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Research Article

Association Between Carbohydrate Nutrition and Successful Aging Over 10 Years

Bamini Gopinath[1], Victoria M. Flood,[2,3] Annette Kifley[1], Jimmy C. Y. Louie,[4] and Paul Mitchell[1]

[1]Centre for Vision Research, Department of Ophthalmology, and The Westmead Institute for Medical Research and [2]Faculty of Health Sciences, University of Sydney, Australia. [3]St Vincent's Hospital, Sydney, Australia. [4]School of Molecular Bioscience, Faculty of Sciences, University of Sydney, New South Wales 2145, Australia.

Address correspondence to Bamini Gopinath, BTech, PhD Centre for Vision Research, Department of Ophthalmology, and The Westmead Institute for Medical Research, University of Sydney, Westmead, Sydney, New South Wales 2145, Australia. Email: bamini.gopinath@sydney.edu.au.

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Abstract

Background: We prospectively examined the relationship between dietary glycemic index (GI) and glycemic load (GL), carbohydrate, sugars, and fiber intake (including fruits, vegetable of breads/cereals fiber) with successful aging (determined through a multidomain approach).
Methods: A total of 1,609 adults aged 49 years and older who were free of cancer, coronary artery disease, and stroke at baseline were followed for 10 years. Dietary data were collected using a semiquantitative Food Frequency Questionnaire. Successful aging status was determined through interviewer-administered questionnaire at each visit and was defined as the absence of disability, depressive symptoms, cognitive impairment, respiratory symptoms, and chronic diseases (eg, cancer and coronary artery disease).
Results: In all, 249 (15.5%) participants had aged successfully 10 years later. Dietary GI, GL, and carbohydrate intake were not significantly associated with successful aging. However, participants in the highest versus lowest (reference group) quartile of total fiber intake had greater odds of aging successfully than suboptimal aging, multivariable-adjusted odds ratio (OR), 1.79 (95% confidence interval [CI] 1.13–2.84). Those who remained consistently below the median in consumption of fiber from breads/cereal and fruit compared with the rest of cohort were less likely to age successfully, OR 0.53 (95% CI 0.34–0.84) and OR 0.64 (95% CI 0.44–0.95), respectively.
Conclusions: Consumption of dietary fiber from breads/cereals and fruits independently influenced the likelihood of aging successfully over 10 years. These findings suggest that increasing intake of fiber-rich foods could be a successful strategy in reaching old age disease free and fully functional.

Key Words: Blue Mountains Eye Study—Carbohydrate—Fiber—Glycemic index—Successful aging

The effect of carbohydrate nutrition on health outcomes and disease has increasingly been the recent focus of research. Some carbohydrate-rich foods have less effect than others to increase blood glucose (1). This property of individual foods is called the "glycemic index (GI)," a measure of carbohydrate quality (1–3). Dietary glycemic load (GL) is the product of a food's GI and total available carbohydrate content and represents both the quantity and quality of carbohydrates, that is, the total glycemic impact of a portion of the food (4,5). Both dietary GI and GL have been proposed to contribute to the development of obesity (6), diabetes, and cardiovascular disease (7). Further, specific aspects of carbohydrate quality, such as intakes of sugary foods and dietary fiber, are thought to influence health outcomes including obesity and its comorbidities (8,9). Moreover, foods that are high in fiber, whole grains, vegetables, fruits, and legumes contain more than just fiber. These co-passengers with fiber may provide the protective health properties of fiber, rather than the fiber itself (10). Also, additional properties of fiber, such as viscosity and fermentability, may be more important characteristics in terms of physiological benefits (11).

Rowe and Kahn first described successful aging as absence of disease, good social engagement, lack of physical disability, and good mental health (12). Resolving the effects of dietary macronutrients on aging and health remains a fundamental challenge, with profound implications for human health (13). Sabia et al. (14) showed that daily consumption of fruits and vegetables by UK adults was associated with a 35% increased odds of aging successfully over 16.3 years. More recently, a Australian cohort study showed that a fruit-based eating pattern was positively associated with a successful aging outcome (ie, lack of chronic disease, little limitation in physical function, and good mental health) for12 years (15). We recently showed that greater compliance with recommended national dietary guidelines (higher diet quality) was associated with an increased likelihood of successful aging, as determined through a multidomain approach (16). However, no population-based cohort study has investigated the temporal association between a range of carbohydrate nutrition variables (total dietary carbohydrate, GI, GL, fiber, and total sugars) and aging status. Associations of inflammation with age-related pathologies are well documented (17), and given that the effects of carbohydrate nutrition variables such as GI/GL and fiber on inflammatory markers are also established (18), it is plausible that carbohydrate nutrition is of particular relevance to the aging process.

Therefore, in this study, we aimed to examine the independent relationship between various aspects of carbohydrate nutrition (total dietary carbohydrate, GI, GL, fiber from different food sources, and sugars) and a comprehensive definition of successful aging that included being free of disability and chronic disease (coronary artery disease, stroke, diabetes, and cancer); having good mental health and functional independence; and having good physical, respiratory, and cognitive function for a follow-up period of 10 years. For comparison, we also examined the association between the aforementioned carbohydrate nutrition variables and 10-year mortality risk in this cohort of older adults.

Methods

Study Population

The Blue Mountains Eye Study (BMES) is a population-based cohort study of common eye diseases and other health outcomes in a suburban Australian population located west of Sydney. Study methods and procedures have been described elsewhere (19). Baseline examinations of 3,654 residents aged 49 years and older were conducted during 1992–1994 (BMES-1, 82.4% participation rate). Surviving baseline participants were invited to attend examinations after 5 years (1997–1999, BMES-2), 10 years (2002–2004, BMES-3), and 15 years (2007–2009, BMES-4) at which 2,334 (75.1% of survivors), 1,952 participants (75.6% of survivors), and 1,149 (55.4% of survivors) were reexamined, respectively, with complete data. The University of Sydney and the Western Sydney Area Human Ethics Committees approved the study, and written informed consent was obtained from all participants at each examination. All study methods were performed in accordance with the approved guidelines.

Nutritional Assessment

Dietary data were collected using a 145-item self-administered semiquantitative Food Frequency Questionnaire (FFQ) (20). At all BMES examinations, participants used a nine-category frequency scale to indicate the usual frequency of consuming individual food items during the past year. For the current study, FFQ data collected at BMES-1 were used in the analyses. This FFQ included questions about the types of breakfast cereals consumed that were used to increase the accuracy of the GI calculations. The FFQ showed reasonable agreement for carbohydrates and GI, yielding correlation coefficients of 0.55 and 0.57, respectively, and correctly classifying nearly 80% of participants within one quintile for carbohydrate intake and 74% participants within one quintile for GI, in a subset of participants who had completed 12 days of weighed food records over three seasons (21,22). The methodology used to determine intakes of specific carbohydrate nutrition variables are presented in Supplementary Material.

Assessment of Study Outcomes (Aging Status and Mortality)

We assessed chronic diseases throughout the 10-year follow-up (ie, from BMES-1 to BMES-3). Medical history was determined by interviewer-administered questionnaire at each visit. The suboptimal aging group in the context of this study included all participants who were alive 10 years later, but who were not classified as aging successfully (see definition subsequently) (14). Among surviving participants aged 60 years and older, we used a definition similar to that used by Sabia et al. (14), which defined successful aging as satisfying each of the following criteria: no history of cancer, coronary artery disease, stroke, angina, acute myocardial infarction, or diabetes; good cognitive, physical, respiratory, and cardiovascular functioning; and the absence of disability; good mental health, and functional independence (see Supplementary Material) (16).

To identify and confirm persons who died after BMES-1, demographic information including surname, first and second names, gender, and date of birth of the participants were cross-matched with Australian National Death Index (NDI) data, as previously described (23). Validity of NDI data has been reported to have high sensitivity and specificity for cardiovascular mortality (92.5% and 89.6%, respectively) (24). The census cutoff point for deaths was end of December 2004 (ie, a 10-year period from BMES-1 or the baseline examination).

Statistical Analysis

SAS 9.2 software (SAS Institute, Cary, NC) was used for statistical analyses. Study factors were carbohydrate nutrition (total carbohydrates, GI, GL, total sugars, and fiber) and three categories of study outcome were defined: successful aging (key study outcome), death during follow-up, and suboptimal aging. Baseline characteristics of study participants who were followed over 10 years were compared using χ^2 tests and general linear model. Multivariable polytomous logistic regression analyses for the outcome of aging status (successful aging, suboptimal aging, and having died) used the generalized logit link and adjusted for age, sex, marital status, living status, smoking, and weight status. Further adjustment for energy-adjusted total fiber intake was performed when total carbohydrates, GI, GL, and total sugars were analyzed as the study factors. Participants also reported who they lived with (alone or with, eg, partner, child, or friend) and current marital status (married, widowed, divorced, or never married). Body mass index was calculated as weight divided by height squared (kg/m^2). Participants also self-reported history of smoking as never, past, or current smoking. Current smokers included those who had stopped smoking within the past year. Carbohydrate nutrition variables were analyzed as a continuous variable (per 1 unit) and categorical variable (quartiles). Associations between baseline dietary intake and sustained low intake (below the median dietary intake over 10 years) and the three categories of outcomes (suboptimal aging, successful aging, and death) were both explored.

Results

Of the 3,654 participants aged 49 years and older examined at the baseline examination (BMES-1), 1,116 were excluded as they had cancer, coronary artery disease, and/ or stroke at the baseline examination. A further 929 were excluded as they did not have dietary data and/or had insufficient information to characterize their aging status 10 years later, leaving 1,609 participants for longitudinal analyses. Of these 1,609 participants, 610 (37.9%) had died, 750 (46.6%) were suboptimal agers, and 249 (15.5%) were successful agers 10 years later. Supplementary analysis was conducted where we compared dietary intakes between those who were followed up (n = 1,327) versus those who were excluded because they were not followed up 10 years later but who also had not passed away during this follow-up period (n = 361); regardless of their aging status. We found that those who were excluded because they did not return for the 10-year examination (BMES-3) versus those who came back had higher dietary GI intakes (56.9 vs 56.1, p = 0.01) but lower total fiber intake (26.3 vs 28.0 g/day, p = 0.002), fruit fiber (6.3 vs 7.2 g/day, p = 0.003) and breads/ cereal fiber intakes (6.7 vs 7.7 g/day, p = 0.002). We found no significant differences with the other dietary variables (data not shown). Supplementary Figure 1 shows that with increasing age at baseline there is an increase in mortality rate, however, the proportion of participants who aged successfully or were suboptimal agers decreased with increasing age. At baseline, those who aged successfully compared with those who were classified as suboptimal agers or had died were more likely to be younger, less likely to smoke, and have lower dietary GI intake but higher intakes of total fiber and breads/cereal fiber (Table 1). Those who died versus those who were suboptimal and successful agers were more likely to be men and have higher dietary GL intake (Table 1).

Table 2 shows that participants who were in the highest quartile compared with the lowest quartile of dietary GI intake at baseline had 65% increased risk of dying rather than suboptimal aging 10 years later, adjusted odds ratio (OR) 1.65 (95% confidence interval [CI] 1.10–2.47). Compared with those in the first quartile, participants in the third and fourth quartile of total fiber intake were more likely to age successfully rather than suboptimal aging, OR 2.06 (95% CI 1.31–3.23) and OR 1.79 (95% CI 1.13–2.84), respectively (Table 3). Participants in the third versus first tertile of baseline breads/cereal fiber consumption had 78% increased odds of successfully aging 10 years later. An inverse association between consumption of breads/cereal fiber and mortality risk was also observed (Table 3). Participants in the third and fourth quartile of fruit fiber intake versus those in the first quartile had 64% and 81% increased likelihood of aging successfully than suboptimal aging, respectively.

We examined the linear associations between baseline intakes of carbohydrate nutrition variables and aging status over the 10 years. After multivariable adjustment, each 1-unit increase in dietary GI intake at baseline was associated with 4% increase in risk of death rather than suboptimal aging 10 years later, OR 1.04 (95% CI 1.01–1.07). Also, each 1-unit increase in energy-adjusted total fiber intake was associated with a 2% increased likelihood of aging successfully versus suboptimal aging, multivariable-adjusted OR 1.02 (95% CI 1.00–1.04). Each 1-unit increase in baseline bread/cereal fiber intake at baseline was associated with increased odds of successful aging compared with suboptimal aging, multivariable-adjusted OR 1.03 (95% CI 1.00–1.06).

We also assessed the aging status of participants who remained consistently below the median intake of the various carbohydrate nutrition variables compared with all other participants, that is, those who remained consistently above the median or fluctuated between above/below the median during the 10 years. For these analyses, we had 810 participants who had complete dietary data at all three time points (BMES-1, -2, and -3) as well as sufficient information to characterize their aging status 10 years later (Table 4). Participants who remained consistently below the median in consumption of fiber from breads/cereal and fruit compared with the

Table 1. Study Characteristics of Participants at Baseline Stratified by Aging Status

Characteristics	Suboptimal Aging (n = 750)	Successful Aging (n = 249)	Died (n = 610)	p-Value
Age, y	61.9 (7.4)	59.9 (6.1)	71.2 (9.4)	<.0001
Male sex	280 (37.3)	105 (42.2)	312 (51.2)	<.0001
Marital status				
Married	500 (66.7)	191 (76.7)	363 (59.8)	<.0001
Widowed/divorced/never married	250 (33.3)	58 (23.3)	244 (40.2)	
Living status				<.0001
Lives alone	161 (21.6)	46 (18.6)	196 (32.6)	
Does not live alone	585 (78.4)	202 (81.5)	406 (67.4)	
Current smoking	105 (14.2)	20 (8.2)	106 (18.0)	.001
Weight status				.20
Normal	614 (82.4)	216 (86.8)	509 (85.0)	
Overweight/obese	131 (17.6)	33 (13.3)	90 (15.0)	
Mean dietary intakes of				
Glycemic index, g/day	56.3 (4.5)	55.9 (4.2)	57.5 (4.6)	<.0001
Glycemic load	131.2 (22.6)	132.7 (21.8)	135.3 (24.8)	.01
Total carbohydrates, g/day	233.1 (39.6)	237.0 (36.5)	235.9 (41.9)	.28
Total sugars, g/day	123.9 (32.9)	124.7 (32.1)	126.5 (37.4)	.38
Total fiber, g/day	27.7 (8.5)	29.0 (8.0)	26.4 (9.0)	.0002
Breads/cereals fiber, g/day	7.5 (4.8)	8.2 (5.1)	6.8 (4.8)	.0001
Vegetable fiber, g/day	10.0 (4.3)	10.0 (3.9)	9.8 (4.4)	.67
Fruit fiber, g/day	7.1 (5.3)	7.6 (4.7)	6.7 (5.1)	.06

Note. N = 1,609. All data are presented as mean (SD) or n (%).

Table 2. Associations Between Baseline Intakes of Energy-Adjusted Dietary GI, GL, and Total Carbohydrate and Aging Status 10 y Later in the Blue Mountains Eye Study

Energy-adjusted Variable	Suboptimal Aging (*n* = 750)		Successful Aging (*n* = 249)		Died (*n* = 610)	
	n (%)	OR (95% CI)*	*n* (%)	OR (95% CI)*	*n* (%)	OR (95% CI)*
Mean dietary GI						
First quartile (*n* = 391)	195 (49.9)	1.0 (reference)	75 (19.2)	1.0 (reference)	121 (31.0)	1.0 (reference)
Second quartile (*n* = 400)	199 (49.8)	1.0 (reference)	67 (16.8)	0.94 (0.63–1.42)	134 (33.5)	0.91 (0.62–1.33)
Third quartile (*n* = 398)	189 (47.5)	1.0 (reference)	58 (14.6)	0.87 (0.56–1.34)	151 (37.9)	1.04 (0.70–1.53)
Fourth quartile (*n* = 420)	167 (39.8)	1.0 (reference)	49 (11.7)	0.97 (0.60–1.56)	204 (48.6)	**1.65 (1.10–2.47)**
Mean dietary GL						
First quartile (*n* = 425)	213 (50.1)	1.0 (reference)	64 (15.1)	1.0 (reference)	148 (34.8)	1.0 (reference)
Second quartile (*n* = 394)	190 (48.2)	1.0 (reference)	70 (17.8)	1.15 (0.76–1.74)	134 (34.0)	1.04 (0.72–1.50)
Third quartile (*n* = 388)	176 (45.4)	1.0 (reference)	58 (15.0)	1.08 (0.70–1.66)	154 (39.7)	1.05 (0.73–1.52)
Fourth quartile (*n* = 402)	171 (42.5)	1.0 (reference)	57 (14.2)	0.99 (0.64–1.53)	174 (43.3)	**1.46 (1.01–2.10)**
Mean total carbohydrate						
First quartile (*n* = 432)	211 (48.8)	1.0 (reference)	59 (13.7)	1.0 (reference)	162 (37.5)	1.0 (reference)
Second quartile (*n* = 384)	186 (48.4)	1.0 (reference)	62 (16.2)	1.09 (0.68–1.75)	136 (35.4)	1.39 (0.92–2.09)
Third quartile (*n* = 398)	180 (45.2)	1.0 (reference)	65 (16.3)	1.16 (0.74–1.81)	153 (38.4)	1.31 (0.89–1.92)
Fourth quartile (*n* = 395)	173 (43.8)	1.0 (reference)	63 (16.0)	1.13 (0.73–1.76)	159 (40.3)	0.92 (0.63–1.33)

Note. GI = glycemic index; GL = glycemic load; OR = odds ratio; CI = confidence interval. Values in bold indicate significant associations.
*Adjusted for age, sex, marital status, living status, smoking, weight status, and energy-adjusted total fiber intake.

Table 3. Associations Between Baseline Intakes of Energy-adjusted Dietary Fiber and Aging Status 10 y Later in the Blue Mountains Eye Study

Energy-adjusted Variable	Suboptimal Aging (*n* = 750)		Successful Aging (*n* = 249)		Died (*n* = 610)	
	n (%)	OR (95% CI)*	*n* (%)	OR (95% CI)*	*n* (%)	OR (95% CI)*
Mean total fiber						
First quartile (*n* = 432)	187 (43.3)	1.0 (reference)	42 (9.7)	1.0 (reference)	203 (47.0)	1.0 (reference)
Second quartile (*n* = 393)	190 (48.4)	1.0 (reference)	57 (14.5)	1.44 (0.90–2.30)	146 (37.2)	0.76 (0.53–1.08)
Third quartile (*n* = 386)	186 (48.2)	1.0 (reference)	80 (20.7)	**2.06 (1.31–3.23)**	120 (31.1)	**0.68 (0.47–0.99)**
Fourth quartile (*n* = 398)	187 (47.0)	1.0 (reference)	70 (17.6)	**1.79 (1.13–2.84)**	141 (35.4)	0.89 (0.62–1.28)
Mean vegetable fiber						
First quartile (*n* = 417)	189 (45.3)	1.0 (reference)	61 (14.6)	1.0 (reference)	167 (40.1)	1.0 (reference)
Second quartile (*n* = 428)	196 (45.8)	1.0 (reference)	63 (14.7)	1.11 (0.73–1.69)	169 (39.5)	1.05 (0.74–1.49)
Third quartile (*n* = 381)	188 (49.3)	1.0 (reference)	59 (15.5)	1.04 (0.68–1.60)	134 (35.2)	0.87 (0.60–1.25)
Fourth quartile (*n* = 383)	177 (46.2)	1.0 (reference)	66 (17.2)	1.26 (0.83–1.91)	140 (36.6)	1.15 (0.80–1.66)
Mean breads/cereal fiber						
First quartile (*n* = 422)	177 (41.9)	1.0 (reference)	46 (10.9)	1.0 (reference)	199 (47.2)	1.0 (reference)
Second quartile (*n* = 389)	185 (47.6)	1.0 (reference)	54 (13.9)	1.17 (0.74–1.86)	150 (38.6)	0.71 (0.50–1.01)
Third quartile (*n* = 395)	185 (46.8)	1.0 (reference)	80 (20.3)	**1.78 (1.14–2.76)**	130 (32.9)	**0.61 (0.42–0.88)**
Fourth quartile (*n* = 403)	203 (50.4)	1.0 (reference)	69 (17.1)	1.36 (0.87–2.13)	131 (32.5)	**0.56 (0.39–0.81)**
Mean fruit fiber						
First quartile (*n* = 411)	192 (46.7)	1.0 (reference)	44 (10.7)	1.0 (reference)	175 (42.6)	1.0 (reference)
Second quartile (*n* = 416)	195 (46.9)	1.0 (reference)	63 (15.1)	1.41 (0.90–2.21)	158 (38.0)	0.88 (0.61–1.25)
Third quartile (*n* = 382)	180 (47.1)	1.0 (reference)	66 (17.3)	**1.64 (1.03–2.59)**	136 (35.6)	0.91 (0.63–1.32)
Fourth quartile (*n* = 400)	183 (45.8)	1.0 (reference)	76 (19.0)	**1.81 (1.15–2.83)**	141 (35.3)	0.96 (0.66–1.39)

Note. OR = odds ratio; CI = confidence interval. Values in bold indicate significant associations.
*Adjusted for age, sex, marital status, living status, smoking, and weight status.

rest of cohort were less likely to age successfully, OR 0.53 (95% CI 0.34–0.84) and OR 0.64 (95% CI 0.44–0.95), respectively.

Discussion

We provide novel epidemiological evidence of an independent association between dietary fiber intake and successful aging (as determined through a multidomain approach), during 10-year follow-up. Higher baseline consumption of energy-adjusted total fiber, breads/cereal fiber, and fruit fiber were all associated with a greater likelihood of aging successfully than suboptimal aging. In contrast, a reduced likelihood of aging successfully rather than suboptimal aging was observed among participants whose consumption of dietary breads/cereal fiber and fruit fiber remained consistently below the median during the 10 years. Baseline dietary GI intake was positively associated with risk of death, whereas breads/cereal fiber consumption was inversely associated with 10-year mortality risk. However, dietary GI, GL, and total carbohydrate and sugar intake were not associated with aging successfully.

Table 4. Aging Status of Participants Who Remained Consistently Below the Median Intake of Energy-adjusted Carbohydrate Nutrition Variables Throughout the 10 y Compared With the Rest of the Cohort*

Energy-adjusted Variable	Successful Aging (n = 223)†
	OR (95% CI)
Mean dietary GI‡,§	
Below the median (n = 217)	1.39 (0.96–2.01)
Rest of the cohort (n = 593)	1.0 (reference)
Mean dietary GL‡,§	
Below the median (n = 208)	0.91(0.63–1.33)
Rest of the cohort (n = 602)	1.0 (reference)
Mean total carbohydrate‡,§	
Below the median (n = 210)	0.72 (0.49–1.08)
Rest of the cohort (n = 600)	1.0 (reference)
Mean total sugars‡,§	
Below the median (n = 196)	0.85 (0.58–1.25)
Rest of the cohort (n = 614)	1.0 (reference)
Mean total fiber‡	
Below the median (n = 216)	0.72 (0.48–1.06)
Rest of the cohort (n = 594)	1.0 (reference)
Mean vegetable fiber‡	
Below the median (n = 201)	0.97 (0.67–1.42)
Rest of the cohort (n = 609)	1.0 (reference)
Mean breads/cereal fiber‡	
Below the median (n = 165)	**0.53 (0.34–0.84)**
Rest of the cohort (n = 645)	1.0 (reference)
Mean fruit fiber‡	
Below the median (n = 234)	**0.64 (0.44–0.95)**
Rest of the cohort (n = 576)	1.0 (reference)

Note. n = 810. Values in bold indicate significant associations.

*Participants who either remained consistently above the median intake or had intakes that fluctuated between above and below the median throughout the 10 years.

†Compared with reference group who were classified as suboptimal agers, ie, did not satisfy successful aging criteria (n = 512).

‡Adjusted for age, sex, marital status, living status, smoking, and weight status.

§Further adjusted for energy-adjusted total fiber intake.

Among older adults, fiber from fruits and breads/ cereals (primarily from rolled oats and wholemeal/wholegrain breads), but not from vegetables independently predicted successful aging. This suggests that the influence of dietary fiber on health and aging could vary depending on the food sources which are consistent with prior studies that have shown varying effects of fiber from different sources on cardiovascular outcomes and kidney disease (25,26). Several mechanistic pathways could explain the association between dietary fiber intake and aging status. First, aging is associated with the development of a systemic state of low-grade chronic inflammation and with progressive deterioration of metabolic function (27). Hence, the protective effect of dietary fiber could be partly attributed to the avoidance of postprandial hyperglycemic peaks (28), because recurrent postprandial hyperglycemia results in overproduction of reactive free radical molecules and greater release of inflammatory cytokines (28–30). Moreover, it was proposed that short-chain fatty acids produced by fermentation of dietary fiber by intestinal microbiota interact with the anti-inflammatory chemoattractant receptor GPR43, that is, dietary fiber may be molecularly linked to positive influences on inflammatory responses (18,31). Also, observational studies addressing dietary fiber or whole grain intake almost consistently suggest a benefit of a higher consumption on low-grade inflammation (18).

In the BMES, older adults who consistently consumed a diet that was high in dietary GI and GL had a greater risk of dying over the 10 years. The positive association between dietary GI/GL intake and reduced life expectancy is consistent with the growing evidence that increasing the consumption of high GI and GL foods could contribute to increased oxidative stress and both acute and chronic low-grade inflammation (18,28,29). However, dietary GI/GL was not a significant predictor of successful aging. This is surprising, given that dietary GI/GL are associated with inflammatory markers (18,28,29), and associations of inflammation with age-related pathologies are established (17). It is unclear as to why dietary GI/GL was associated with mortality risk but not with successful aging, it could be that there was inadequate statistical power to detect a link with mortality, as over a third had died over the 10 years as opposed to only around 15% who had aged successfully, which could have led to the inability to detect any modest associations with GI/GL. We also caution that our findings could be due to chance and would require confirmation by other larger cohort studies.

Strengths of our study include its prospective study design, representative population-based sample with relatively high participation minimizing selection bias, use of a validated food questionnaire to collect information on dietary intakes and a comprehensive definition of successful aging. A study limitation is that some of the aging outcomes were self-report and not objectively measured (eg, respiratory function), hence, it could be subject to potential measurement errors. Similarly, there is potential for misclassification because information on dietary intake was collected by self-report. Although random within-person variation could attenuate any true association, the FFQ was designed to minimize this error by assessing average long-term dietary intake during the successive follow-up period (32). These repeated measurements take into account possible changes in diet with time and reduce random variation in reporting. Although the total effects of carbohydrate intake may not be fully depicted by the questionnaire, any measurement errors should be unrelated to the end points due to the prospective study design (25,32). Finally, because there were differences in, for example, dietary intakes of fiber and GI at baseline between those who were examined at 10 years versus those who had not died, but had also not come back for the 10-year follow-up, there is the possibility of selection bias influencing observed associations in this study.

In summary, our study findings underscore the importance of diet for aging and age-related diseases. Specifically, we show that older adults whose diets are consistently high in fiber consumption (particularly from breads/cereals and fruits) have a greater likelihood of aging successfully in the longer term. Conversely, our findings indicate that other aspects of carbohydrate nutrition including total carbohydrate intake and dietary GI/GL are not independent predictors of successful aging. These epidemiological data suggest that lifestyle interventions increasing the intake of fiber-rich foods could be a successful strategy in reaching old age disease free and fully functional.

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Conflict of Interest

The authors have no conflict of interest to declare.

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