

Association of diet-related knowledge, attitudes, behaviors and self-rated health among Chinese adults: a population-based study

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Abstract

Background: Diet and nutrition play an important role in one's health status. The objectives of this study were to (a) determine knowledge, attitudes, and behaviors (KAB) related to diet among a sample of Chinese adults, and (b) assess the association between diet-related KAB and self-rated health.

Methods: We applied the 2015 China Health and Nutrition Survey (CHNS) with cross-sectional study design. Individuals aged 18 years and older were included as study subjects ($n = 12,814$). Six variables were selected to assess diet-related knowledge, attitudes, and behaviors, composed of two for each dimension. Comparison of diet-related KAB in urban and rural was conducted using chi-square test. Ordinal logistic regression was conducted to quantify the association between diet-related KAB and self-rated health.

Results: The awareness rate for Chinese diet pagoda/DGCR was 27.1%, and only 34.3% of the subjects were assessed as having adequate dietary knowledge literacy. 24.3% and 21.4% reported positive attitudes towards healthy diet and being physically active, respectively. 27.6% and 65.9% reported the behavior of actively looking for nutrition knowledge and eating fruit & vegetables, respectively. Chi-square test indicated that rural residents experienced significant poorer diet-related knowledge, attitudes, and behaviors than urban (all p -values < 0.05). Adjusted ORs with 95% CI revealed significant association between diet-related KAB and self-rated health.

Conclusions: Chinese adults experienced poor diet-related knowledge, attitudes, and behaviors, while rural residents were significantly worse than urban. Improving diet-related knowledge, attitudes, and behaviors was extremely beneficial to individual's self-rated health.

Background

According to the Global Burden of Disease Study 2017, 11 million deaths (22% of all deaths among adults) and 255 million DALYs were attributable to dietary risk factors [1]. In China, we are confronting with the plight: coexistence of under- and over-nutrition, as well as high incidence of nutrition-related diseases [2]. Chinese residents' daily salt and edible oil intake, together with fat ratio is all higher than the recommended standards (WHO and Dietary Guidelines for Chinese Residents (DGCR)) in 2012 [2]. The overweight and obesity rates in adults maintain an upward trend, while 6.0% and 9.0% of whom still have problems of malnutrition and weight loss. To promote the solution of nutrition-related problems, the Chinese government announced the implementation of "Healthy China Action (2019–2030)" in July 2019, "Appropriate Diet" was involved as one of its fifteen major actions [3].

Knowledge, Attitude/Belief, and Behavior/Practice (KAB) is originally proposed to emphasize the vital role of knowledge, attitude, and behavior in promoting individuals' health management [4]. According to the theory, individuals' health behavior is composed of three consecutive processes: acquire knowledge, generate beliefs and form behaviors. KAB evaluation is considered the first step of health behavior education, which can grasp the individual's understanding, health beliefs, and actions taken regards a

specific health issue, and then provide scientific basis for the development of intervention plan. Adequate knowledge of health-related behavior has been reported to influence the patient's attitude and practice in health management [5]. Specifically, assessing diet-related knowledge, attitudes, and behaviors has been reported to be vitally important in achieving dietary health promotion at the population level [6–8], thus should be a necessary prerequisite for dietary intervention in China.

Previous studies have shown that diet-related behavior is a key factor influencing individuals' health, for example, associating with mortality and morbidity of non-communicable diseases [1], risk of cardiovascular disease [9, 10], metabolic syndrome [11–13], cancer [9, 14], and all-cause mortality [9]. Knowledge and attitude indirectly affect health status by promoting behavioral change [15, 16]. However, no existing study has systematically described the association of Chinese residents' dietary behavior on individuals' health, based on the KAB theory perspective. For these consideration, we conducted the present study to (a) determine knowledge, attitudes, and behaviors related to diet among a sample of Chinese adult residents, and (b) assess the association between diet-related KAB and self-rated health.

Methods

Date source

The China Health and Nutrition Survey (CHNS) is a longitudinal survey and open cohort conducted from 1989 to the currently available 2015 wave, with multistage and random cluster procedures. This comprehensive dataset aims to study the influences of nutrition, health, and family planning policies established by both national and local government agencies in China. Furthermore, the CHNS investigates the impact of social and economic transitions in Chinese society on residents' overall health and nutrition status. In the 2015 CHNS wave, a total of 15,291 individuals from nine provinces (Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guangxi, and Guizhou) and three municipalities (Beijing, Chongqing, and Shanghai) were surveyed.

In the present study, we used the data of adult population (aged 18 and over) in the 2015 CHNS wave ($n = 12872$). After excluding those with missing socio-demographic, diet related variables, and self-rated health information, a total of 12,814 subjects were involved in the final analysis.

We used de-identified and publicly-available datasets from the official CHNS website (<https://www.cpc.unc.edu/projects/china>). Hence, approvals from Institutional Review Boards were not required at authors' institutions.

Variables

Diet-related knowledge

We applied two variables to assess diet-related knowledge: the awareness of Chinese diet pagoda or Dietary Guidelines for Chinese Residents (DGCR) (K1) and adequate dietary knowledge literacy (K2). The awareness of diet pyramid/ DGCR was identified by a question “Do you know about the Chinese Pagoda or the Dietary Guidelines for Chinese Residents (yes/no)?” Dietary knowledge literacy was computed from 17 dietary questions. Referring to the statistical analysis of Chinese residents health literacy monitoring [17] and previous relevant article [18], individuals with the actual dietary knowledge score $\geq 80\%$ were defined as having adequate dietary knowledge literacy (i.e. the total score of 17 dietary questions ≥ 14).

17 questions which originally coded as “strongly disagree”, “disagree”, “neutral”, “agree”, and “strongly agree” in the 2015 CHNS questionnaire was transferred into dichotomous variables. For six negative items (Q2, Q4, Q6, Q12, Q15, Q16), the response of “strongly disagree” or “disagree” was scored 1 point, otherwise 0. For the other eleven positive items, the response of “strongly agree” or “agree” was scored 1 point, otherwise 0. Cronbach’s alpha for the 17 dietary questions was 0.86 in this study.

Diet-related attitudes

Two categorical variables were selected as diet-related attitudes measurement, that is, the attitudes towards the importance of “eating a healthy diet (A1)” and “being physically active (A2)”. The answers were dichotomized to positive attitude (“very important” or “the most important”) and non-positive attitude (“not important at all”, “not very important”, or “neutral”).

Diet-related behaviors

Two categorical variables were applied to assess diet-related behaviors: actively looking for nutrition knowledge (B1), and prefer eating fruits & vegetables (B2). The behavior of looking for nutrition knowledge was measured by a question “Do you proactively look for nutrition knowledge (yes/no)?” The response of “yes” was referred to as positive behavior. The question regarding behavior of eating fruits & vegetables were dichotomized to positive behavior (“like” and “like very much”) and non-positive behavior (“dislike very much”, “dislike”, “neutral”).

Self-rated health

Self-rated health was assessed by the question “How do you rate the quality of your life at present?” The original coding included “very good”, “good”, “fair”, “bad”, and “very bad”. The response of “very good” and “good” was recognized as good health, “fair” as moderate health, “bad” and “very bad” as poor health.

Covariates

Covariates including age, sex, marital status, education level, work status, and place of residence were collected. Age was classified into three categories (18–44, 45–59, and ≥ 60). Marital status was dichotomized into married and others (never married, divorced, widowed, separated, etc.). Education level was classified into four categories (elementary school and below, middle school, high school, and college and above). Work status was classified into two categories (yes and no). Place of residence was dichotomized into urban and rural.

Statistical analysis

Data analysis was performed by using IBM SPSS Statistics Version 22.0 (SPSS, Inc., Chicago, IL). Descriptive statistics including means and standard deviation (SD), frequency and percentages were calculated. Comparison of diet-related knowledge, attitudes, and behaviors among urban and rural residents were conducted using chi-square test. Ordinal logistic regression was conducted yielding adjusted odds ratios (ORs) to identify the association between diet-related KAB and self-rated health. In all analyses, a p -value of ≤ 0.05 was considered significant.

Results

General information

A total of 12814 adult individuals were involved in this study, composed of 39.5% ($n = 5061$) in urban and 60.5% ($n = 7753$) in rural areas. The participants' average age was 52.6 years old (SD = 15.3), of which 30.3% ($n = 3887$), 34.1% ($n = 4375$), and 35.5% ($n = 4552$) were young, middle, and older adults, respectively. Of these participants, 46.9% ($n = 6016$) were male, 86.1% ($n = 11038$) were married, 32.2% ($n = 4132$) received an education level below middle school, 46.0% ($n = 5891$) were currently employed. 8.5% ($n = 1089$), 40.3% ($n = 5159$), and 51.2% ($n = 6566$) of the participants self-reported poor, moderate, and good health status, respectively. The differences of self-rated health in demographic characteristics were statistically significant (all p -values < 0.05). *Table 1* lists the detailed characteristics of the study sample by self-rated health.

Diet-related KAB

In regards to diet-related knowledge, only 27.1% of the participants knew Chinese diet pagoda/DGCR, and 34.3% were assessed as having adequate dietary knowledge literacy. In attitudes, 24.3% and 21.4% of the participants hold positive attitudes towards healthy diet and being physically active, respectively. In terms of behaviors, 27.6% of the participants reported the behavior of actively looking for nutrition knowledge, and the majority (65.9%) reported preference to fruits & vegetables. The comparative analysis indicated that participants in urban areas had significantly better knowledge, attitudes, and behaviors related to diet than that in rural (all p -values < 0.01). Most prominently, the awareness rate of Chinese diet pagoda/DGCR

(38.6%) and the proportion of actively looking for nutrition knowledge (40.5%) in urban was almost the double of which in rural (19.5% and 19.2%). As shown in *Table 2*.

Besides, *table 3* demonstrated the awareness rate of 17 dietary knowledge-based questions and the differences in urban and rural. The awareness rate of the 17 questions ranged from 28.1% (Q14, *refined grains contain more vitamins and materials than unrefined grains*) to 83.2% (Q9, *consuming beans and bean products is good for one's health*), with an average of 64.9%. And only 1.1% (n = 143) of the participants were aware of all the 17 items. Urban participants reported significantly higher awareness rate of dietary knowledge (except for Q9 and Q14) than rural (p -value < 0.01).

Association between diet-related KAB and self-rated health

Adjusted ORs with 95% CI were computed to clarify the association between diet-related KAB and individuals' self-rated health (*Table 4*). Participants who aware of Chinese diet pagoda/DGCR (OR = 1.11, 95% CI = 1.08–1.15), having diet knowledge literacy (OR = 1.12, 95% CI = 1.09–1.15), holding positive attitudes towards the importance of healthy diet (OR = 1.06, 95% CI = 1.00–1.11) and being physically active (OR = 1.10, 95% CI = 1.06–1.15), actively looking for nutrition knowledge (OR = 1.11, 95% CI = 1.08–1.14), and preferring fruits & vegetables (OR = 1.09, 95% CI = 1.07–1.12) were detected with significant better self-rated health.

Discussion

This study showed that Chinese adults experienced poor diet-related knowledge, attitudes, and behaviors, while rural residents were notably worse than urban. We also found that diet-related knowledge, attitudes, and behaviors all associated with individuals' self-rated health. With the improvement of people's living standards, the dietary patterns of Chinese residents have gradually changed – the unhealthy dietary structure such as high-energy, high-fat, and high-sugar intake has been increasingly prominent [19, 20]. Advocating a balanced diet and strengthening diet-related health education has become a noteworthy topic for all Chinese residents [3].

The present study demonstrated that the awareness rate of Chinese diet pagoda/DGCR was 27.1%, and the proportion of having adequate dietary knowledge literacy was 34.3%, which was consistent with Li et al.'s report (27.0% and 36.0%) [18]. Compared with historical data [21], the awareness rate of Chinese diet pagoda/DGCR presented a clear upward trend (2004, 7.8%; 2006, 11.9%; 2009, 14.6%; and 2011, 24.4%), but still at a lower level. Only about one-third of the Chinese adult residents equipped with basic dietary knowledge, and the awareness of several dietary knowledge was extremely low. For example, the correct awareness rates for Q14 (*Refined grains contain more vitamins and materials than unrefined grains*), Q5 (*Choosing a diet with a lot of staple foods is not good for one's health*), and Q16 (*Vegetables contain more starch than staple foods*) were only 28.1%, 41.2% and 44.5%, respectively. It can be seen that certain diet-related knowledge of Chinese adult residents is still poor and needs to be strengthened. Furthermore, the residents are not only supposed to acquire basic nutrient information, but also should be

recommended appropriate diet patterns according to their nutritional status by general practitioner, nutritionist and related professionals [22]. Confusion from news media exposure to contradictory information about diet knowledge should be avoided.

As the important dimension of the health belief model, individuals' health-related attitude greatly affects the formation of health-related behaviors [23]. Only about one-fifth of participants reported positive attitudes towards healthy eating (24.3%) and being physically active (21.4%) in this study, indicating that Chinese residents have not yet generally recognized the importance of healthy lifestyle. However, there is substantial evidence that high diet quality is closely associated with lower incidence of hypertension and other diseases [24, 25].

In terms of diet-related behavior, we obtained identical results with Li et al. [18] that only minority of the participants (27.6%) reported actively looking for nutrition knowledge. Most (65.9%) adult residents preferred fruits and vegetables in their daily diet, but according to Li et al. [26] and Ouyang et al. [27], the actual intake of fruits and vegetables of Chinese residents have not yet met the international recommendation. Some even reported a decrease in the consumption of vegetables [28]. The preparation and cooking method is another factor that lead to nutrient deficiency and ultra-processed foods are known to decrease the overall diet quality [29, 30]. Thus, future measures are expected to encourage intake of fruits and vegetables as well as improve the traditional Chinese cooking methods to prevent nutrient loss.

In general, diet-related knowledge, attitudes, and behaviors of Chinese adult residents are not satisfactory, and it is necessary to carry out targeted health education to guide and improve.

Comparative analyses suggested that rural residents experienced significant worse diet-related knowledge, attitudes and behaviors. Especially for the awareness rate of Chinese diet pagoda/DGCR (knowledge) and the proportion of actively looking for nutrition knowledge (behavior), rural areas were just about 1/2 of urban. The results were consistent with previous findings that also exhibited an obvious urban-rural dual structure of diet-related KAB in China [31, 32]. Due to economic and cultural differences, the dietary health status of Chinese residents showed obvious urban-rural inequality. There was thus a need to address this gap in research and to develop interventions that targeted rural residents in particular. Urbanization in China gave rural residents more opportunity to all aspects of the information, while the government still should strengthen the effort to promote diet-related health education, for example, both free clinic activity and bulletin boards are valid health promotion medium.

The results of regression analysis showed that great diet-related knowledge, attitudes, and behaviors were the protective factors for individuals' self-rated health. A study across five European countries addressed consistent findings that [16], good nutrition-related knowledge and positive nutrition-related attitudes could strongly and positively influence the health status and quality of life among the older population. Aune et al. [9] stated that fruit and vegetable intakes closely associated with individuals' health, and could effectively reduce the risk of cardiovascular disease, total cancer, and all-cause

mortality. These findings are primer for policy makers to implement diet-related educational programs in order to improve the health status of Chinese population.

To promote the construction of “Health China” and improve Chinese residents’ dietary health, the Chinese government implemented “Appropriate Diet” action as part of the “Healthy China Action (2019–2030)” [3]. However, improving diet-related KAB in China is not an easy task, it requires not only an understanding of the demand discrepancy between urban and rural adults, but also an insight into the factors prevent adults from a healthy diet. As the KAB theory demonstrates, our study reinforced the importance of creating good conditions for diet-related knowledge and medical resources, especially in rural areas. Holistic policy intervention is warranted to target Chinese adults’ overall diet-related knowledge and behavior rather than relative motivation alone.

Several potential limitations should be mentioned regarding the present study. Firstly, limited by the data structure and content of the CHNS database, we only selected two variables (looking for nutrition knowledge, eating fruit and vegetables) to evaluate diet-related behavior, which may not fully reflect the dietary behavior of Chinese adult residents. Secondly, all measures in the study are self-reported, and thus are subject to various measurement errors. For example, the application of self-rated health may result a assess gap with individuals’ actual health status. Due to data limitation, this study is not able to address more objective and comprehensive health status indicators (i.e. illness, blood pressure, blood glucose). Thirdly, considering the data timeliness, the 2015 CHNS data may not fully reflect China’s current situation. Despite these limitations, the present study systematically described the dietary condition of Chinese adult residents based on large sample data. And this is the first to explore the impact of diet-related knowledge, attitudes, and behaviors on individuals’ health among the Chinese adult population, which might be a valuable reference for the implementation of current “Appropriate Diet” actions and further relevant research.

Conclusions

Chinese adults experienced poor diet-related knowledge, attitudes, and behaviors, while rural residents were significantly worse than urban. Great diet-related knowledge, attitudes, and behaviors significantly associated with the improving of individuals’ self-rated health. The “Appropriate Diet” action implemented in China is in line with the general scientific path of promoting population health through behavioral intervention. It is necessary to develop targeted interventions towards three dietary dimensions (knowledge, attitude, and behavior). Moreover, the focus of policy on rural areas to address the urban-rural gap in dietary health might make great sense.

Abbreviations

CHNS: China Health and Nutrition Survey; CI: Confidence interval; DGCR: Dietary Guidelines for Chinese Residents; KAB: Knowledge, attitude, and behavior; OR: Odds ratio; SD: Standard deviation

Declarations

Ethics approval and consent to participate

We used publicly-available datasets from the official CHNS website (<https://www.cpc.unc.edu/projects/china>). Hence, the need for ethics approval was waived by the Institutional Review Board of Wuhan University. The CHNS provides respondents guarantees of their privacy and confidentiality. All participants provided written informed consent. Details about the study design are available elsewhere [33].

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analysed during the current study are available from the official CHNS website (<https://www.cpc.unc.edu/projects/china>).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YY and DH designed the study. LW, SW, LC, ML analyzed and interpreted the data. YY and DH drafted the manuscript. ZM supervised the study and critically revised the manuscript for important intellectual content and final approval of the version to be published. All authors have read and approved the manuscript.

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References

1.Afshin A, Sur PJ, Fay KA, Cornaby L, Ferrara G, Salama JS, Mullany EC, Abate KH, Abbafati C, Abebe Z et al. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet* 2019, 393(10184):1958–1972.

[http://dx.doi.org/10.1016/S0140-6736\(19\)30041-8](http://dx.doi.org/10.1016/S0140-6736(19)30041-8)

2.Department of Disease Prevention and Control, National Health and Family Planning Commission. Report on Chinese Residents' Chronic Diseases and Nutrition, 2015. Beijing: People's Medical Publishing House; 2015.

3.National Health Commission of the People's Republic of China. Healthy China Initiative (2019–2030). 2016; [cited November 2019]. Available from:

<http://www.nhc.gov.cn/guihuaxxs/s3585u/201907/e9275fb95d5b4295be8308415d4cd1b2.shtml>

4.Zhu J. Health Behavior and Health Education. Shanghai: Fudan University Press; 2013.

5.Maruf FA, Ojukwu CC, Akindele MO. Perception, Knowledge, and Attitude toward Physical Activity Behaviour: Implications for Participation among Individuals with Essential Hypertension. *High Blood Pressure & Cardiovascular Prevention* 2018, 25(1):53–60. <http://dx.doi.org/10.1007/s40292-017-0235-y>

6.Spronk I, Kullen C, Burdon C, O'Connor H. Relationship between nutrition knowledge and dietary intake. *Br J Nutr* 2014, 111(10):1713–1726. <http://dx.doi.org/10.1017/S0007114514000087>

7. Axelson ML, Federline TL, Brinberg D. A meta-analysis of food- and nutrition-related research. *Journal of Nutrition Education* 1985, 17(2):51–54. [http://dx.doi.org/10.1016/S0022-3182\(85\)80175-8](http://dx.doi.org/10.1016/S0022-3182(85)80175-8)
8. Macías YF, Glasauer P. Guidelines for assessing nutrition-related knowledge, attitudes and practices. Rome: Food and Agriculture Organization of the United Nations; 2014.
9. Aune D, Giovannucci E, Boffetta P, Fadnes LT, Keum N, Norat T, Greenwood DC, Riboli E, Vatten LJ, Tonstad S. Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality - a systematic review and dose-response meta-analysis of prospective studies. *INT J EPIDEMIOL* 2017, 46(3):1029–1056. <http://dx.doi.org/10.1093/ije/dyw319>
10. Ruan Y, Huang Y, Zhang Q, Qin S, Du X, Sun Y. Association between dietary patterns and hypertension among Han and multi-ethnic population in southwest China. *BMC PUBLIC HEALTH* 2018, 18(1):1106–1108. <http://dx.doi.org/10.1186/s12889-018-6003-7>
11. Mirmiran P, Ziadlou M, Karimi S, Hosseini-Esfahani F, Azizi F. The association of dietary patterns and adherence to WHO healthy diet with metabolic syndrome in children and adolescents: Tehran lipid and glucose study. *BMC PUBLIC HEALTH* 2019, 19(1):1457. <http://dx.doi.org/10.1186/s12889-019-7779-9>
12. Mumme KD, von Hurst PR, Conlon CA, Jones B, Haskell-Ramsay CF, Stonehouse W, Heath AM, Coad J, Beck KL. Study protocol: associations between dietary patterns, cognitive function and metabolic syndrome in older adults - a cross-sectional study. *BMC PUBLIC HEALTH* 2019, 19(1):535. <http://dx.doi.org/10.1186/s12889-019-6900-4>
13. Mohammadi S, Jalaludin MY, Su TT, Dahlui M, Mohamed M, Majid HA. Dietary and physical activity patterns related to cardio-metabolic health among Malaysian adolescents: a systematic review. *BMC PUBLIC HEALTH* 2019, 19(1):251. <http://dx.doi.org/10.1186/s12889-019-6557-z>
14. Chang YJ, Hou YC, Chen LJ, Wu JH, Wu CC, Chang YJ, Chung KP. Is vegetarian diet associated with a lower risk of breast cancer in Taiwanese women? *BMC PUBLIC HEALTH* 2017, 17(1):800. <http://dx.doi.org/10.1186/s12889-017-4819-1>
15. Pickard AS, Jalundhwala YJ, Bewsher H, Sharp LK, Walton SM, Schumock GT, Caskey RN. Lifestyle-related attitudes: do they explain self-rated health and life-satisfaction? *QUAL LIFE RES* 2018, 27(5):1227–1235. <http://dx.doi.org/10.1007/s11136-017-1774-3>
16. Jeruszka-Bielak M, Kollajtis-Dolowy A, Santoro A, Ostan R, Berendsen AAM, Jennings A, Meunier N, Marseglia A, Caumon E, Gillings R et al. Are Nutrition-Related Knowledge and Attitudes Reflected in Lifestyle and Health Among Elderly People? A Study Across Five European Countries. *FRONT PHYSIOL* 2018, 9. <http://dx.doi.org/10.3389/fphys.2018.00994>
17. Nie X, Li Y, Li L. Statistic analysis of 2012 Chinese residents health literacy monitoring. *Chinese Journal of Health Education* 2014, 30(02):178–181. <http://dx.doi.org/10.16168/j.cnki.issn.1002->

- 18.Li Y, Zhang F, Wang T. Status quo of dietary knowledge and attitudes and influencing factors of dietary health literacy among adult residents in China, 2015. *Chin J Public Health* 2019;1–4.
<http://dx.doi.org/10.11847/zgggws1121422>
- 19.Ju L, Yu D, Fang H, Guo Q, Xu X, Zhao L. Dietary patterns among Chinese residents, 2010–2012. *Chin J Public Health* 2018, 34(10):1373–1376. <http://dx.doi.org/10.11847/zgggws1116952>
- 20.Liu M, Yan L, Liu M, Liu Z, Ma M, Yang Y. The Dietary Status of Residents in Sichuan Province. *J Prev Med Inf* 2018, 34(03):357–361
- 21.Huang F, Wang H, Zhang J, Zhai F, Zhang B. The trends in awareness rate of the dietary guidelines for Chinese residents and the effect on dietary pattern. *Acta Nutrimenta Sinica* 2015, 37(04):325–329.
<http://dx.doi.org/10.13325/j.cnki.acta.nutr.sin.2015.04.007>
- 22.Baldwin C, Weekes CE: Dietary advice with or without oral nutritional supplements for disease-related malnutrition in adults. *The Cochrane database of systematic reviews* 2011(9):D2008.
<http://dx.doi.org/10.1002/14651858.CD002008.pub4>.
- 23.Le J, Dallongeville J, Wagner A, Arveiler D, Haas B, Cottel D, Simon C, Dauchet L: Attitudes toward healthy eating: a mediator of the educational level-diet relationship. *EUR J CLIN NUTR* 2013, 67(8):808–814. <http://dx.doi.org/10.1038/ejcn.2013.110>
- 24.Livingstone KM, McNaughton SA. Diet quality is associated with obesity and hypertension in Australian adults: a cross sectional study. *BMC PUBLIC HEALTH* 2016, 16(1):1037.
<http://dx.doi.org/10.1186/s12889-016-3714-5>
- 25.Wang X, Liu A, Du M, Wu J, Wang W, Qian Y, Zheng H, Liu D, Nan X, Jia L et al. Diet quality is associated with reduced risk of hypertension among Inner Mongolia adults in northern China. *PUBLIC HEALTH NUTR* 2019;1–12. <http://dx.doi.org/10.1017/S136898001900301X>
- 26.Li YC, Jiang B, Zhang M, Huang ZJ, Deng Q, Zhou MG, Zhao ZP, Wang YF, Wang LM. Vegetable and Fruit Consumption among Chinese Adults and Associated Factors: A Nationally Representative Study of 170,847 Adults. *BIOMED ENVIRON SCI* 2017, 30(12):863–874. <http://dx.doi.org/10.3967/bes2017.117>
- 27.Ouyang Y, Zhang B, Wang Z, Su C, Zhang J, Du W, Jiang H, Huang F, Jia X, Wang Y et al. Intake of vegetables and fruits among the Chinese aged 60 and above in 15 provinces (autonomous region and municipatily) in 2015. *Journal of Hygiene Research* 2019, 48(01):23–27
- 28.Zhang Q, Chen X, Liu Z, Varma DS, Wan R, Zhao S. Diet diversity and nutritional status among adults in southwest China. *PLOS ONE* 2017, 12(2):e172406. <http://dx.doi.org/10.1371/journal.pone.0172406>

- 29.Fabbri ADT, Crosby GA. A review of the impact of preparation and cooking on the nutritional quality of vegetables and legumes. *International Journal of Gastronomy and Food Science* 2016, 3:2–11. <http://dx.doi.org/10.1016/j.ijgfs.2015.11.001>
- 30.Koiwai K, Takemi Y, Hayashi F, Ogata H, Matsumoto S, Ozawa K, Machado PP, Monteiro CA. Consumption of ultra-processed foods decreases the quality of the overall diet of middle-aged Japanese adults. *PUBLIC HEALTH NUTR* 2019, 22(16):2999–3008. <http://dx.doi.org/10.1017/S1368980019001514>
- 31.Gao X, Xue P, Liu S, Liu H. Current status of dietary knowledge among urban and rural elderly residents in China. *Chinese Journal of Gerontology* 2012, 32(12):2572–2573. <http://dx.doi.org/10.3969/j.issn.1005-9202.2012.12.057>
- 32.He Q. Urban-rural Disparities of Dietary, Nutrition and Health in China: Based on China Health and Nutrition Survey. Huazhong University of Science & Technology; 2016.
- 33.Popkin BM, Du S, Zhai F, Zhang B. Cohort Profile: The China Health and Nutrition Survey—monitoring and understanding socio-economic and health change in China, 1989–2011. *Int J Epidemiol* 2010, 39(6):1435–40. <http://dx.doi.org/10.1093/ije/dyp322>