Successful Aging: Predictors and Associated Activities

William J. Strawbridge, 1 Richard D. Cohen, 1 Sarah J. Shema, 1 and George A. Kaplan 2

Six-year predictors of successful aging were analyzed for 356 Alameda County Study men and women aged 65–95 years measured prospectively in 1984 and followed to 1990. Successful aging was defined as needing no assistance nor having difficulty on any of 13 activity/mobility measures plus little or no difficulty on five physical performance measures. After adjusting for baseline successful aging, sex, and age, the authors found that 1984 predictors of 1990 successful aging included income above the lowest quintile (odds ratio (OR) = 2.01, 95% confidence interval (CI) 0.99–4.11), >12 years of education (OR = 1.67, 95% CI 0.98–2.84), white ethnicity (OR = 2.12, 95% CI 0.93–4.86), diabetes (OR = 0.10, 95% CI 0.01–0.79), chronic obstructive pulmonary disease (OR = 0.41, 95% CI 0.17–0.97), arthritis (OR = 0.43, 95% CI 0.26–0.71), and hearing problems (OR = 0.48, 95% CI 0.25–0.89). Adjusting for all variables, the authors found that behavioral and psychosocial predictors included the absence of depression (OR = 1.94, 95% CI 1.10–3.42), having close personal contacts (OR = 1.82, 95% CI 1.05–3.18), and often walks for exercise (OR = 1.77, 95% CI 1.00–3.12). Cross-sectional comparisons at follow-up revealed significantly higher community involvement, physical activity, and mental health for those aging successfully. Am J Epidemiol 1996;144:135–41.

This paper addresses two questions: What factors are prospectively associated with subsequent successful aging, and what difference does successful aging make in terms of activities and mental outlook?

The concept of successful aging was introduced by Rowe and Kahn (1) in the context of separating the effects of disease from the aging process itself. Rowe and Kahn specifically proposed that those aging successfully would show little or no age-related decrements in physiologic function, while those aging "usually" would show disease-associated decrements, often interpreted as the effects of age. While the notion of successful aging is an attractive one and directly addresses the quality of life while aging, it has proven difficult to operationalize and its public health significance is problematic. For example, it is not clear how to define successful aging. Following Rowe and Kahn's definition leads to a focus on a very small, elite segment of the population and thus reduces interest in secondary and tertiary prevention. Media features on "super elders" who do physical feats that most younger persons cannot (such as senior marathon runners) suffer the same problem. It is also not necessarily the case that risk factor patterns observed in such an elite group will lead to useful interventions for the rest of the older population.

Nevertheless, there is increasing interest in health promotion and disease prevention in older persons, and interest in successful aging shifts the focus to those older persons who are doing well as opposed to the usual focus on the "four Ds" (disease, disability, death, and dementia). Similar terms for successful aging include healthy aging, aging well, and productive aging (2–4).

Most researchers studying successful aging have selected older persons with minimal disability or high levels of physical functioning. Guralnik and Kaplan (4) considered subjects aging successfully who scored in the top 20 percent on a combined physical function and exercise scale. The MacArthur studies (5, 6) of successful aging included 70- to 79-year-olds who had correct scores on at least six of nine mental status questions, remembered at least three of six elements of a short story, reported no disabilities on any of seven activities of daily living, had no more than one disability on eight mobility and physical performance items, were able to hold a semi-tandem balance for at least 10 seconds, and were able to stand from a seated position five times within 20 seconds. For their active...
life expectancy analyses, Manton and Stallard (7) used 27 activities of daily living, instrumental activities of daily living, physical performance, and mobility measures to define six disability profiles; the highest profile (functionally unimpaired) constituted 32 percent of their sample.

Criteria for Roos and Havens (8) included living for 12 years following baseline interview, community dwelling, receiving less than 60 days of home care services in the last year, fair or better perceived health, not dependent on five activities of daily living, not using a wheelchair, not needing help to go outdoors, able to walk outdoors, successful score on a mental status test, and state of mind no worse than "a bit weak."

There appears to be no agreed-upon standard or underlying theme for measuring successful aging nor is it clear what the concept means in terms of what older persons actually do with their lives and how they feel. For this study, we adopted a general definition proposed by Schmidt (9, p. 4) as "minimal interruption of usual function, although minimal signs and symptoms of chronic disease may be present." We then examined risk factors measured 6 years earlier to predict subsequent successful aging and assessed how different those aging successfully at follow-up were on a variety of everyday activities and mental health from those not aging successfully.

MATERIALS AND METHODS
Study sample

The Alameda County Study is a longitudinal study of factors related to health and mortality that has followed nearly 7,000 adults since 1965 (10). Subjects were originally selected to be a representative sample of Alameda County, California.

In 1984, cohort members aged 65 years or older who had responded to all previous surveys were designated for a special study on factors related to physical functioning in old age using a telephone interview (4). Completed interviews were obtained with 508 of 550 for a response rate of 92 percent. At the 6-year follow-up in 1990, there were 127 confirmed deaths and 381 members of this 1984 cohort still surviving; 356 (93 percent) responded to the follow-up questionnaire. Nursing home residents (15 of the 356 in 1990) were included. Among the 356 survivors were 147 men (41 percent) and 209 women (59 percent). Blacks numbered 44 (12 percent) with nearly everyone else white (88 percent). The mean age was 71.9 years. Among the 127 nonsurvivors were 55 men (43 percent) and 72 women (57 percent). Blacks numbered 16 (13 percent). The mean age was 77.0 years. Additional information on this cohort including physical functioning is available elsewhere (11-13). Differences between survivors and nonsurvivors on selected factors are shown in appendix table 1. These differences have been shown in previous analyses of the entire Alameda Study Cohort to be related to mortality (10, 14, 15).

Measures

Successful aging. Subjects were considered to be aging successfully if they could do all the basic physical activities expected of an adult with no difficulty and had no more than a little difficulty on selected physical performance measures. Subjects were asked about their ability to do 13 basic physical activities: bathing, eating, dressing, grooming, using the toilet, walking across a room, transferring from bed to chair, shopping, cooking, doing housework, walking a half mile (0.8 km), walking up a flight of stairs, and having no problem getting where they needed to go. They were also asked about their ability to do five physical performance activities: lifting or carrying weights over 10 pounds (4.54 kg); stooping, crouching, or kneeling; pushing or pulling a large object (like a living room chair); lifting arms above the shoulders; and writing or handling small objects. Response alternatives included not able to do at all, have a lot of difficulty doing, have some difficulty doing, have a little difficulty doing, and have no difficulty doing the particular activity in question. Subjects were also asked if they needed any help doing the activity. All of these 18 items are from established scales and have been used extensively in measuring physical functioning in old age (16-20).

Subjects who reported doing all 13 basic activities with no difficulty or help needed and who had no more than a little difficulty doing each of the five physical performance activities were scored as aging successfully. Subjects not meeting these criteria were scored as not aging successfully. Identical questions were used to measure successful aging at baseline in 1984 and at follow-up in 1990.

1984 Predictors. Sociodemographic variables included age, sex, ethnicity (white/black), education (12 years or more vs. less), family income (upper four quintiles vs. lowest), and marital status (married vs. else). Chronic conditions were based upon the reported absence/presence in the past 12 months of diabetes, arthritis, cancer, stroke, asthma, and chronic obstructive pulmonary disease, defined as bronchitis or emphysema. The absence of hearing problems was measured by comparing those reporting excellent or good hearing with those reporting fair, poor, or unable to hear at all. Behavioral and psychosocial factors included often walks for exercise, does not currently smoke cigarettes, moderate alcohol consumption of
4–30 oz (120–900 ml) per month compared with never or greater amounts, having five or more close personal contacts versus fewer, and not often depressed (never or sometimes vs. often).

Associated characteristics. In 1990 subjects were asked an additional set of questions about activities, physical health, and mental outlook. Information on activities included paid employment, volunteer work, exercise and sports activities, automobile driving, attendance at religious services, and how many days per week subjects went out to do things they enjoyed doing. Physical health items included how often they saw a physician in the past year, how many days they were sick in bed, whether they felt too tired to do things they enjoyed doing, and how often they took naps. Mental health items included how often they felt depressed and how often they felt excited or pleased.

Data analysis

Multiple logistic regression was used to assess the relations between 1984 predictors and 1990 successful aging. 1990 successful aging was regressed on each predictor variable measured in 1984. Because the association between baseline successful aging and 1990 successful aging was quite strong, 1984 successful aging was included along with age and sex in all regression models to adjust for confounding effects. When the associations for behavioral and psychosocial variables were examined, there was additional adjustment for education, ethnicity, income, and number of reported chronic conditions in 1984. After analyzing the relations between each individual predictor variable and follow-up successful aging, we fit a single model containing the three behavioral factors associated with successful aging to test for independent associations. We then combined the three variables into a scale to estimate the impact on follow-up successful aging of doing one, two, or three of the factors compared with doing none. In all cases, predictor variables were dichotomized to facilitate comparisons.

A cross-sectional analysis strategy was used to assess what old age would be like if more aged successfully. Logistic regression was used to describe the relations between 1990 activities and 1990 successful aging. Each activity or mental state was entered as the outcome in a model with successful aging, age, sex, education, and income as predictors. The model allows one to compare the estimated proportions of those doing each activity by successful aging status based upon setting fixed values for the other variables. Specifically, the models assume an age of 75, income in the upper four quintiles, and high school graduation. Age 75 was selected because it was near the mean age at follow-up and represented the beginning of the "old" category in the familiar "young old," "old," and "old old" trichotomy. For many of the models, however, the logistic coefficient for age was small; sensitivity tests using the ages of 70 and 80 years revealed only minor differences on most variables from the percentages obtained when age 75 was used. Results are presented separately for males and females to highlight the large sex differences in some of the outcomes.

RESULTS

Nearly 60 percent of all subjects were scored as aging successfully in 1984, while only 35 percent were so classified in 1990 (table 1). However, there was some movement in the positive direction as 18 subjects moved from not aging successfully in 1984 to aging successfully in 1990. The only statistically significant difference in risk factors used in these analyses between these 18 and the 107 who were aging successfully at both times was a higher prevalence of arthritis for the former (67 percent vs. 42 percent; p = 0.05 using a χ² test). All but one of the 18 who improved were also unsuccessful in 1984 on only one or two of the variables used to measure successful aging, indicating that the change was minimal. At both points men were more likely to be aging successfully than were women (71 percent vs. 48 percent in 1984 and 44 percent vs. 29 percent in 1990). These sex differences were both statistically significant (p < 0.01 using a χ² test).

1984 Predictors

Odds ratios for relations between the single baseline predictors and follow-up successful aging with age, sex, and baseline successful aging included in the models are shown in table 2. Note the strong association between baseline successful aging, used elsewhere as a control variable, and follow-up successful aging (odds ratio (OR) = 7.21, 95 percent confidence interval (CI) 4.06–12.78). Positive demographic predictors included income above the lowest quintile (OR = 2.01, 95 percent CI 0.99–4.11) and 12 or more

TABLE 1. Successful aging status of 356 Alameda Study Cohort members aged 65–95 years at baseline in 1984 and follow-up in 1990

<table>
<thead>
<tr>
<th>Aging successfully in 1984</th>
<th>Aging successfully in 1990</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (58)</td>
<td>107 (30)</td>
<td>125 (35)</td>
</tr>
<tr>
<td>No (42)</td>
<td>18 (5)</td>
<td>31 (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>205</td>
<td>356</td>
</tr>
</tbody>
</table>

* Numbers in parentheses, percentage.
TABLE 2. Baseline predictors of 1990 successful aging for 356 Alameda Study Cohort members aged 65–95 years at baseline interviewed in 1984 and 1990

<table>
<thead>
<tr>
<th>1984 Baseline predictor</th>
<th>OR*,†</th>
<th>95% CI*,†</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline successful aging and sociodemographic predictors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline successful aging</td>
<td>7.21</td>
<td>4.06–12.78</td>
</tr>
<tr>
<td>White ethnicity</td>
<td>2.12</td>
<td>0.93–4.86</td>
</tr>
<tr>
<td>Income above lowest quintile</td>
<td>2.01</td>
<td>0.99–4.11</td>
</tr>
<tr>
<td>Aged 65–74 years compared with older</td>
<td>1.62</td>
<td>1.02–3.27</td>
</tr>
<tr>
<td>≥12 years of education</td>
<td>1.67</td>
<td>0.98–2.84</td>
</tr>
<tr>
<td>Male sex</td>
<td>1.30</td>
<td>0.79–2.11</td>
</tr>
<tr>
<td>Married</td>
<td>0.82</td>
<td>0.45–1.51</td>
</tr>
<tr>
<td><strong>Chronic conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.10</td>
<td>0.01–0.79</td>
</tr>
<tr>
<td>Asthma</td>
<td>0.27</td>
<td>0.05–1.36</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.34</td>
<td>0.07–1.61</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>0.41</td>
<td>0.17–0.97</td>
</tr>
<tr>
<td>Arthritis</td>
<td>0.43</td>
<td>0.26–0.71</td>
</tr>
<tr>
<td>Hearing problems</td>
<td>0.48</td>
<td>0.25–0.89</td>
</tr>
<tr>
<td>Cancer</td>
<td>0.73</td>
<td>0.36–1.49</td>
</tr>
<tr>
<td><strong>Behavioral and psychosocial predictors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not often depressed</td>
<td>1.82</td>
<td>1.05–3.16</td>
</tr>
<tr>
<td>Has five or more close personal contacts</td>
<td>1.76</td>
<td>1.02–3.02</td>
</tr>
<tr>
<td>Often walks for exercise</td>
<td>1.70</td>
<td>0.98–2.96</td>
</tr>
<tr>
<td>Moderate alcohol use</td>
<td>1.48</td>
<td>0.83–2.62</td>
</tr>
<tr>
<td>Does not currently smoke cigarettes</td>
<td>1.22</td>
<td>0.60–2.47</td>
</tr>
</tbody>
</table>

* OR, odds ratio; CI, confidence interval.
† Based upon logistic regression models. All models include age, sex, and baseline successful aging. Behavioral and psychosocial predictors also include adjustments for ethnicity, income, education, and number of chronic conditions.

Prevalent cancer (OR = 0.73, 95 percent CI 0.36–1.49) was not associated with successful aging.

After adjustment for age, sex, baseline successful aging, education, income, and number of chronic conditions, three behavioral and psychosocial factors were prospectively associated with increased odds of subsequent successful aging: not often depressed (OR = 1.82, 95 percent CI 1.05–3.16), having five or more close personal contacts (OR = 1.76, 95 percent CI 1.02–3.02), and often walks for exercise (OR = 1.70, 95 percent CI 0.98–2.96). Moderate alcohol use (OR = 1.48, 95 percent CI 0.83–2.62) and does not currently smoke cigarettes (OR = 1.22, 95 percent CI 0.60–2.47) were not associated with subsequent successful aging.

In order to test the independence of the observed associations for the behavioral and psychosocial predictors, the three factors of not often depressed, having five or more close personal contacts, and often walking for exercise were included in a single logistic regression model along with age, sex, baseline successful aging, education, income, and number of chronic conditions. Results are shown in table 3. The associations for each variable increased from those obtained in table 2 when these variables were used in separate models.

The three behavioral and psychosocial predictors were also combined into a scale measuring the number of positive responses for each predictor. The reference category was zero positive responses (i.e., someone often feeling depressed, having fewer than five close personal contacts, and not often walking for exercise). The proportion of subjects with zero positive responses was 20.6 percent. Because of small numbers in the three-response category, those with two or three
positive responses were combined. The results for comparing higher steps on the scale with zero positive responses are shown in table 3. Those who did report two or three positive responses (39.0 percent) were three times more likely (OR = 3.16, 95 percent CI 1.42–7.04) to age successfully compared with those with no positive responses, and those with one positive response were twice as likely (OR = 2.00, 95 percent CI 0.92–4.35).

Follow-up cross-sectional activity comparisons

Table 4 presents the estimated proportions of 75-year-old men and women who reported engaging in various activities and expressing certain feelings, comparing those aging successfully at follow-up with those not so doing. A higher proportion of those aging successfully report doing paid or volunteer work and going out 3 days a week or more to do things they enjoy doing. A higher proportion say they exercise or play a sport, attend religious services monthly, and drive a car.

For physical health items, a higher proportion of those successfully aging report seeing a doctor less than once a month over the past year, spending no days sick in bed, not being too tired to do things they enjoy doing, and not usually taking a nap. For mental health, a higher proportion of those successfully aging report never feeling depressed over the past year and often feeling excited or pleased. All associations between successful aging and the activities in table 4 were statistically significant at $p = 0.05$ or less using a $\chi^2$ test and adjusting for age, sex, education, and income.

DISCUSSION

A wide range of factors appears to be prospectively associated with subsequent successful aging. That the four relatively common chronic diseases of diabetes, asthma, arthritis, and chronic obstructive pulmonary disease would reduce the likelihood of subsequent successful aging is consistent with previous research highlighting their known impacts on physical functioning (11, 21, 22). The particularly strong association between diabetes and successful aging is noteworthy, perhaps reflecting the higher prevalence of cardiovascular, podiatric, and visual problems among persons with diabetes.

The pathway through which hearing loss might affect successful aging 6 years later is not readily apparent. Perhaps hearing loss is a marker for more systemic physiologic defects or disease processes that are not otherwise measured. Certainly hearing loss is often underrated as a serious problem in aging. Its prevalence is high (23), and its occurrence makes it much more difficult for older persons to function effectively in a complex society where communication is so important. Withdrawing from physical or social activities because of hearing difficulties could be a

### TABLE 4. Percentage of men and women reporting activities and health status at follow-up by 1990 successful aging status, Alameda County Study, Berkeley, California, 1990a

<table>
<thead>
<tr>
<th>75-year-old men aging successfully (%)</th>
<th>75-year-old women aging successfully (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>1990 Work and leisure activities</strong></td>
<td></td>
</tr>
<tr>
<td>Does any paid or volunteer work</td>
<td>45</td>
</tr>
<tr>
<td>Go out 3 days a week or more</td>
<td>62</td>
</tr>
<tr>
<td>Exercise or play any sport</td>
<td>94</td>
</tr>
<tr>
<td>Attend religious services monthly</td>
<td>77</td>
</tr>
<tr>
<td>Drive a car</td>
<td>97</td>
</tr>
<tr>
<td><strong>Physical health</strong></td>
<td></td>
</tr>
<tr>
<td>See doctor less than once a month</td>
<td>82</td>
</tr>
<tr>
<td>Spent no days sick in bed last year</td>
<td>84</td>
</tr>
<tr>
<td>Not too tired to do things enjoy doing</td>
<td>78</td>
</tr>
<tr>
<td>Do not usually take a nap</td>
<td>53</td>
</tr>
<tr>
<td><strong>Mental health</strong></td>
<td></td>
</tr>
<tr>
<td>Never feel depressed</td>
<td>70</td>
</tr>
<tr>
<td>Often feel excited or pleased</td>
<td>69</td>
</tr>
</tbody>
</table>

* Percentages for 75-year-olds are estimated from logistic regression models with each activity as the dependent variable and age, sex, education, income, and successful aging as independent variables. Estimated percentages are for high school graduates with family income above the lowest quintile. All $p$ values for associations between successful aging and the relevant activity adjusted for age, sex, education, and income were 0.05 or less using a $\chi^2$ test.

possible indirect pathway by which this condition exerts its influence.

The finding that walking for exercise is prospectively associated with successful aging is consistent with previous findings that exercise in old age affects both mortality and physical functioning (24–29). What may be important in this analysis is that walking is the most common form of exercise for older persons and certainly one of the easiest to do (30). At baseline nearly 40 percent of our subjects reported often walking for exercise. This activity has merit for intervention to promote successful aging.

Social contacts have been shown to affect morbidity (31), mortality (32–34), and physical functioning (11). As with hearing loss, the more interesting point may be the specific pathways for the association with subsequent successful aging. The relation could be through friends and relatives possibly encouraging less risky behaviors, providing direct material support, and encouraging more effective medical interventions, or the association might indicate more involvement in community and life itself. Further research is needed to determine exactly how social contacts impact health outcomes occurring much later.

The negative impacts of depression on mortality and morbidity in old age are becoming better known (35, 36). The association found here supports those who argue for a higher awareness of the condition by health care providers, for more aggressive treatment, and for more positive involvement of older persons in community life.

Examining the three behavioral predictors together indicated that their impacts on successful aging are relatively independent of each other. However, other research has indicated that these variables are interrelated (37). The analyses here and the results of the additive scale suggest that emphasizing specific activities and treating depression, as well as stressing the "some is good but more is better" philosophy, could be more effective in promoting successful aging than in emphasizing only one or two factors.

That smoking cigarettes is not significantly associated with successful aging in this data set is not surprising; most of those who did smoke earlier in this cohort have either died or quit. Only 15.8 percent of these subjects still smoked at baseline. The sex difference associated with successful aging was in favor of males but was not statistically significant. However, the association between male sex and successful aging was statistically significant at both baseline and follow-up without other adjustment variables. Researchers using different strategies have indicated that, while incident disability may not vary by sex, disabled females live longer than do disabled males (13, 38, 39). The result is a smaller proportion of surviving males being disabled at any point in time.

Examining characteristics of 75-year-old men and women by successful aging status gave some indication of what old age would be like if more persons aged successfully. Older persons would do more paid and volunteer work, exercise more, and attend more community activities. They would also see physicians less, spend less time sick in bed, and be less apt to feel too tired to do things they enjoy doing. Mental health would be considerably improved with fewer older persons feeling depressed and more feeling excited or pleased. The concept of successful aging appears to have meaning for the everyday activities and mental health of older people.

ACKNOWLEDGMENTS

Supported by grant 1R37AG11375 from the National Institute on Aging and a grant from the Henry J. Kaiser Family Foundation.

REFERENCES


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**APPENDIX**

**APPENDIX TABLE 1.** Baseline comparisons for the 356 Alameda Study Cohort members aged 65–99 years who survived to 1990 compared with 127 nonsurvivors aged 65–99 years

<table>
<thead>
<tr>
<th>1984 Baseline variable</th>
<th>Survivors (n=356)</th>
<th>Nonsurvivors (n=127)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (%)</td>
<td>59</td>
<td>57</td>
<td>0.14</td>
</tr>
<tr>
<td>Black (%)</td>
<td>12</td>
<td>13</td>
<td>0.49</td>
</tr>
<tr>
<td>Married (%)</td>
<td>71</td>
<td>50</td>
<td>0.001</td>
</tr>
<tr>
<td>High school graduate (%)</td>
<td>66</td>
<td>51</td>
<td>0.03</td>
</tr>
<tr>
<td>With stroke (%)</td>
<td>6</td>
<td>14</td>
<td>0.33</td>
</tr>
<tr>
<td>With cancer (%)</td>
<td>14</td>
<td>22</td>
<td>0.10</td>
</tr>
<tr>
<td>With diabetes (%)</td>
<td>6</td>
<td>9</td>
<td>0.25</td>
</tr>
<tr>
<td>With bronchitis or emphysema (%)</td>
<td>11</td>
<td>13</td>
<td>0.26</td>
</tr>
<tr>
<td>Current smoker (%)</td>
<td>16</td>
<td>19</td>
<td>0.01</td>
</tr>
<tr>
<td>Often walk for exercise (%)</td>
<td>38</td>
<td>26</td>
<td>0.04</td>
</tr>
<tr>
<td>Not depressed (%)</td>
<td>51</td>
<td>47</td>
<td>0.08</td>
</tr>
<tr>
<td>Moderate alcohol use (%)</td>
<td>63</td>
<td>54</td>
<td>0.09</td>
</tr>
</tbody>
</table>

* The mean ages for survivors and nonsurvivors were 71.9 years and 77.0 years, respectively (p = 0.001).

† The difference in mean age was tested using a t test. All other associations were tested with a logistic regression model adjusting for age and sex.

‡ Defined as 4–30 oz/month (120–900 ml).