

# Analysis of Dietary Characteristics of Chinese Elderly with Alzheimer's Disease

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**Abstract.** In recent years, there has been an increasing discussion about the high cost of Alzheimer's Disease (AD) treatment, which imposes a great financial, physical, and psychological burden on patients' families. With the increasing number of studies on AD, more and more nutrients and dietary patterns have been associated with AD, and more and more dietary patterns have been applied to the prevention and intervention of AD, providing new ideas in nutrition for the treatment and intervention of AD. This article, based on the dietary patterns of the elderly in China, gradually analyzes the diet and nutrition deficiencies of the elderly in China, and summarizes the latest research on the relationship between nutrition and AD, in an attempt to contribute to the treatment and intervention of AD in terms of nutrition, and provide a new reference for the diet of AD patients. However, the number of studies and surveys on dietary patterns of the Chinese elderly is relatively small, and the suitability of these dietary patterns for the Chinese elderly is still questionable. There are also few surveys and analyses on cognitive function of the elderly in China and even in East Asia. It is expected that dietary patterns and cognitive impairment in China and East Asia will be paid attention to in the future, more studies on dietary patterns and AD in the elderly in China and even in East Asia are expected in the future.

**Keywords:** Alzheimer's Disease; diet; Chinese elderly.

## 1. Introduction

Alzheimer's disease (AD) is a dementia disease of the central nervous system (CNS) characterized by progressive cognitive and behavioral impairments. It is estimated that the number of dementia patients worldwide has now exceeded 50 million, with an annual cost exceeding 1 trillion dollars [1]. With the continuous growth of the global elderly population, the incidence rate of AD and related dementia will continue to increase, which will seriously affect the cognitive level and independent living ability of patients, and cause huge psychological, physical and economic burden on patients' families and society. At present, the pathogenesis of AD is very complex, because the mechanism of treatment is still unclear, the drugs used for the treatment of AD can only alleviate the symptoms to a certain extent, but can not stop the course of the disease. At present, there are only A few highly accepted hypotheses, such as the Amyloid Cascade Hypothesis and Tau protein abnormal phosphorylation hypothesis. In addition, many factors are involved in the initiation of AD, such as aging, genetic factors, air pollution, metals and infections, as well as diet. Until the mechanism of disease is clear, improving nutritional intake to prevent and reduce the risk of disease is a good direction. A number of studies have shown that nutrition has the ability to reduce the risk of disease and alleviate symptoms, and studies have confirmed that there is a certain link between dietary patterns and AD, a reasonable diet, such as the Mediterranean diet, can reduce the risk of AD, and equally irrational diet will increase the risk of disease.

This paper will start with the dietary survey data of the elderly in China, gradually analyze the dietary nutrition characteristics of the elderly in China. And from the study of nutrition and dietary patterns and AD, give some prospects and suggestions. In order to reduce the incidence of AD in Chinese elderly people, reduce the risk of disease and try to alleviate the disease.

## 2. Nutrition Status of the Elderly in China

According to the data survey, the elderly in China basically reached the recommended dietary guideline range (250-400g) in cereals and multi-grain beans, but the potato category was far below (76.6%) the minimum value recommended by the dietary guideline (50-100g), and for soybean products, 76.6% of the elderly were below the recommended minimum intake value. In terms of vegetables and fruits, nearly 70% and 95% of the elderly did not meet the recommended intake range, respectively. For dairy products, only 1.2% of people consume the recommended amount. In terms of meat, nearly half of the elderly exceed the intake of livestock and poultry meat, but four out of five people do not meet the lower limit of the recommended intake of aquatic products. And more than 60% of the elderly have insufficient energy intake and malnutrition [2,3]

For the dietary analysis, because the intake of aquatic products and nuts is far below the recommended intake, the intake of high-quality fatty acids (such as omega-3 unsaturated fatty acids) of the elderly in China is insufficient. The deficiency of fruits and vegetables also leads to the deficiency of many vitamins (such as vitamin D, vitamin B12, vitamin C) and minerals (calcium, phosphorus, etc.). The intake of less than the recommended amount of milk also makes the intake of high-quality protein too little, these all will become the hidden factors of AD.

## 3. Pathogenesis of AD

### 3.1. Amyloid Hypothesis

Under pathological conditions, beta-amyloid protein ( $A\beta$ ) is the proteolytic product of amyloid precursor protein (APP) via  $\beta$ -secretase and  $\gamma$ -secretase via the amyloid pathway [4]. Degradation of  $A\beta$  decreases with age or pathological conditions, which will lead to the accumulation of  $A\beta$  peptides ( $A\beta_{40}$  and  $A\beta_{42}$ ). As the ratio of  $A\beta_{42}/A\beta_{40}$  increases,  $A\beta$  fibrils are formed and, due to the toxicity of the substances produced, neuronal cells die and thus become toxic, resulting in neurodegeneration [5].

### 3.2. Tau Protein Hypothesis

Tau protein is a microtubule-associated protein that is responsible for the assembly and stabilization of tubulin. As the main cytoskeletal component of neurons, microtubules play an important role in the development and function of neurons. The dissociation of Tau protein induces microtubule depolymerization, which can impair nerve function. Phosphorylation of Tau is a normal metabolic process under physiological conditions, but excessive phosphorylation of tau protein will make it easy to dissociate from microtubules, which will lead to a series of adverse effects such as axon transport disturbance, mitochondrial and cytoskeleton dysfunction, neuroinflammation, oxidative stress and synaptic loss, thus triggering AD [6].

### 3.3. Neuroinflammatory Hypothesis

More and more studies have shown a close relationship between inflammatory factors and AD. Excessive deposition of  $A\beta$  in the brain can trigger neuroinflammatory reactions. Microglia release various immune mediators, which play an important role in inflammatory responses but also cause damage to surrounding nerve cells. In areas where  $A\beta$  is excessively deposited, microglia will produce a series of intense reactions, which will form a vicious cycle of intensified inflammation. The intensification of verification plays an important role in exacerbating AD [7].

## 4. Nutrients and AD

### 4.1. Vitamin

Several studies have shown that vitamins and AD prevention and intervention have a strong relationship. A randomized, double-blind, placebo-controlled trial of 210 AD patients found that daily vitamin D supplementation for 12 months resulted in decreased A $\beta$ 42, APP protein and mRNA expression levels [8]. The reduction of these data will lead to less neurotoxic effects and better protection of neurons, thus reducing the risk of developing AD. Hyperphosphorylation of Tau resulted in decreased binding force to tubulin, resulting in cytoskeleton destruction and impaired axoplasmic transport function. As a result, neurons deform and die [9]. A study has shown that the interaction between vitamin B12 and Tau protein can inhibit tau protein hyperphosphorylation and aggregation [10]. The reductibility of vitamin C reflects its antioxidant function, and H<sub>2</sub>O<sub>2</sub> acts as a damage factor triggering oxidative stress and oxidative damage. The decrease in H<sub>2</sub>O<sub>2</sub> suggests that vitamin C plays an important role in combating oxidative damage caused by A $\beta$ 1-40 [11].

### 4.2. $\omega$ -3 fatty Acid

Omega-3 fatty acid ( $\omega$ -3PUFAs) is mainly divided into  $\alpha$ -linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). From the current epidemiological data and clinical data, the application of  $\omega$ -3PUFAs is one of the most promising nutritional interventions in neurodegenerative diseases. In particular, with DHA, green et al demonstrated by using genetically modified mice that produced both A $\beta$  plaques and tau tangles that a diet supplemented with DHA reduced the accumulation of A $\beta$  and was able to lower tau levels over a period of three months. This effect was even more pronounced after nine months, especially in the group supplemented only with DHA. DHA supplementation has been shown to be beneficial for Alzheimer's disease prevention and intervention [12]. A study of 1,264 non-dementia participants aged  $84 \pm 3$  years showed that [13], during the follow-up window of seven years, 233 participants developed dementia. Higher concentrations of EPA were associated with a lower incidence of AD (hazard ratio (HR) 0.76 (95%CI 0.63; 0.93). The findings can confirm that the higher the EPA concentration, the lower the risk of developing AD. This will further confirm the positive role of  $\omega$ -3PUFAs in the prevention and intervention of AD.

### 4.3. Flavonoids

Flavonoids are ubiquitous compounds in plants, produced by plants for growth and defense against various types of stress, and their main sources are apples, red fruits, onions, citrus fruits, nuts, and beverages such as tea, coffee, beer, and red wine. In a follow-up survey involving 2,101 volunteers for an average of 19.7 years on AD, it was found that flavonoid intake at the 60th percentile or above had the greatest protective effect, and participants were about 40% less likely to develop AD and related dementia. Higher dietary flavonoid intake over time was associated with a lower risk of AD [14].

## 5. Dietary Patterns and AD

Recent years, more and more studies have been conducted on the relationship between dietary patterns and AD. As more nutrients are proven to prevent and interfere with AD, more attention is focused on dietary patterns in daily life. There are many dietary patterns that have been proven to be beneficial for AD prevention and intervention, such as anti-inflammatory diet, mediterranean diet and ketogenic diet.

### 5.1. Anti-inflammatory Diets

The Anti-inflammatory Diet Index (DII) is a coefficient that reflects the inflammatory potential of a diet. The higher the coefficient, the proinflammatory tendency of diet. The lower it is, the diet has

an anti-inflammatory tendency. Anti-inflammatory diet refers to the daily diet of some low food intake, such as dietary fiber, magnesium, zinc, vitamin A, vitamin D, flavonoids and so on. A prospective study of pro-inflammatory diets involving 166,377 British volunteers [15] showed a strong association between pro-inflammatory diets and an increased risk of AD. The study found a positive association between DII and the total volume of white matter hyperintensities. With each unit increase in DII associated with 73.30 - mm<sup>3</sup> increase in the volume of white matter hyperintensities ( $P = 0.006$ ), and with the increase of DII, the hippocampal gray matter volume continues to decrease, and the increase or decrease of these data will lead to the decline of cognitive ability, especially the increase of AD risk.

## 5.2. Mediterranean Diet

Mediterranean diet, which has been popular around the world in recent years, has also been proved to be beneficial to the intervention and treatment of AD. The help of the Mediterranean diet for AD is more like the accumulation of nutritional benefits [16]. This diet pattern consumes more fish and nuts, which are rich in unsaturated fatty acids. A diet rich in fruits and vegetables is good for the intake of vitamins B6, B12 and many minerals. Olive oil and wine are better for anti-inflammatory and antioxidant activities than other dietary patterns. This diet is low in red meat and processed meat, all of which are associated with a lower risk of AD.

## 5.3. Ketogenic Diet

Ketogenic diet, which originated in the 1920s as a way to simulate the physiological changes that occur during prolonged fasting, derives its energy primarily from the use of body fat or dietary fat. The ketogenic diet has been shown to treat epilepsy and also has good potential for preventing and intervening in AD. Some animal studies have shown that A high-fat diet is associated with an elevated A $\beta$  load, while A reduction in A $\beta$  levels was observed after a ketogenic diet high in saturated fat and very low in carbohydrates was given. This opens up the possibility of treating AD with a keto diet. However, if you want to reduce A $\beta$  levels, you cannot ignore the interaction of dietary components and their metabolic outcomes, that is, in the diet, you need to consider total calories, carbohydrate levels and ketone body production. These need to be balanced in future animal studies [17].

## 6. Prospects

As for AD, the current priority is to study the pathogenesis and determine the means of targeted therapy. Secondly, for developing countries such as China, there are few data surveys on AD which need more attention. From the perspective of eating habits, there is no popular diet pattern suitable for the eating habits of Chinese elderly people to prevent AD [18]. In general, AD research has broad prospects. More and deeper research is needed to combat the disease.

## 7. Conclusion

Starting from the dietary habits of the elderly in China, this paper analyzes the adverse aspects of the diet of the elderly in China, lists the nutrients and dietary patterns that are conducive to Alzheimer's disease AD, and tries to provide corresponding solutions for the prevention and intervention of ad in China from the perspective of nutrition, so as to reduce the high medical costs of AD and reduce the physiological and economic burden of patients' families. Although this article lists a variety of nutrients and dietary patterns, these dietary patterns are not suitable for and in line with the daily eating habits of the elderly in China. Whether it can prevent and intervene AD in the elderly in China is a question worthy of discussion. At present, there are few studies and investigations on ad in China and even in East Asia, which makes it difficult to study AD among the elderly in China. It is hoped that in the near future, AD will receive the attention of the society, hospitals and

the government. Through more research and investigation, it will contribute to the treatment of AD in the elderly in China from the perspective of diet and nutrition.

## References

- [1] AD International, McGill University. World Alzheimer Report 2021: Journey through the diagnosis of dementia [EB/OL]. (2021-09-21) [2024-12-25]. <https://www.alzint.org/resource/world-alzheimer-report-2021/>
- [2] Bureau of Disease Prevention and Control, National Health Commission of China. Report on Nutrition and Chronic Disease Status of Chinese Residents (2020) [M]. Beijing: People's Health Publishing House, 2021.
- [3] China Development Research Foundation. Report on Nutrition and Health of the Elderly in China [M]. Beijing: China Development Press, 2016.
- [4] Soldano A, Hassan B A. Beyond pathology: APP, brain development and Alzheimer's disease[J]. *Current Opinion in Neurobiology*, 2014, 27: 61-67.
- [5] Breijyeh Z, Karaman R. Comprehensive review on AD: causes and treatment[J]. *Molecules*, 2020, 25(24): 5789.
- [6] Ju Y, Tam K Y. Pathological mechanisms and therapeutic strategies for Alzheimer's disease[J]. *Neural Regeneration Research*, 2022, 17(3): 543-549.
- [7] Heneka M T, van der Flier W M, Jessen F, et al. Neuroinflammation in Alzheimer disease[J]. *Nature Reviews Immunology*, 2024.
- [8] JIA J, HU J, HUO X, et al. Jia J, HU J, Huo X, et al. Effects of vitamin D supplementation on cognitive function and blood A  $\beta$ -related biomarkers in older people adults with AD: a randomised, double-blind, placebo-controlled trial [J]. *J Neurol Neurosurg Psychiatry*, 2019,90 (12): 1347-1352.
- [9] Shen Yuxiao, BAI Yaru, Shi Yafei, et al. The role of dietary nutrition in regulating the mechanism of AD [J]. *Public Health and Preventive Medicine*, 2022.
- [10] RAFIEE S, ASADOLLAHI K, RIAZI G, et al. Vitamin B12 Check tau fibrillization via binding to cysteine residues of tau[J]. *ACS Chem Neurosci*, 2017,8 (12) : 2676-2682.
- [11] Dai Xueling, Sun Yaxuan, Jiang Zhaofeng et al. Vitamin C protects neurons from oxidative damage induced by A $\beta$ 1-40 Cu(II) complex [J]. *Chinese Journal of Biochemistry and Molecular Biology*, 2007(07):77-82.
- [12] Wen J, Satyanarayanan SK, Li A, Yan L, Zhao Z, Yuan Q, Su KP, Su H. Unraveling the impact of Omega-3 polyunsaturated fatty acids on blood-brain barrier (BBB) integrity and glymphatic function. *Brain Behav Immun*. 2024 Jan; 115: 335-355.
- [13] Melo van Lent D, Egert S, Wolfgruber S, Kleinedam L, Weinhold L, Wagner-Thelen H, Maier W, Jessen F, Ramirez A, Schmid M, Scherer M, Riedel-Heller SG, Wagner M. Eicosapentaenoic Acid Is Associated with Decreased Incidence of Alzheimer's Dementia in the Oldest Old. *Nutrients*. 2021 Jan 30;13(2): 461.
- [14] Shishtar E, Rogers GT, Blumberg JB, Au R, Jacques PF. Long-term dietary flavonoid intake and risk of Alzheimer disease and related dementias in the Framingham Offspring Cohort. *Am J Clin Nutr*. 2020 Aug 1;112(2):343-353
- [15] Shi Y, Lin F, Li Y, Wang Y, Chen X, Meng F, Ye Q, Cai G. Association of pro-inflammatory diet with increased risk of all-cause dementia and Alzheimer's dementia: a prospective study of 166,377 UK Biobank participants. *BMC Med*. 2023 Jul 21;21(1):266.
- [16] Guasch-Ferré M, Willett WC. The Mediterranean diet and health: a comprehensive overview. *J Intern Med* 2021; 290: 549–566.
- [17] Klaus W. Lange, Katharina M. Lange, Ewelina Makulska-Gertruda, Yukiko Nakamura, Andreas Reissmann, Shigehiko Kanaya, Joachim Hauser, Ketogenic diets and Alzheimer's disease, *Food Science and Human Wellness*, 2017, 6(1): 1-9
- [18] J. Wu, X. Song, G.-C. Chen, N. Neelakantan, R.M. van Dam, L. Feng, et al., Dietary pattern in midlife and cognitive impairment in late life: a prospective study in Chinese adults, *Am. J. Clin. Nutr.* 110 (4) (2019) 912–920.