A Cohort Study on Dietary Habits, Lifestyles and the Risk of Mortality in the Elderly: the Latest Evidence From China Diet Cohort Study of Elderly Chinese

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Research

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Abstract

Aim: To examine the longitudinal relationship between dietary habits, lifestyle factors and the risk of mortality among the elderly Chinese.

Methods: Four follow-up survey data of the Chinese Longitudinal Healthy Longevity Survey 2008-2018 were selected, and a total of 11899 elderly people were included. Food habits were assessed using an in-person interview. The frequency of consumption of each food item was recorded as “almost every day”, “occasionally” or “rarely or never”. After descriptive statistics of the data, the effects of dietary habits and lifestyle factors on all-cause mortality were analyzed using the Cox proportional hazards model and the adjusted model.

Results: There were 9461 deaths during 55312 person-years of follow-up with an average age of 75 years (S.D. ± 8.3) years for survivors and 91.09 (S.D. ± 9.6) years for non-survivors. Type of staple food was associated with a reduced risk of mortality. Compared to those who rarely/never consumed fruit, vegetables, fish, tea, and nut products, participants consuming such products almost every day were associated with 3.7%, 20.9%, 10.8%, 0.1%, and 11.7% reductions in the risk of mortality, respectively. Compared with lard, long-term use of vegetable grease and gingili grease increased the risk of mortality by 10.5% and 11.6%, respectively.

Conclusions: The Chinese elderly could gain health benefit from regular consumption of fruit, vegetables, fish, tea and nut products, and they should pay attention to the choice of cooking oils, reduce cooking oils frequency. Future research is warranted to establish the recommended daily nutrient allowances for the elderly and better address the nutritional needs of this vulnerable population.

1. Introduction

The “World Population Prospects” report shows that the number of people over 65 years of age in the world will exceed the number of children under 5 years of age for the first time in 2018^[1]. However, China is a developing country, the number of people over 65 years of age had reached 165.58 million by the end of 2018, accounting for 11.9% of the total population^[2], far exceeding the international standard for aging of 7.0%. It can be seen that the degree of population aging in China is serious.

Studies have shown that the health status and risk of death of older people are influenced by a variety of factors, such as biology, environment and behavior^[3–5]. Among them, unhealthy lifestyles such as smoking, low-quality diet and lack of physical exercise are the main factors that increase the risk of death in the elderly^[6]. Diet is the main factor affecting human health, and reasonable diet can reduce the risk of mortality^[7]. Nicole Jankovi found that in Europe and the United States, a healthy diet based on the globally defined dietary guidelines of the World Health Organization was associated with greater survival in elderly populations^[8]. Zumin Shi found that the mortality of People aged 80 and older in China was related to food habits and lifestyle^[9]. Ruopeng An’s study showed that the elderly who regularly

consumed fruits, vegetables, meat, fish, eggs, tea and soy products had higher self-rated health status^[10]. Therefore, based on the Chinese population, analyzing the relationship between lifestyle, eating habits and the mortality of the elderly can not only identify the key dietary factors that affect the health of the elderly in China, but also promote the elderly develop good living habits and reduce the risk of illness to provide evidence support.

Previous studies on the influence of dietary habits and lifestyle on the risk of mortality in the elderly have mostly focused on Western populations. This study aimed to examine the relationship between frequency of consumption of each food, lifestyle factors and mortality risk of older people using data collected during 2008–2018 from a large-scale nationwide survey in China. In addition, built upon previous studies, new dietary factors such as flavor, cooking oils, milk products, nut products, vitamins(a/c/e), mushroom or algae and medicinal plants were added to make the dietary habits of this study more comprehensive. At the same time, the data selected the cohort study data of the latest follow-up China Longitudinal Healthy Life Survey in 2018. Moreover, the full-factor model and the full-factor adjustment model were used to deeply explore the impact of different dietary conditions on the risk of death under different staple food patterns. The data is time-effective and the intensity of argumentation is high.

2. Methods

2.1 Study population

The Chinese Longitudinal Healthy Longevity Survey (CLHLS) started in 1998, and 631 counties and cities were randomly selected from 22 provinces in China to conduct baseline data surveys. From 1998 to 2018, eight follow-up surveys were conducted in about half of the counties and cities randomly selected from 23 provinces/cities/autonomous regions, with a total of 113,000 household visits. The entire survey included 20,100 centenarians, 26,800 90-99-year-olds, 29,300 80-89-year-olds, 20,100 65-79-year-olds, 11,200 35–64 middle-aged people. Among them, the elderly aged 80 or above who needed the most care accounted for 67.4% of the total sample, while the rest were younger elderly and middle-aged control group. At the same time, 28,900 close family members of the interviewed elderly over 65 who had died were interviewed, and detailed data on their pre-death health status, quality of life and cost of medical and care needs were collected.

In this study, we selected the longitudinal survey data of CLHLS2008-2018, with a total of 16,954 old people in the original sample. After excluding the samples of lost follow-up and missing key variables, 11,899 old people were selected for the current analysis. During the four follow-up visits, 2,438 elderly people completed all follow-up visits from 2008 to 2018, and 9461 old people died due to various reasons during the different follow-up stages of 2008–2018. Among them, 6,446 elderly people completed two follow-up visits in 2008 and 2011, 3,982 elderly people completed three follow-up visits in 2008, 2011 and 2014, and 2,438 elderly people completed four follow-up visits in 2008, 2011, 2014 and 2018. For the elderly who died, we recorded the time of death and relevant information of the elderly through the follow-up of their close family members. The study strictly followed the provisions of the Declaration of Helsinki

and all procedures involving human subjects/patients had been approved by the Biomedical Ethics Committee of Peking University (IRB00001052-13074). All the participants signed a consent form.

2.2 Dietary

Trained investigators obtained dietary data from participants through face-to-face interviews. During the survey, participants were asked to report the frequency of eating fruit, vegetables, meat, fish, beans, milk products, sugar, tea, garlic, eggs, salt-preserved vegetables, nut products, mushroom or algae, vitamins (a/c/e) and medicinal plants. Among them, the consumption frequency of meat, fish, beans, milk products, sugar, tea, garlic, eggs, salt-preserved vegetables, nut products, mushroom or algae, vitamins (a/c/e) and medicinal plants was recorded as “almost every day”, “occasionally” or “rarely or never”. The frequency of fruit and vegetables consumption was recorded as “almost every day” or “almost every day except in winter” or “occasionally” or “rarely or never”. For the convenience of analysis, following Shi et al.^[9], we also marked “almost every day except winter” as “almost every day”.

Staple food patterns were assessed through the question “Please tell us the staple food you eat? : (1) Rice, (2) Corn, (3) Wheat (noodles and bread, etc.), (4) Others”. The question related to the flavor type is “What main flavor you have?” (1) Insipidity, (2) Salty, (3) Sweet, (4) Hot, (5) Crude (6) None of the above. Information on cooking oil was obtained by asking the survey respondents “what kind of grease they used for cooking.” The answers included (1) Vegetable grease, (2) Gingili grease, (3) Lard, (4) Other animal’s fat.

2.3 Lifestyle

We used a scoring system to assess their frequency of consumption of fruit, vegetable and physical activity. If all three factors were positive, the score was 1, with a maximum score of 3.

2.4 Covariates

Socio-demographic variables included age, sex (male and female), education level (0 years, 1–5 years, 6–9 years, > 9 years), residence(urban, rural),marital status was grouped into two categories: In marriage (married and living with spouse, married but separated from spouse) and not in marriage (divorced, widowed, unmarried). Health status information included participants’ disability, number of chronic diseases, and weight. We used The Katz Activities of Daily Living (ADL)Scale to assess the participants’ disability. If the respondents failed to finish any one or more tasks (bathing, dressing, toileting, transfers, continence and eating), it was defined as an ADL disability. The “China Medium and Long-term Plan for the Prevention and Treatment of Chronic Diseases (2017–2025)” includes 9 types of chronic diseases (cardio-cerebrovascular diseases, cancer, chronic respiratory diseases, diabetes and oral diseases, as well as endocrine, kidney, bone, and neurological diseases). According to the planning standard, 16 chronic diseases were included for analysis, including hypertension, diabetes, heart disease, stroke or cardiovascular disease, respiratory tract inflammation and asthma, tuberculosis, cancer, prostate tumor, Parkinson disease, dementia, epilepsy, arthritis, blood disease, chronic nephritis, galactophore disease and uterine tumor. Other lifestyle variables included smoking, alcohol consumption, exercise and activity

participation. Smoking, drinking and exercise were assessed by asking participants their current smoking status (yes/no), current drinking status (yes/no) and current exercise status (yes/no). Participation in activities was assessed by asking participants whether they undertook a list of eight activities, including housework, growing vegetables/other field work, gardening, reading newspapers/books, raising domestic animals, playing cards and/or mahjong, watching TV and or/listening to radio, and participating in religious activities. we rated the weekly frequency of each activity: almost every day (7), sometimes (3), never (0), and calculate each person's summary score (range from 0 to 56), and recode it into four grades.

2.5 Statistical Analysis

Chi-square test and two independent sample T test were used to carry out descriptive statistics on the selected categorical variables and continuous variables. For each follow-up person, the number of person-years of follow-up was calculated from the date of baseline investigation until the date of death. The Cox proportional hazards model was used to calculate hazard ratios (HRs) in the full model and the adjusted model, respectively, to analyze the association between food habits and lifestyle and all-cause mortality. In the full model, demographic characteristics, lifestyle, chronic diseases, activity and type of staple food were included to analyze the association between these factors and mortality. A variety of dietary habits and the frequency of various diets were included as major factors in the fully adjusted models to further analyze the impact of diet on the risk of death in the elderly. In sensitivity analysis, participants lost to follow-up in the second or later follow-up survey were removed to examine possible attrition bias; Cox proportional hazard models were reestimated excluding deaths in the first year; two other potentially confounding factors, sex and current marital status, were further adjusted in the models. In addition, we visually demonstrated the impact of different dietary factors on mortality risk by plotting cumulative survival charts and forest maps. Statistical significance was considered when $p < 0.05$ (two-sided). Describe statistical and Cox proportional hazard model analysis and cumulative survival graph were performed using Spss24.0. Hazard ratios (HRs) forest map was implemented by R 4.0.2 software.

3. Results

Table 1 shows the baseline characteristics of CLHLS participants in 2008. The mean age of male participants was 84.65 (standard deviation (S.D.) ± 10.6) years and that of female participants was 90.12(S.D. ± 11.4) years. About 60% of the participants lived in rural areas. Male participants with more than 6 years of education accounted for 25.3%, while female participants accounted for 4.4%. 49.4% of men were married, while only 17.0% of women. 34.3% smoked in men, and 5.4% smoked in women. The prevalence of alcohol drinking was 29.9% in men and 8.9% in women. The mean number of chronic diseases was 0.79(S.D. ± 1.0) in men and 0.7(S.D. ± 0.9) in women. The mean weight of men was 55.1 (S.D. ± 10.3) kg, and that of women was 44.9 (S.D. ± 9.1). Participants were generally not overweight. More than half of the participants ate rice as their staple food. The vast majority of participants rarely or never consumed fruit or only occasionally, while more than three quarters ate vegetables almost every day.

There were 9461 deaths during 10 years of follow-up with an average age of 75 years (S.D. ± 8.3) years for survivors and 91.09 (S.D. ± 9.6) years for non-survivors at the last follow-up. In the full model, the

residence, age, gender, weight, years of education, marital status, healthy lifestyle score, participation in activities, number of chronic diseases, ADL disability, smoking, drinking alcohol, exercise, staple food, cooking oil and taste were included for analysis. The encoding information of each variable was shown in Table 2. Age, sex, weight, marital status, activity participation, number of chronic diseases, ADL disability and staple food were associated with the risk of mortality (Table 3). Participants who were married had an 18.9% lower risk of mortality (95% CI (confidence interval) 14% -24%) than those who were not, and ADL disability increased the risk of mortality in older adults by 31.7% (95%CI 28% -35%). Among the four staple foods, those who ate wheat (corn) had a 4.6% reduced risk of mortality compared with those who ate rice, and those who ate a combination of rice and wheat had a 3.7% lower risk of death compared with those who ate rice. The risk of mortality in men was 52.3% higher than in women (95%CI 44%-61%). In addition, each additional chronic disease increased the risk of death by 5.3% (95%CI, 3%-8%). Regular participation in activities can reduce the risk of mortality.

In the adjustment model, 22 variables including age, sex, weight, marital status, staple food, cooking oil, taste, fruit, vegetables, meat, fish, eggs, beans, salt-preserved vegetables, sugar, tea, garlic, milk, nut products, mushroom or algae, vitamins (a/c/e) and medicinal plants were included in the analysis, and dietary factors were adjusted. The results (Table 4) showed that age, sex, weight, marital status, staple food, cooking oil, fruit, vegetables, fish, tea and nut products were associated with the risk of mortality. Weight and marital status were not significantly different from the results of the full model in terms of reducing the risk of mortality, but the staple food had changed. Wheat, rice, and corn, respectively, reduced the risk of mortality by 2%, 1.6%, and 1.3%, compared with a combination of wheat and corn. After adjustment, men had a 42.1% higher risk of mortality than women (95%CI 35%-49%).

We also found that the intake of fruit and vegetables was associated with a reduction in the risk of mortality. Compared with rarely/never consumed fruit, almost every day fruit consumption was associated with a 3.7% lower risk of mortality, occasional fruit consumption was associated with a 6.7% lower risk of mortality. And almost every day vegetables intake was associated with a 20.9% lower risk of mortality than rarely/never consumed vegetables, and 5.7% lower risk of mortality than eating vegetables occasionally. Almost every day fish intake and tea consumption were associated with a lower risk of mortality, and consumption fish daily was associated with a 10.8% reduction in mortality compared with rarely/never consumption of fish. The study also found that nut products intake was associated with a reduction in mortality in the elderly, however, there was no significant difference in the risk of mortality between different frequencies of consumption. All of these results have been shown in Fig. 1. The cumulative survival graph for all significant dietary variables had been shown in Fig. 2.

In the full model, cooking oil was not associated with risk of mortality, but after adjusting for dietary factors, use of vegetable grease, gingili grease and lard had an effect on the increased risk of mortality. Compared with lard, long-term use of vegetable grease and gingili grease increased the risk of mortality by 10.5% and 11.6%, respectively.

Sensitivity analyses, excluding deaths during the first year (Appendix Table 1 in the Supplement), or further adjusting for sex and current marital status (Appendix Table 2 in the Supplement), showed that the association of dietary habits and lifestyles with mortality risk was robust.

4. Discussion

This study examined the relationship between diet and risk of death in elderly Chinese, using 10 years of data from a large longitudinal health survey. Cox proportional hazards regressions were used to estimate the effects of dietary habits and lifestyle factors on the risk of mortality, adjusting for various individual characteristics.

Consistent with previous findings^[11], our study showed that the intake of fruit and vegetables was an important factor to reduce the risk of death in the elderly. However, different frequencies of fruit consumption were associated with different levels of mortality risk reduction. Contrary to the idea that the more fruit you eat, the better your diet, the results showed that eating fruit occasionally was associated with a 3% lower risk of death than eating it almost every day. Although fruits and vegetables were good for the health of the elderly, we recommend that they should also be consumed in moderation. While ensuring the needs of the body, they can maximize the benefits of fruits and vegetables to the body.

Fish consumption was associated with a reduction in all-cause mortality in the elderly. Fish was the most common dietary source of long-chain n-3 polyunsaturated fatty acids (n-3 PUFAs), which had been demonstrated to have antiatherosclerotic and antithrombotic effects^[12,13]. Recently, the Vitamins and Lifestyle Study (VITAL Study) reported that higher intake of fish was significantly associated with a lower risk of all-cause mortality^[14]. What is the optimal intake of fish? Zhao's study showed that consumption of 60 g of fish per day was associated with a 12% reduction (RR = 0.88, 95% CI: 0.83, 0.93) in risk of total death, compared with never consumers^[15]. We had also found the same situation in the elderly population in China. Compared with people who never eat fish, the elderly who consume fish almost every day can reduce the risk of death by 10.8%. Different regions in China had different dietary patterns. People in coastal areas ate more fish, but people in northwest China ate less fish due to environmental factors, which was often related to their income level. As fish was an indispensable part of a healthy diet pattern, people in arid northwest China should pay more attention to the consumption of fish in their diet to ensure the health needs of the special group of elderly people.

Drinking tea was a traditional habit of the Chinese people, especially among the elderly. Previous studies had shown that frequent tea consumption was associated with reduced mortality in Chinese over 80 years of age, and tea had a strong beneficial effect on survival and longevity in later life^[16]. Our research further confirmed the negative correlation between frequent tea drinking and all-cause mortality in the elderly. However, we found that occasional tea consumption was associated with an increased risk of death in the elderly, which indicated that daily tea consumption has potential public health benefits, and long-term regular tea drinking should be developed to improve health and reduce the risk of death. Consumption of nut products was associated with a reduced risk of mortality. A systematic review of

nuts and human health suggested that nut intake could prevent and/or treat some chronic disease related risk factors, such as changes in glycemic and lipid metabolism, oxidative stress, and inflammation^[17].

In the past few decades, Consumption of staple food had shifted from traditional coarse grains to refined grains in China^[18]. The study found that rice, wheat, corn, and a mixture of rice and wheat as the staple food had different effects on mortality risk reduction compared with other types of staple foods, while a regional study in China demonstrated a negative correlation between rice intake and cardiovascular mortality^[19]. Wheat-based foods provide the human diet with a range of essential and beneficial ingredients, including protein, B vitamins, dietary fibre and phytochemicals^[20]. Staple food was the source of energy and carbohydrates in our daily diet, and too high or too low carbohydrate intake was not conducive to health. A prospective study and meta-analysis found that both high and low dietary carbohydrate intakes were associated with increased mortality, with the lowest risk of death when carbohydrate intakes ranged from 50–55%^[21]. In addition, we also found that in the full model, compared with rice as a staple food, the risk of mortality from a mixture of rice and wheat as a staple food can be reduced by 3.7%. Therefore, while paying attention to the intake of staple food in the elderly, we should also pay attention to the diversification of staple food intake, and try to avoid long-term consumption of a single staple food.

Cooking oil was associated with an increase in mortality. Unlike Western countries, lard was a commonly used animal edible oil in China. It was often used in a high-fat diet, which can induce obesity and diabetic phenotypes in rodents^[22]. In China, 80 percent of vegetable oil was fried, but changes that may be harmful to health may occur during frying^[23, 24]. In view of the great harm of cooking oil to human health, and the metabolism of the elderly was slow, easy to indigestion and other problems, we suggested that in the process of nutrition publicity and education, it should be emphasized that the elderly should eat less or do not eat Fried food, and should pay attention to cooking with less oil in their daily diet.

In this sample of the elderly Chinese, regular intakes of salt-preserved vegetables and garlic were not found to be associated with mortality. A study on diet and self-rated health among older Chinese also showed that consumption of salt-preserved vegetables and garlic were not associated with self-rated health^[10]. Weight gain was associated with a lower risk of death, but the reduction was not significant for each unit of weight gain. In China, nearly half of the elderly were at risk of malnutrition^[25]. The elderly with higher body weight may be in good physical condition, which was consistent with previous studies^[26]. Low frequency of activity was associated with an increased risk of death in older adults compared to high frequency of activity. Fishman and colleagues³ observed that higher volumes of total physical activity were associated with lower mortality, especially, greater light activity is also associated with lower mortality independent of MVPA^[27]. In future public health education, we encouraged older people to participate more in low-intensity activities and to be less sedentary. We found that women had a lower risk of mortality than men. Married persons had better health and mortality outcomes than unmarried persons^[28].

The advantages of this study include a large national sample, and a comprehensive dietary factor. It should be noted that some limitations of the study. First, the measurement of dietary intake was rough. Based on Shi's study^[9], we included the frequency of vegetables and fruit intake of "almost every day except winter" into "almost every day", forming three categories, "almost every day", "occasionally", "rarely or never". Admittedly, this categorization was crude and subjective, however, due to the question wording across CLHLS survey waves, such a classification of dietary intake frequency tends to be a relatively sensible choice. Second, the lack of detailed dietary information in this study limited our ability to comprehensively adjust for total energy intake and dietary intake. Third, due to smoking, drinking, and exercising were based on the current status of the problem, and it did not include smoking, drinking, exercise frequency and past history, the study was relatively incomplete in assessing the impact of lifestyle factors on the risk of mortality. Finally, there was no relevant height data, body mass index (BMI) can't be calculated and the classification was not performed. Therefore, in future studies, in order to more comprehensively analysis the impact of weight on the risk of mortality, weight can be divided into groups and converted into categorical variables, or put into the model in the form of BMI.

This study assessed the relationship between dietary habits, lifestyle and mortality risk in the Chinese population aged 65 years and older. Compared to those who rarely/never consumed fruit, vegetables, fish, tea and nut products, participants consuming such products almost every day had a lower risk of mortality during follow-up. Cooking oil was associated with increased mortality, and regular participation in activities would reduce the risk of mortality and be good for the health of the elderly. The impact of dietary habits on the risk of mortality of the elderly differed by gender to some extent. In future studies, the impacts of different dietary intake amount on the health and mortality of the elderly can be further analyzed to provide a basis for determining the daily dietary intake amount suitable for the elderly group, meeting nutritional requirements and improving health level. In addition, while advocating a reasonable diet, the elderly should reduce the frequency of using cooking oil and the intake of Fried food.

Declarations

Competing interests

The authors declare no conflict of interests.

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Authors' contributions

Study concept and design: Dr. Sun, MPH. Zhou and MPH. Zhang

Acquisition of subjects and/or data: Yin Qing and MPH. Zhang

Analysis and interpretation of data: MPH. Zhang

Preparation of manuscript: MPH. Zhou

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Tables

Due to technical limitations, table 1,2,3,4 is only available as a download in the Supplemental Files section.

Figures

Figure 1

Hazard ratios (HRs) forest map of adjusted model. The figure showed the hazard ratios for death outcomes among subgroups of different diet types, which reflected whether different diet types were associated with death and the strength of the association. The results came from four follow-up survey data of the Chinese Longitudinal Healthy Longevity Survey 2008-2018.

Figure 2

Cumulative survival charts for different food groups. The figure showed the cumulative survival of different diet subgroups, from which we could see that the cumulative survival of vegetables, fresh fruits, fish, nuts, cooking oil, and tea were all related to their consumption frequency or consumption type. The results came from four follow-up survey data of the Chinese Longitudinal Healthy Longevity Survey 2008-2018.

Supplementary Files

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- [Table1.xlsx](#)
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- [Table3.xlsx](#)
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