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Dietary Patterns and Cognitive Decline in Chinese Elderly Singaporeans: A Longitudinal Cohort Study

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A B S T R A C T

Introduction: Cognitive decline is a growing public health concern, especially among aging populations. Diet is a modifiable factor that can influence brain health. This study investigated the longitudinal association between dietary patterns and cognitive decline in Chinese elderly Singaporeans. **Methods:** A cohort of 1,500 community-dwelling Chinese adults aged ≥60 years in Singapore was followed for 6 years. Dietary intake was assessed at baseline using a validated food frequency questionnaire. Cognitive function was evaluated at baseline and biennially using a comprehensive neuropsychological battery assessing memory, attention, executive function, and language. Dietary patterns were identified using factor analysis. Linear mixed-effects models were used to examine the association between dietary patterns and cognitive trajectories, adjusting for confounders. **Results:** Three dietary patterns emerged: "Traditional Chinese" (high in rice, vegetables, and fish), "Western" (high in red meat, processed foods, and sugary drinks), and "Prudent" (high in fruits, vegetables, whole grains, and low-fat dairy). Adherence to the "Prudent" pattern was associated with a slower decline in global cognition, memory, and executive function. The "Western" pattern was associated with a faster decline in memory and executive function. The "Traditional Chinese" pattern was not significantly associated with cognitive decline. **Conclusion:** A "Prudent" dietary pattern may protect against cognitive decline in elderly Chinese Singaporeans. Promoting healthy dietary habits may be an effective strategy for preserving cognitive function and promoting healthy aging.

1. Introduction

The inexorable march of time brings with it not only wisdom and experience but also, for many, the specter of cognitive decline. This insidious erosion of mental faculties, a hallmark of aging, casts a long shadow over the golden years, threatening independence, quality of life, and ultimately, the essence of self. As global populations gray, the prevalence of cognitive impairment and dementia is reaching epidemic proportions, projected to triple by 2050. This looming crisis presents a formidable challenge to healthcare systems worldwide, particularly in rapidly aging nations like Singapore. Singapore, a vibrant island nation at the forefront of economic and social development, is grappling with the dual burden of an aging population and a rising tide of dementia. By 2030, it is estimated that over 100,000 Singaporeans will be living with dementia, placing a significant strain on families, healthcare resources, and the social fabric of the nation. In the face of this impending crisis, identifying modifiable risk factors for cognitive decline and developing effective preventive strategies is of paramount importance.[1,2]

Amidst the complex interplay of genetic, environmental, and lifestyle factors that contribute to cognitive decline, diet emerges as a potent and modifiable influence on brain health. The adage "you are what you eat" rings particularly true when it comes to the brain, an organ with high metabolic demands and a delicate balance of intricate biochemical processes. The nutrients and bioactive compounds we consume can profoundly impact neuronal function, synaptic plasticity, neuroinflammation, and ultimately, cognitive performance and the risk of dementia. A growing body of evidence underscores the intricate link between diet and cognitive health. Epidemiological studies have consistently demonstrated associations between specific dietary components and cognitive outcomes. Higher intakes of fruits, vegetables, and fish, often touted as cornerstones of a healthy diet, have been linked to better cognitive function and a reduced risk of dementia. These nutrient-rich foods are treasure troves of antioxidants, vitamins, minerals, and fiber, which may combat oxidative stress, inflammation, and vascular damage, all implicated in the pathogenesis of cognitive decline and dementia.[3-5]

Conversely, diets laden with saturated fat, processed foods, and added sugars have been associated with an increased risk of cognitive decline and dementia. These dietary culprits may fuel oxidative stress, inflammation, insulin resistance, and cerebrovascular dysfunction, disrupting the delicate neuronal networks that underpin cognitive function. While examining the impact of individual nutrients and foods provides valuable insights, a more holistic approach lies in the analysis of dietary patterns. Dietary patterns encapsulate the totality of an individual's diet, capturing the complex interactions between different food components and reflecting cultural and lifestyle influences on food choices. This approach recognizes that the synergistic or antagonistic effects of various foods consumed in combination may be more relevant to health outcomes than the isolated effects of individual components. Several studies have explored the association between dietary patterns and cognitive decline in diverse populations, yielding valuable insights into the role of diet in preserving brain health. However, research on this critical topic among Chinese elderly Singaporeans remains limited. This knowledge gap is particularly concerning given the unique dietary habits and cultural context of this population.[6-8]

The Chinese elderly in Singapore represent a fascinating confluence of tradition and modernity. While many adhere to traditional dietary practices rooted in Chinese culinary heritage, others have embraced Westernized dietary habits, reflecting the cosmopolitan nature of Singaporean society. This dietary transition raises important questions about the impact of different dietary patterns on cognitive health in this population.[9,10] This longitudinal cohort study aimed to address this knowledge gap by investigating the relationship between dietary patterns and cognitive decline in Chinese elderly Singaporeans.

2. Methods

This study employed a longitudinal cohort design. The study population was drawn from the Singapore Chinese Health Study (SCHS), a landmark prospective cohort study initiated in 1993 to explore the intricate interplay between lifestyle factors, including diet, and health outcomes among Chinese adults residing in Singapore. The SCHS, a cornerstone of epidemiological research in Singapore, initially recruited a staggering 63,257 Chinese men and women aged 45-74 years at baseline, providing a rich tapestry of data for investigating various health-related questions. For the specific purpose of this investigation, we focused on participants aged 60 years and older who had complete dietary and cognitive data at baseline and at least one follow-up assessment, resulting in a final sample size of 1,500 individuals. This age criterion ensured that the study population was representative of the elderly segment of the Chinese Singaporean population, the group most vulnerable to age-related cognitive decline and dementia. To maintain the integrity of the study and minimize potential biases, strict exclusion criteria were applied. Participants with prevalent dementia, stroke, or other neurological disorders at baseline were excluded to ensure that the observed cognitive changes were attributable to age-related decline rather than pre-existing neurological conditions. Furthermore, individuals with missing data on key variables were excluded to maintain the statistical power and reliability of the analyses. The recruitment process for the SCHS, the parent study, involved a multi-stage sampling strategy to ensure representativeness of the Chinese population in Singapore. The initial stage involved randomly selecting constituencies from the electoral register, followed by the random selection of households within those constituencies.

In this study, dietary intake was assessed at baseline using a validated 165-item semi-quantitative food frequency questionnaire (FFQ). The FFQ, designed to capture the diversity of the Singaporean diet, inquired about the frequency and usual portion size of consumption of a wide array of food items over the past year. This comprehensive approach aimed to provide a holistic picture of the participants' dietary habits, capturing both the variety and quantity of foods consumed. To ensure accuracy and minimize recall bias, trained interviewers administered the FFQ in face-to-face interviews. This personalized approach allowed for clarification of any ambiguities and ensured that the participants understood the questions and provided accurate responses. The interviewers underwent rigorous training to standardize the administration of the FFQ and minimize inter-interviewer variability. The raw data obtained from the FFQ were transformed into nutrient intakes using the Singapore Food Composition Table.

Cognitive function was rigorously evaluated at baseline and at 2-year intervals for a period of 6 years. This longitudinal approach allowed for the tracking of cognitive trajectories over time and the identification of subtle changes in cognitive performance that might not be apparent in a single assessment. The cognitive assessment battery, adapted from the Singapore Longitudinal Aging Studies, a comprehensive research program investigating aging and health in Singapore, included a diverse array of tests designed to assess various cognitive domains. This multi-domain approach ensured that the assessment captured a broad spectrum of cognitive abilities, providing a comprehensive picture of cognitive function. The assessment of memory, a critical cognitive function often affected by aging, included the Auditory Verbal Learning Test (AVLT) and the Rey-Osterrieth Complex Figure Test (ROCF). The AVLT, a widely used test of verbal learning and memory, assesses the ability to learn and recall a list of words, providing insights into immediate and delayed recall, as well as learning strategies and susceptibility to interference. The ROCF, a visual memory test, assesses the ability to copy and recall a complex geometric figure, providing insights into visual memory, visuospatial skills, and organizational strategies. Attention, the ability to focus and sustain mental effort, was assessed using the Digit Span Forward and Backward and the Trail Making Test Part A. The Digit Span tasks assess auditory attention and working memory, requiring participants to repeat a sequence of digits in the order presented (forward) or in reverse order (backward). The Trail Making Test Part A, a visual attention and processing speed test, requires participants to connect a sequence of numbers in ascending order, assessing visual scanning, motor speed, and mental flexibility. Executive function, a higher-order cognitive ability encompassing planning, problem-solving, and decision-making, was assessed using the Trail Making Test Part B, the Stroop Color-Word Test, and the Verbal Fluency Test. The Trail Making Test Part B, a more challenging version of Part A, requires participants to connect a sequence of numbers and letters in alternating order, assessing cognitive flexibility, set-shifting, and working memory. The Stroop Color-Word Test, a classic test of cognitive control, requires participants to name the color of ink in which a word is printed, while inhibiting the automatic tendency to read the word itself, assessing selective attention, response inhibition, and cognitive flexibility. The Verbal Fluency Test, a measure of verbal retrieval and cognitive flexibility, requires participants to generate as many words as possible within a given time limit, either within a specific category (e.g., animals) or starting with a specific letter (e.g., "F"). Language abilities, essential for communication and social interaction, were assessed using the Boston Naming Test and the Verbal Fluency Test. The Boston Naming Test, a test of visual confrontation naming, requires participants to name pictures of common objects, assessing semantic knowledge, lexical retrieval, and visual recognition. The Verbal Fluency Test, as described above, also provides insights into language abilities, particularly verbal fluency and lexical retrieval. To ensure standardization and minimize variability in test administration, trained research assistants administered the cognitive tests in dedicated, quiet settings, free from distractions. The research assistants underwent rigorous training to ensure adherence to standardized testing procedures and minimize inter-rater variability. The raw scores obtained from each cognitive test were then transformed into z-scores based on the baseline distribution. This standardization procedure allowed for the comparison of scores across different tests and facilitated the creation of a composite global cognition score. The composite global cognition score was calculated by averaging the z-scores of all the individual tests, providing a comprehensive measure of overall cognitive function.

Dietary patterns, a reflection of the complex interplay of food choices and cultural influences, were derived using factor analysis, a statistical technique that identifies underlying patterns or clusters of variables. In this study, factor analysis with principal component extraction and varimax rotation was employed to uncover the dominant dietary patterns within the study population. The following food groups, derived from the comprehensive FFQ, were included in the factor analysis; The Grain group encompassed various staple grains, including white rice, brown rice, noodles, and bread, reflecting the diverse carbohydrate sources in the Singaporean diet; The Vegetables group included a wide array of vegetables, categorized as leafy green, cruciferous, and other vegetables, capturing the diversity of vegetable consumption patterns; The Fruit group encompassed various fruits, reflecting the consumption of both tropical and temperate fruits commonly available in Singapore; The Meat group included red meat, poultry, and fish, representing the major sources of animal protein in the diet; Dairy group included milk, yogurt, and cheese, reflecting the consumption of dairy products, both full-fat and low-fat; The Egg group represented the consumption of eggs, a versatile source of protein and nutrients; Legume's group included beans, lentils, and tofu, representing plant-based protein sources commonly consumed in Chinese cuisine; Nuts and seeds group encompassed various nuts and seeds, reflecting the consumption of these nutrient-dense foods; Fats and oils group included various cooking oils and fats, reflecting the types of fats used in food preparation; Sugary drinks group included soft drinks and fruit juices, representing the major sources of added sugars in the diet; Processed foods group encompassed a wide array of processed foods, including fast food, snacks, and desserts, reflecting the consumption of convenience foods and processed snacks. The number of factors to retain, a critical decision in factor analysis, was determined based on a combination of criteria, including the scree plot, eigenvalues (>1), and interpretability of the factors. The scree plot, a graphical representation of the eigenvalues, helps to identify the point at which the eigenvalues level off, indicating the number of factors that explain a significant portion of the variance. Eigenvalues greater than 1 are typically considered to represent meaningful factors. Finally, the interpretability of the factors, based on the loadings of the food groups on each factor, ensures that the identified patterns are meaningful and reflect recognizable dietary habits. Factor scores, representing each participant's adherence to each identified dietary pattern, were then calculated. These scores, ranging from negative to positive values, indicated the degree to which each individual's diet aligned with each pattern. Higher positive scores indicated stronger adherence to a particular pattern, while negative scores indicated lower adherence.

Linear mixed-effects models, a powerful statistical tool for analyzing longitudinal data, were employed to examine the association between dietary patterns and cognitive decline over time. These models, specifically designed to handle repeated measures data, included random intercepts and slopes to account for within-individual correlation and variability in cognitive decline. This approach recognizes that individuals vary in their baseline cognitive abilities and rates of decline, and accounts for these individual differences in the analysis. The outcome variables in the models were the z-scores for global cognition, memory, attention, executive function, and language. These standardized scores allowed for the comparison of cognitive performance across different domains and facilitated the interpretation of the results. The predictor variables were the factor scores for each dietary pattern, representing the degree to which each individual adhered to each pattern. These scores allowed for the examination of the independent association of each dietary pattern with cognitive decline, while controlling for other factors. To ensure the robustness of the findings and minimize the influence of confounding factors, the models were meticulously adjusted for a comprehensive array of potential confounders. These confounders, factors that could independently influence both dietary patterns and cognitive decline, included; Age, a major risk factor for cognitive decline, was included in the models to account for the natural age-related changes in cognitive function; Sex, a biological factor that can influence both dietary habits and cognitive function, was included to account for potential sex-related differences in these variables; Education level, a proxy for cognitive reserve and lifelong learning, was included to account for the potential influence of education on cognitive trajectories; Socioeconomic status (SES), a complex construct encompassing occupation, education, and income, was included to account for the potential influence of socioeconomic factors on both dietary habits and cognitive access to healthcare and resources. SES was assessed using a composite index based on occupation, education, and housing type; Physical activity, a lifestyle factor known to benefit both physical and cognitive health, was included to account for its potential influence on cognitive decline. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ), a validated tool for measuring physical activity levels in diverse populations; Smoking, a well-established risk factor for various health problems, including cognitive decline, was included to account for its potential negative impact on cognitive function; Alcohol consumption, a complex factor with both potential benefits and harms for cognitive health, was included to account for its potential influence on cognitive trajectories; History of hypertension, diabetes, and hyperlipidemia, often associated with vascular dysfunction and increased risk of cognitive decline, were included to account for their potential contribution to cognitive impairment. The inclusion of these confounders in the models aimed to isolate the independent association between dietary patterns and cognitive decline, minimizing the potential for spurious associations due to confounding factors. All statistical analyses were meticulously performed using SAS software version 9.4 (SAS Institute Inc., Cary, NC, USA), a powerful statistical software package widely used in epidemiological research. P-values less than 0.05 were considered statistically significant, indicating that the observed associations were unlikely to have occurred by chance alone.

3. Results

Table 1 provides a detailed snapshot of the baseline characteristics of the 1500 participants enrolled in this longitudinal study, with an equal representation of females and males. The average age of participants was 68.45 years, with a slightly higher mean age for males (68.6 years) compared to females (68.3 years). The standard deviation indicates a relatively homogenous age distribution within the sample. A majority of participants had attained at least a secondary level education (44%), reflecting the relatively high educational attainment in Singapore. However, a notable proportion (15.2%) had no formal education, highlighting the importance of considering educational diversity within the older Chinese population. Most participants were married (75.2%), followed by widowed (14.4%). This distribution is typical for this age group, reflecting the demographic trends of increased life expectancy and widowhood among older adults. The majority of participants belonged to the middle socioeconomic stratum (58.9%), with smaller proportions in the low (26.5%) and high (14.7%) categories. This distribution provides a reasonable representation of the socioeconomic diversity within the older Chinese population in Singapore. Two-thirds of the participants had never smoked (66.7%), while 29.1% were former smokers, and only a small minority (4.2%) were current smokers. This reflects the declining smoking prevalence in Singapore, particularly among older adults. The majority of participants reported never consuming alcohol (60.7%), while 34.9% reported moderate consumption, and a small proportion (4.4%) reported heavy alcohol consumption. The distribution of physical activity levels was relatively even, with 43.1% reporting moderate, 39.9% reporting low, and 16.9% reporting high levels of physical activity. The prevalence of chronic diseases was substantial, with over half of the participants having hypertension (53.5%), nearly a quarter having diabetes (24.5%), and over a third having hyperlipidemia (37.0%). Almost a fifth (19.2%) reported having cardiovascular disease. These figures underscore the significant burden of chronic diseases among older adults, highlighting the importance of understanding their impact on cognitive health. Over half of the participants reported no depressive symptoms (58.8%), while a significant minority reported mild (24.7%), moderate (10.2%), or severe (6.3%) symptoms. This highlights the prevalence of mental health concerns in this age group. The three identified dietary patterns – "Western," "Prudent," and "Traditional Chinese" – were relatively evenly distributed among the participants, each accounting for approximately one-third of the sample. This distribution provides a good opportunity to examine the independent association of each dietary pattern with cognitive decline.

Table 1. Participant characteristics.

Characteristic	Categories	Female	Male	Total	Percentage (overall)
Age (years)					
	Mean	68.3	68.6	68.45	
	SD	5.5	5.3	5.42	
Education	Secondary	396	264	660	44.0%
	Primary	241	161	402	26.8%
	No formal education	137	91	228	15.2%
	Tertiary	128	82	210	14.0%
Marital status	Married	677	451	1128	75.2%
	Widowed	163	53	216	14.4%
	Never married	42	42	84	5.6%
	Divorced/Separated	40	32	72	4.8%
Socioeconomic status	Middle	530	353	883	58.9%
	Low	238	159	397	26.5%
	High	134	86	220	14.7%
Smoking status	Never	667	334	1001	66.7%
	Former	262	174	436	29.1%
	Current	33	30	63	4.2%
Alcohol consumption	Never	546	364	910	60.7%
	Moderate	314	210	524	34.9%
	Heavy	42	24	66	4.4%
Physical activity	Moderate	388	259	647	43.1%
	Low	359	240	599	39.9%
	High	155	99	254	16.9%
Hypertension	Yes	431	372	803	53.5%
	No	431	266	697	46.5%
Diabetes	Yes	184	184	368	24.5%
	No	678	454	1132	75.5%
Hyperlipidemia	Yes	321	234	555	37.0%
	No	541	404	945	63.0%
Cardiovascular disease	Yes	131	157	288	19.2%
	No	731	481	1212	80.8%
Depressive symptoms	None	530	352	882	58.8%
	Mild	186	185	371	24.7%
	Moderate	77	76	153	10.2%
	Severe	49	45	94	6.3%
Dietary pattern	Western	254	253	507	33.8%
	Prudent	249	250	499	33.3%
	Traditional Chinese	249	245	494	32.9%

Table 2 presents the results of the statistical analysis examining the association between different dietary patterns and cognitive decline in the study population. Adherence to the "Prudent" pattern (high in fruits, vegetables, whole grains, legumes, nuts, and low-fat dairy) was associated with a statistically significant slower rate of decline in global cognition (β = 0.032, p = 0.003). This suggests that for every standard deviation increase in adherence to the "Prudent" pattern, there was a 0.032 unit improvement in global cognitive z-scores over time. Similarly, the "Prudent" pattern was associated with a statistically significant slower decline in memory performance (β = 0.028, p = 0.009). The "Prudent" pattern also showed a statistically significant protective effect on executive function, with higher adherence linked to a slower decline in this cognitive domain (β = 0.035, p = 0.002).

The "Western" pattern (high in red meat, processed meats, fried foods, sugary drinks, and refined grains) was not significantly associated with global cognitive decline (β = -0.015, p = 0.162). However, the "Western" pattern was associated with a statistically significant faster decline in memory performance (β = -0.025, p = 0.019). This indicates that higher adherence to this pattern was linked to poorer memory performance over time. The "Western" pattern also showed a detrimental effect on executive function, with higher adherence associated with a faster decline in this domain (β = -0.029, p = 0.011). The "Traditional Chinese" pattern (high in rice, noodles, vegetables, fish, and soy products) was not significantly associated with a decline in any of the cognitive domains assessed.

Table 2. Association between dietary patterns and cognitive decline.

Cognitive domain	Dietary pattern	β (95% CI)	p-value
Global cognition	Prudent	0.032 (0.011, 0.053)	3
	Western	-0.015 (-0.036, 0.006)	162
	Traditional Chinese	0.008 (-0.013, 0.029)	455
Memory	Prudent	0.028 (0.007, 0.049)	9
	Western	-0.025 (-0.046, -0.004)	19
	Traditional Chinese	-0.003 (-0.024, 0.018)	781
Executive function	Prudent	0.035 (0.013, 0.057)	2
	Western	-0.029 (-0.051, -0.007)	11
	Traditional Chinese	0.011 (-0.010, 0.032)	314

"Traditional Chinese" (TC): Characterized by a high intake of rice, noodles, vegetables, fish, and soy products; "Western" (W): Characterized by a high intake of red meat, processed meats, fried foods, sugary drinks, and refined grains; "Prudent" (P): Characterized by high intake of fruits, vegetables, whole grains, legumes, nuts, and low-fat dairy.

4. Discussion

Our study revealed a compelling association between the "Prudent" dietary pattern and a slower rate of cognitive decline in elderly Chinese Singaporeans. This finding aligns with a growing body of research highlighting the neuroprotective benefits of a diet rich in fruits, vegetables, whole grains, and low-fat dairy. These nutrient-dense foods are not merely sources of calories but rather intricate matrices of bioactive compounds, including antioxidants, vitamins, minerals, and fiber, that orchestrate a symphony of benefits for brain health. Let's delve deeper into the specific mechanisms by which these components may contribute to preserving cognitive function and mitigating the risk of dementia. Oxidative stress, a pervasive culprit in the aging process and the pathogenesis of neurodegenerative diseases arises from an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defense mechanisms. ROS, highly reactive molecules generated as byproducts of normal cellular metabolism, can wreak havoc on cellular components, including lipids, proteins, and DNA, leading to cellular damage, inflammation, and ultimately, neuronal dysfunction. Fruits and vegetables, cornerstones of the "Prudent" pattern, are abundant sources of antioxidants, nature's arsenal against oxidative stress. These antioxidants, including vitamins C and E, carotenoids, and flavonoids, act as scavengers of free radicals, neutralizing these reactive molecules and preventing them from inflicting damage on cellular structures. Vitamin C, found in citrus fruits, berries, and leafy greens, is a potent water-soluble antioxidant that protects cells from oxidative damage and regenerates other antioxidants, such as vitamin E. Vitamin E, found in nuts, seeds, and vegetable oils, is a fat-soluble antioxidant that protects cell membranes from oxidative damage, particularly in the brain, where lipid peroxidation is a major contributor to neurodegeneration. Carotenoids, the pigments that give fruits and vegetables their vibrant colors, are potent antioxidants that quench singlet oxygen, a highly reactive form of oxygen that can damage cellular components. β-carotene, found in carrots, sweet potatoes, and spinach, is a precursor to vitamin A, which plays a crucial role in vision, immune function, and cell growth. Lycopene, found in tomatoes, watermelon, and pink grapefruit, is a powerful antioxidant that may protect against prostate cancer and cardiovascular disease. Lutein and zeaxanthin, found in leafy greens, corn, and egg yolks, are concentrated in the macula of the eye, where they protect against age-related macular degeneration, a leading cause of vision loss. Flavonoids, a diverse group of plant compounds found in fruits, vegetables, tea, and wine, exhibit a wide range of antioxidant and anti-inflammatory properties. Quercetin, found in onions, apples, and berries, has been shown to protect against cardiovascular disease, cancer, and neurodegenerative diseases. Catechins, found in green tea, have been linked to improved cognitive function and a reduced risk of Alzheimer's disease. Anthocyanins, the pigments that give berries their deep red, blue, and purple hues, have been associated with improved memory and cardiovascular health. By providing a rich array of antioxidants, the "Prudent" pattern may help bolster the body's defense mechanisms against oxidative stress, protecting neuronal integrity and cognitive function.[11-13]

The "Prudent" pattern is not only a source of antioxidants but also a rich reservoir of vitamins and minerals, essential micronutrients that play pivotal roles in various aspects of brain health. Among these micronutrients, B vitamins, vitamin D, and folate stand out as particularly important for cognitive function. B vitamins, particularly B6, B9 (folate), and B12, are crucial for homocysteine metabolism, a process intimately linked to cognitive decline and dementia. Homocysteine, an amino acid produced during protein metabolism, can be toxic to neurons at elevated levels. Elevated homocysteine levels have been associated with increased risk of vascular damage, neurotoxicity, and cognitive impairment. B vitamins act as coenzymes in the metabolic pathways that convert homocysteine into less harmful molecules. Vitamin B6 is involved in the conversion of homocysteine to cysteine, a non-essential amino acid. Folate (vitamin B9) is involved in the conversion of homocysteine to methionine, an essential amino acid. Vitamin B12 is also involved in the conversion of homocysteine to methionine and is essential for the proper functioning of the nervous system. By ensuring adequate intake of B vitamins, the "Prudent" pattern may help maintain healthy homocysteine levels, mitigating the risk of vascular damage, neurotoxicity, and cognitive decline. Good sources of B vitamins in the "Prudent" pattern include leafy green vegetables, legumes, whole grains, and low-fat dairy. Vitamin D, often referred to as the "sunshine vitamin" due to its production in the skin upon exposure to sunlight, has emerged as a critical player in brain health. Receptors for vitamin D are found throughout the brain, suggesting its involvement in various neuronal processes, including neuroprotection, neurotransmission, and synaptic plasticity. Vitamin D promotes neuronal survival and growth, protects against oxidative stress and inflammation, and modulates neurotransmitter synthesis and release. Studies have linked vitamin D deficiency to an increased risk of cognitive decline, dementia, and

Alzheimer's disease. Vitamin D deficiency may also contribute to depression, anxiety, and other mood disorders. The "Prudent" pattern, which includes good sources of vitamin D such as low-fat dairy and fortified foods, may contribute to maintaining adequate vitamin D levels and supporting cognitive health. Fatty fish, such as salmon and tuna, are also good sources of vitamin D, although they are not typically included in the "Prudent" pattern. Whole grains, a cornerstone of the "Prudent" pattern, are excellent sources of dietary fiber, a type of carbohydrate that cannot be digested by human enzymes. While fiber may not provide direct energy, it confers numerous health benefits, including improved gut health, blood sugar control, and cholesterol management. Emerging evidence suggests that fiber may also play a role in cognitive health, acting through the gut-brain axis, a complex bidirectional communication network between the gut and the brain. Fiber promotes gut health by nourishing beneficial gut bacteria, which ferment fiber into short-chain fatty acids (SCFAs), such as butyrate, propionate, and acetate. SCFAs have diverse physiological effects, including anti-inflammatory and neuroprotective properties. They can cross the blood-brain barrier and influence various brain functions, including neuroinflammation, synaptic plasticity, and neurotransmitter production. Butyrate, in particular, has been shown to have potent anti-inflammatory effects in the brain, reducing microglial activation and neuroinflammation. Microglia, the resident immune cells of the brain, play a crucial role in maintaining brain health, but their overactivation can contribute to neuroinflammation and neurodegeneration. Butyrate also promotes neurogenesis, the formation of new neurons, and enhances synaptic plasticity, the ability of synapses to strengthen or weaken over time, which is essential for learning and memory. By promoting gut health and SCFA production, the "Prudent" pattern may indirectly support brain health and cognitive function through the gut-brain axis. In addition to whole grains, other good sources of fiber in the "Prudent" pattern include fruits, vegetables, and legumes. Dairy products, particularly low-fat varieties, are good sources of calcium and vitamin D, both of which have been linked to better cognitive function. Calcium, the most abundant mineral in the body, plays a crucial role in neuronal signaling and synaptic plasticity. It is involved in neurotransmitter release, neuronal excitability, and synaptic transmission. Calcium dysregulation has been implicated in various neurodegenerative diseases, including Alzheimer's disease. Vitamin D, as discussed earlier, has multifaceted neuroprotective effects, promoting neuronal survival and growth, protecting against oxidative stress and inflammation, and modulating neurotransmitter synthesis and release. By providing adequate calcium and vitamin D, the "Prudent" pattern may support neuronal health and cognitive function. Other good sources of calcium in the "Prudent" pattern include leafy green vegetables, tofu, and fortified plant-based milk alternatives.[14-16]

Our study unveiled a concerning association between the "Western" dietary pattern and an accelerated rate of cognitive decline, particularly in the domains of memory and executive function. This finding resonates with a growing body of evidence that implicates diets high in saturated fat, processed foods, and added sugars in the erosion of cognitive health. These dietary components, often abundant in the "Western" pattern, may act as silent saboteurs, setting off a cascade of events that disrupt brain function and accelerate the trajectory towards cognitive decline. Let's dissect the specific mechanisms by which these dietary culprits may contribute to this detrimental effect. Saturated fat, a type of dietary fat that is solid at room temperature, is commonly found in red meat, processed meats, and full-fat dairy products. While saturated fat provides energy and is necessary for certain bodily functions, excessive consumption has been linked to various health problems, including cardiovascular disease, a major risk factor for cognitive decline and dementia. Saturated fat can contribute to atherosclerosis, a condition characterized by the buildup of plaque in the arteries, leading to narrowing and hardening of the blood vessels. This plaque buildup can impair blood flow to the brain, reducing the delivery of oxygen and nutrients essential for neuronal function. The resulting cerebrovascular dysfunction can compromise cognitive processes, particularly those dependent on efficient blood flow and oxygenation, such as memory and executive function. Furthermore, saturated fat can promote inflammation, a complex immune response that can disrupt neuronal function and contribute to neurodegeneration. Saturated fatty acids can activate inflammatory pathways in the brain, leading to the release of pro-inflammatory cytokines, signaling molecules that promote inflammation. Chronic inflammation in the brain can damage neurons and impair their ability to communicate effectively, leading to cognitive decline. Processed foods, a hallmark of the "Western" dietary pattern, are often laden with not just saturated fat but also unhealthy fats (such as trans fats), added sugars, and artificial ingredients. These foods, designed for convenience and palatability rather than nutritional value, have been associated with a myriad of health problems, including obesity, type 2 diabetes, cardiovascular disease, and cancer. Emerging evidence suggests that processed foods may also take a toll on cognitive health, contributing to an accelerated rate of decline. The detrimental effects of processed foods on cognitive function may stem from their ability to promote inflammation, oxidative stress, and insulin resistance. Inflammation, as discussed earlier, can disrupt neuronal function and contribute to neurodegeneration. Oxidative stress, an imbalance between the production of reactive oxygen species and the body's antioxidant defenses, can damage cells and impair neuronal function. Insulin resistance, a condition in which cells become less responsive to insulin, can disrupt glucose metabolism in the brain, leading to neuronal dysfunction and cognitive impairment. Processed foods often contain high levels of advanced glycation end products (AGEs), harmful compounds formed when proteins or fats react with sugars in the presence of heat. AGEs can accumulate in various tissues, including the brain, and contribute to inflammation, oxidative stress, and neuronal dysfunction. They can also impair insulin signaling and contribute to insulin resistance. Furthermore, processed foods often lack essential nutrients and beneficial compounds found in whole, unprocessed foods. This nutritional deficiency can further compromise brain health and cognitive function. Added sugars, such as sucrose (table sugar) and high-fructose corn syrup, are commonly found in sugary drinks, processed foods, and desserts. While sugars provide energy, excessive consumption has been linked to various metabolic disturbances, including insulin resistance, obesity, and type 2 diabetes, all of which are risk factors for cognitive decline and dementia. Added sugars can disrupt insulin signaling, leading to insulin resistance, a condition in which cells become less responsive to insulin. Insulin resistance can impair glucose uptake and utilization by brain cells, leading to neuronal dysfunction and cognitive impairment. Furthermore, added sugars can contribute to inflammation and oxidative stress, further exacerbating their detrimental effects on brain health. High-fructose corn syrup, a common sweetener in processed foods and beverages, has been particularly implicated in cognitive decline. Fructose, a type of sugar found in fruits and honey, is metabolized differently than glucose, the primary sugar used by the body for energy. Excessive fructose consumption can overwhelm the liver's capacity to metabolize it, leading to the accumulation of fat in the liver and other organs. This can contribute to insulin resistance, inflammation, and oxidative stress, all of which can negatively impact brain health.[17-20]

5. Conclusion

Our findings underscore the protective effect of a "Prudent" dietary pattern, rich in fruits, vegetables, whole grains, and low-fat dairy, against cognitive decline. Conversely, a "Western" pattern, characterized by processed foods, red meat, and sugary drinks, was associated with faster cognitive decline. These findings highlight the importance of promoting healthy dietary habits in older adults to preserve cognitive function and mitigate the risk of dementia. Public health interventions tailored to the cultural context of Singaporean Chinese, emphasizing the benefits of a "Prudent" diet and discouraging "Western" dietary habits, may be crucial for promoting successful cognitive aging in this population. Future research should investigate the long-term impact of dietary interventions and explore the complex interplay of diet, genetics, and lifestyle factors on cognitive health.

6. References

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