and self-reported health status, blacks were 1.41 times as likely to be edentulous (95% CI: 1.13, 1.75). Compared with white dentate elderly, black dentate elderly were more likely to wear dentures (P = 0.0001) and to report chewing pain (P = 0.0019).

Nutrient intake patterns between edentate and dentate persons were compared by using multivariate analyses. Regardless of edentate status, adjusted mean intakes of specific nutrients by the Health ABC cohort were higher than dietary recommendations except for vitamin E, calcium, magnesium, and dietary fiber. Blacks consumed more energy and cholesterol but had lower energy-adjusted mean intakes of dietary fiber and most micronutrients (vitamin A, vitamin E, vitamin B-6, calcium, magnesium, iron, zinc, and phosphorus) than did whites. Regardless of race, total energy intake and solid food intake did not differ significantly between edentate and dentate elderly (Table 2). Edentate elderly had significantly lower intakes of...
Characteristics of edentate and dentate white and black elderly participants of the Health, Aging, and Body Composition Study

### TABLE 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>White (n = 1789)</th>
<th>Black (n = 1279)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Edentate (n = 284)</td>
<td>Dentate (n = 1505)</td>
</tr>
<tr>
<td>Age (y)</td>
<td>73.8 ± 0.2&lt;sup&gt;1&lt;/sup&gt;</td>
<td>73.8 ± 0.1</td>
</tr>
<tr>
<td>Male (%)</td>
<td>54.9</td>
<td>52.0</td>
</tr>
<tr>
<td>Study site (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memphis</td>
<td>43.3</td>
<td>53.9&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>56.7</td>
<td>46.1&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Income &lt;$10 000/y (%)</td>
<td>8.5</td>
<td>3.5&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Has doctor or place for health care (%)</td>
<td>96.1</td>
<td>95.3</td>
</tr>
<tr>
<td>&lt;12 y of education (%)</td>
<td>24.7</td>
<td>9.9&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lives alone (%)</td>
<td>28.2</td>
<td>25.9</td>
</tr>
<tr>
<td>Smoking history (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoker</td>
<td>29.6</td>
<td>45.7&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Current smoker</td>
<td>9.5</td>
<td>5.6&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Former smoker</td>
<td>60.9</td>
<td>48.7&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Exposure to cigarettes (pack-years)</td>
<td>34.4 ± 1.8</td>
<td>18.3 ± 0.8&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Drinking history (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never drinker</td>
<td>24.8</td>
<td>24.9&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Current drinker</td>
<td>50.4</td>
<td>59.8&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Former drinker</td>
<td>24.8</td>
<td>15.3&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Wears dentures (%)</td>
<td>89.8</td>
<td>34.9&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Has chewing pain (%)</td>
<td>7.1</td>
<td>3.5&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Diseases (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>22.9</td>
<td>16.5&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>7.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Diabetes</td>
<td>13.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Hypertension</td>
<td>39.1</td>
<td>37.7</td>
</tr>
<tr>
<td>Ulcer</td>
<td>16.9</td>
<td>13.2</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Self-reported poor health status (%)</td>
<td>18.3</td>
<td>6.5&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Has poor appetite (%)</td>
<td>10.6</td>
<td>5.1&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup> ± SEM.  
<sup>2</sup> Significantly different from edentate of same race, P < 0.05.

Energy-adjusted dietary fiber, vitamin C, calcium, and magnesium and lower percentages of energy from protein and sweets and desserts than did dentate elderly independent of race.

The energy-adjusted intake pattern of dietary fats and several micronutrients in edentate and dentate elderly persons, however, differed by race (Table 3). Among whites, edentate elderly had marginally but significantly higher intakes of energy-adjusted total fat, saturated fat, and cholesterol and a higher percentage of energy from fat than did dentate elderly. White edentate elderly also had marginally but significantly lower energy-adjusted mean intakes of vitamin A and β-carotene than did their dentate counterparts. Among blacks, however, intakes of most dietary fats and several micronutrients were not significantly different between edentate and dentate elderly, except for intakes of phosphorus. Blacks consumed a greater percentage of energy from total fat and had a higher intake of cholesterol and lower intakes of vitamin A and phosphorus than did whites, and dentate status did not further influence this pattern in blacks as much as in whites.

Overall, more edentate than dentate elderly tended to consume less than two-thirds of the recommendations for most nutrients (NS; Table 4). Intakes of total and saturated fats between edentate and dentate elderly differed by race. Relative to dietary guidelines, white edentate elderly tended to consume more fat than their dentate counterparts [total fat odds ratio (OR): 1.35 (95% CI: 0.97, 1.87); saturated fat OR: 1.64 (95% CI: 1.22, 2.22)]. Dietary fat intake did not differ significantly between black edentate and dentate elderly [total fat OR: 0.86 (95% CI: 0.63, 1.20); saturated fat OR: 1.02 (95% CI: 0.75, 1.38)].

Intakes of several food groups and of foods that are hard or easy to chew by dentate status are shown in Table 5. Blacks consumed fewer vegetables, fewer dairy group foods, and fewer hard-to-chew foods than did whites. Regardless of race, edentate elderly consumed significantly fewer foods from the fruit and fruit juice group; fat, oils, and sweets group; and hard-to-chew food group than did dentate elderly. Intake of foods in the meat group by edentate and dentate elderly, however, differed by race. Relative to dietary recommendations, white edentate elderly had significantly higher intakes of meats than did their dentate counterpart, unlike black edentate elderly, who did not have significantly different intake of meats from dentate black elderly (Table 3).

Overall, there were no significant differences in anthropometry or biochemical indexes between edentate and dentate elderly, regardless of race. However, edentate elderly persons were more likely to have weight gains of >5% of baseline weight in 1 y than were dentate elderly (Figure 1). Multiple logistic regression results showed that edentulism significantly increased the odds of a weight gain of >5% of baseline weight, even after control for confounders (OR: 1.73; 95% CI: 1.17, 2.57; P = 0.0060).
TABLE 2
Average energy and energy-adjusted nutrient intakes of edentate and dentate elderly participants of the Health, Aging, and Body Composition Study

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Edentate (n = 490)</th>
<th>Dentate (n = 870)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid foods (g)²</td>
<td>5892.6 ± 108.6</td>
<td>6009.2 ± 99.4</td>
</tr>
<tr>
<td>Energy (kJ)³</td>
<td>8456.4 ± 202.3</td>
<td>8325.8 ± 185.3</td>
</tr>
<tr>
<td>Protein (%) of energy²</td>
<td>14.3 ± 0.2</td>
<td>14.7 ± 0.2³</td>
</tr>
<tr>
<td>Carbohydrate (%) of energy¹</td>
<td>67.1 ± 1.0</td>
<td>68.6 ± 0.9</td>
</tr>
<tr>
<td>Dietary fiber (g)²</td>
<td>15.9 ± 0.4</td>
<td>17.0 ± 0.3³</td>
</tr>
<tr>
<td>Sweets and desserts (% of energy)²</td>
<td>15.3 ± 0.7</td>
<td>13.4 ± 0.6³</td>
</tr>
<tr>
<td>Vitamin A (RAE)²</td>
<td>243.9 ± 2.5</td>
<td>244.6 ± 2.3</td>
</tr>
<tr>
<td>Vitamin C (mg)²</td>
<td>129.4 ± 4.4</td>
<td>141.7 ± 4.0⁴</td>
</tr>
<tr>
<td>Vitamin B-6 (mg)²</td>
<td>2.1 ± 0.1</td>
<td>2.2 ± 0.1</td>
</tr>
<tr>
<td>Folate (mg)²</td>
<td>476.1 ± 10.8</td>
<td>490.3 ± 9.9</td>
</tr>
<tr>
<td>Magnesium (mg)²</td>
<td>733.8 ± 19.5</td>
<td>767.2 ± 17.9⁴</td>
</tr>
<tr>
<td>Calcium (mg)²</td>
<td>270.2 ± 4.1</td>
<td>284.9 ± 3.7⁴</td>
</tr>
<tr>
<td>Iron (mg)²</td>
<td>21.6 ± 0.7</td>
<td>22.3 ± 0.7</td>
</tr>
<tr>
<td>Zinc (mg)²</td>
<td>9.4 ± 0.3</td>
<td>9.7 ± 0.2</td>
</tr>
</tbody>
</table>

¹ x ² SEM. Mean energy intake was calculated from a multiple linear regression analysis controlled for age, race, sex, income, education, study site, smoking, drinking, living alone, having chewing pain, and self-reported health status. Other adjusted mean nutrient intakes were calculated similarly, including total energy intake as an additional confounder. There were significant interactions between race and edentulism on intakes of total fat, saturated fat, cholesterol, vitamin A, β-carotene, and phosphorus and on percentage of energy from fat, P < 0.05. Analyses of the intake of these nutrients by dentate status were stratified by race (see Table 3).

² Significantly higher in whites than in blacks, P < 0.05.
³ Significantly higher in blacks than in whites, P < 0.05.
⁴ Significantly different from edentate, P < 0.05.

DISCUSSION

More than 1 in every 5 of this well-functioning, community-dwelling elderly cohort was edentulous. The overall prevalence of edentulism in our sample was close to the national objective set in Healthy People 2010 (20%) (2), but the prevalence was not equally distributed across different socioeconomic subgroups. Consistent with previous research (1, 17, 45), edentulism was more common among the less educated, the poor, and those reporting poorer health status. In particular, blacks had a higher prevalence of edentulism than did whites, and this pattern remained even after control for socioeconomic status. Racial-ethnic differences in edentulism may be due to differences in not only socioeconomic status but also health behaviors, access to professional dental services, and exposure to community-based oral disease prevention services between the 2 groups, as suggested by previous research (5, 32, 45, 48).

The present results show that both black and white edentate elderly, even though a large majority wore dentures, had compromised masticating ability and reported more chewing pain than did dentate elderly. Their compromised masticating ability was not associated with total energy or food intake, but it did affect the food groups consumed, particularly fat and micronutrients. Similarly to previous research (9, 15, 17–20, 22), edentate elderly were more likely to consume more fats, oils, and sugars than were their dentate counterparts, which may reflect the ease of chewing these foods. These alterations in nutrient intake may explain the higher weight changes (particularly gain) among the edentate participants. Overall, the absolute differences in nutrient intake by dentition status were marginal compared with findings in frail elderly who were institutionalized and hospitalized (25, 31). This may in part be due to generally good dietary intake in the present cohort of well-functioning older adults compared with recommended intakes.

Black participants had poorer dental status and a higher proportion of edentulism than did whites, so it was expected that the implication of edentulism on nutrition would be greater in blacks than in whites. However, edentulism was more strongly linked to nutrient and food intake patterns in whites than in blacks. White edentate elderly were more likely to have

TABLE 3
Average energy-adjusted nutrient and food group intakes of edentate and dentate white and black elderly participants of the Health, Aging, and Body Composition Study

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>White (n = 1434)</th>
<th>Black (n = 926)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Edentate (n = 221)</td>
<td>Dentate (n = 1213)</td>
</tr>
<tr>
<td>Fat (% of energy)²</td>
<td>35.3 ± 0.6</td>
<td>36.6 ± 0.5⁴</td>
</tr>
<tr>
<td>Total fat (g)²</td>
<td>75.2 ± 1.3</td>
<td>71.8 ± 1.0⁴</td>
</tr>
<tr>
<td>Saturated fat (g)²</td>
<td>22.5 ± 0.4</td>
<td>20.9 ± 0.3⁴</td>
</tr>
<tr>
<td>Cholesterol (mg)²</td>
<td>236.2 ± 8.3</td>
<td>220.0 ± 6.6⁴</td>
</tr>
<tr>
<td>Vitamin A (RAE)²</td>
<td>994.3 ± 37.7</td>
<td>1087.9 ± 29.7⁴</td>
</tr>
<tr>
<td>β-Carotene (µg)²</td>
<td>3025.5 ± 219.7</td>
<td>3434.5 ± 173.2⁴</td>
</tr>
<tr>
<td>Phosphorus (mg)²</td>
<td>1162.9 ± 20.8</td>
<td>1190.3 ± 16.4</td>
</tr>
<tr>
<td>Meats³,⁶</td>
<td>80.6 ± 2.9</td>
<td>75.2 ± 2.2⁴</td>
</tr>
</tbody>
</table>

² x ² SEM. Energy-adjusted mean nutrient intakes were calculated from a race-stratified multiple linear regression analysis controlled for total energy intake, age, sex, income, education, study site, smoking, drinking, living alone, having chewing pain, and self-reported health status. RAE, retinol activity equivalents.

³ Significant interaction between race and edentulism, P < 0.05.
⁴ Significantly higher in blacks than in whites, P < 0.05.
⁵ Significantly different from edentate of same race, P < 0.05.
⁶ Significantly higher in whites than in blacks, P < 0.05.
⁷ Food group intake as a percentage of daily recommended servings appropriate for sex and energy requirement.
Vitamin C

Protein

participants of the Health, Aging, and Body Composition Study

table of daily intake frequencies for edentate and dentate elderly

TABLE 5

Fats, oils, and sweets

Dairy products (%)

Zinc

Magnesium

Calcium

Vitamin B-6

Dietary fiber

TABLE 4

Nutrients

Edentate

Dentate

Adjusted OR

(n = 490)

(n = 1870)

(%)

(%)

(95% CI)

Protein <67% of RDA 2

9.3

6.8

1.18 (0.81, 1.72)

Dietary fiber <67% of AI

56.1

51.2

1.17 (0.94, 1.45)

Vitamin A <67% of RDA 2

16.7

14.0

1.07 (0.80, 1.42)

Vitamin E <67% of RDA

73.3

71.9

1.12 (0.89, 1.42)

Vitamin C <67% of RDA 2

9.8

6.2

1.17 (0.81, 1.70)

Vitamin B-6 <67% of RDA 2

13.7

9.7

1.25 (0.91, 1.71)

Folate <67% of RDA

14.4

10.6

1.19 (0.87, 1.64)

Calcium <67% of AI

61.7

59.4

1.02 (0.82, 1.26)

Magnesium <67% of RDA

41.5

36.5

1.15 (0.92, 1.42)

Iron <67% of RDA 2

2.9

1.3

1.63 (0.79, 3.35)

Zinc <67% of RDA 2

25.6

20.4

1.28 (1.00, 1.63)

Phosphorus <67% of RDA 2

5.7

3.3

1.46 (0.90, 2.36)

2 ORs were calculated from a logistic regression analysis controlled for age, race, sex, income, education, study site, smoking, drinking, living alone, and self-reported health status. Intakes were examined to see whether they were less than two-thirds of the recommended dietary allowance (RDA) or average intake (AI). There was a significant interaction between race and edentulism on intakes of total fat and saturated fat, P < 0.05. Race-stratified analysis of these variables by dentate status is shown in the text.

2 Proportion significantly higher in whites than in blacks, P < 0.05.

poorer intakes of dietary fats and micronutrients than were their dentate counterparts, unlike black edentate elderly, in whom intakes of dietary fats and micronutrients were not significantly different from those in their dentate counterparts.

Blacks consumed more fat, fewer vegetables, and less calcium, magnesium, and dietary fiber than did whites irrespective of dentition status, similar to the findings of previous reports

TABLE 5

Average food group intakes as a percentage of daily recommended servings and as daily intake frequencies for edentate and dentate elderly participants of the Health, Aging, and Body Composition Study 2

Food group

Edentate

Dentate

( n = 490)

( n = 1870)

Fruit and fruit juice 2

1.97 ± 0.06

2.09 ± 0.06 a

Vegetables (% 3) 2

70.1 ± 2.8

73.7 ± 2.5

Grains (% 4)

82.6 ± 1.7

82.7 ± 1.5

Dairy products (% 5)

86.8 ± 3.5

92.3 ± 3.1

Fats, oils, and sweets 2

3.42 ± 0.09

3.24 ± 0.08 a

Hard-to-chew foods 2, 5

1.51 ± 0.05

1.69 ± 0.05 a

Easy-to-chew foods 2

1.21 ± 0.05

1.21 ± 0.05

1 x ± SEM. Intakes were calculated from a multiple linear regression analysis controlled for age, race, sex, education, income, study site, smoking, drinking, living alone, having chewing pain, and self-reported health status. There was a significant interaction between race and edentulism on intake of the meat group, P < 0.05. The stratified analysis result is reported in Table 3.

2 Reported as daily intake frequency.

3 Significantly different from edentate, P < 0.05.

4 Reported as the percentage of daily recommended servings appropriate for sex and energy requirement.

5 Significantly higher in whites than in blacks, P < 0.05.

FIGURE 1. Percentage of 493 edentate and 1883 dentate participants of the Health, Aging, and Body Composition Study with a change in body weight of >5% of baseline weight in 1 y. □, weight gain; ■, weight loss. *Significantly different from edentate, P < 0.05.

(33, 50–52). Among blacks, edentate elderly did not have significantly different fat intakes from those in dentate elderly, unlike white edentate elderly, who consumed more foods high in fat than did their dentate counterparts. At least 2 interpretations are possible to explain the racial-ethnic differences in nutrient and food intake patterns related to edentulism. One interpretation is that fundamental differences in sociodemographic and economic characteristics exist between racial groups, and that because of this, blacks’ diets are less sensitive to changes in dentition status. Blacks had lower socioeconomic status. Thus, blacks might have limited ability to get adequate quality and sufficient quantity of foods to maintain healthy eating regardless of dentition status.

The other interpretation is that edentulism alone may not be a good indicator of diminished masticating ability, which results in significant changes in nutrient intake, particularly among blacks. Consistent with another report (53), the results of higher denture use and chewing pain in black than in white dentate elderly suggest that the former group has poorer dental status. This poor dental status may compromise masticating ability as much as in edentate elderly. Thus, similar nutrient and food group intakes were shown between edentate and dentate black elderly. More information on dental status, masticating ability, and food choice and eating behavior along with socioeconomic status needs to be considered to determine which or what other possible interpretations can explain racial-ethnic differences in nutrient intake.

This study has limitations. Most of the data used were cross-sectional, such that it was not possible to determine whether any observed relation between edentulism and nutritional status was causal in either racial group. In particular, higher intakes of sweets and lower intakes of calcium among edentate elderly of both races suggest the potential of reverse causality. Sweets are known to be cariogenic, leading to dental caries and mediated tooth loss (44, 54). Furthermore, lower calcium intake is known to lead to bone loss and potentially tooth loss (55, 56). Demonstration of an association between edentulism and nutrient intake irrespective of reverse causality, however, indicates that edentate elderly are at risk of poorer nutrient intake. Nutrient and food group intakes were estimated with the use of an FFQ designed specially for this study, which made use of the best approaches available. However, inherent limitations of the FFQ may not be avoidable in assessing the dietary intake pattern of a biracial older population, in whom little validity research has been done (57–61).
Our analysis did not include detailed information on dental status (ie, number of natural teeth remaining, functional units, denture use, or periodontal diseases) or oral health behavior variables. In particular, lack of extensive information on denture use (type, age, quality, fit, and frequency of use) limits a complete understanding of the heterogeneous dental status of the participants (especially the dentate participants), which may result in underestimates of the association between edentulism and nutritional status. Some previous research showed that wearing dentures may not be associated with poorer dietary intake and may depend on the type of food selected within or across food groups (13, 62, 63). More data on full dental and periodontal examinations conducted in the Health ABC Study will provide a better understanding of the relation between edentulism and nutritional status.

The results of the present study suggest several strategies for maintaining or improving the nutritional status of edentate elderly. First, appropriate dental, medical, and public health services should be provided to prevent or delay edentulism as long as dental status permits and to help edentate elderly compensate for their compromised masticating ability. Particular attention needs to be given to the underserved and disadvantaged elderly. Second, nutrition education or other interventions should be provided to help edentate elderly consume appropriate servings of the food guide pyramid with easy-to-chew choices. Racial-ethnic differences in the effect of edentulism on nutritional status warrant investigation so that nutrition education messages can be tailored to different racial groups. Finally, more emphasis needs to be placed on providing easy-to-chew, tasty food products that have a high proportion of nutrients to calories. Such products would be of practical help for edentate elderly to achieve healthy eating. Nutritionists, food scientists, and food manufacturers need to work together to develop these types of foods.

The present results underscore the message from the first-ever Surgeon General’s report on oral health (1), which stated that general health cannot be achieved without oral health. With increasing proportions of elderly in the population, particularly persons aged ≥85 y, the actual number of edentate elderly is expected to grow. More attention needs to be given to maintaining and improving the nutritional status of edentate elderly and to preparing relevant health professionals to provide needed services and education to edentate elderly and their caregivers (64, 65). These efforts will contribute to improving the overall quality of life and well-being among older adults.

JSL and ABN were responsible for the study concept and research design. JSL performed the data analysis and drafted the article. ABN, TBH, RJW, SBK, and RR critically revised the article for important intellectual content. SMR and PC provided administrative, technical, or logistic support. None of authors had any possible conflicts of interest.

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