

An association between diet quality index for Koreans (DQI-K) and total mortality in Health Examinees Gem (HEXA-G) study

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BACKGROUND/OBJECTIVES: Diet quality scores or indices, based on dietary guidelines, are used to summarize dietary intake into a single numeric variable. The aim of this study was to examine the association between the modified diet quality index for Koreans (DQI-K) and mortality among Health Examinees-Gem (HEXA-G) study participants.

SUBJECTS/METHODS: The DQI-K was modified from the original diet quality index. A total of 134,547 participants (45,207 men and 89,340 women) from the HEXA-G study (2004 and 2013) were included. The DQI-K is based on eight components: 1) daily protein intake, 2) percent of energy from fat, 3) percent of energy from saturated fat, 4) daily cholesterol intake, 5) daily whole-grain intake, 6) daily fruit intake, 7) daily vegetable intake, and 8) daily sodium intake. The association between all-cause mortality and the DQI-K was examined using Cox proportional hazard regression models. Hazard ratios and confidence intervals were estimated after adjusting for age, gender, income, smoking status, alcohol drinking, body mass index, and total energy intake.

RESULTS: The total DQI-K score was calculated by summing the scores of the eight components (range 0-9). In the multivariable adjusted models, with good diet quality (score 0-4) as a reference, poor diet quality (score 5-9) was associated with an increased risk of all-cause mortality (hazard ratios = 1.23, 95% confidence intervals = 1.06-1.43). Moreover, a one-unit increase in DQI-K score resulted in a 6% higher mortality risk.

CONCLUSIONS: A poor diet quality DQI-K score was associated with an increased risk of mortality. The DQI-K in the present study may be used to assess the diet quality of Korean adults.

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INTRODUCTION

Despite nutritional recommendations and food guidelines, the pandemic of chronic disease continues to be a leading cause of mortality [1]. Therefore, it is important to evaluate major modifiable lifestyle risk factors such as diets of individuals or groups in order to prevent chronic diseases [2]. Diet quality indices are a popular topic in nutritional epidemiology. People consume food as a complex mixture of various food products or as a certain type of diet rather than as a single nutrient product. In addition, a strong intercorrelation among some nutrients and foods makes it difficult to detect their isolated effects as a single nutrient or food item [3,4]. The diet quality

index (DQI) was developed as a composite assessment of diet, including measures for eight food groups and nutrient-based recommendations, by Patterson and colleagues in 1994 in order to examine clusters of healthy and unhealthy lifestyle characteristics [5]. The index presents summary scores of an individual's overall dietary intake pattern rather than just one aspect of that diet; therefore, it is useful in estimating variability within a diet and overall dietary quality for individual populations.

A great quantity of research has been done regarding the relationship between individual nutrients and mortality. However, the entire diet must be examined since nutrients are not consumed independently but together within a variety of foods in the diet. Thus, a simple and inexpensive method for monitoring

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diet quality in various populations must be developed. Dietary quality indices or indicators aim to evaluate overall diet and categorize individuals according to the “healthiness” of their eating behavior [6]. They were developed to assess overall dietary quality and are interpreted in a manner in which high diet quality can predict chronic disease risk [7,8].

In recent years, research has examined the association of overall diet quality with risk of mortality [9-11]. Previous publications have detected significant risk reductions of 10-15% in total mortality based on the healthy diet indicator (HDI) [12,13]. In the National Institutes of health-aarp cohorts, higher diet quality based on the healthy eating index (HEI), the alternate healthy eating index (AHEI), and dietary approaches to stop hypertension (DASH) scores has been reported to be associated with a 17-24% reduction in all-cause mortality [14]. In the EPIC- Spain cohort, high diet quality was shown to reduce all-cause mortality by 21% [15]. In a recent meta-analysis consisting of 13 cohort studies, the pooled relative risk estimate for overall 6.5 to 20-year mortality was 0.78, with a variation from 0.76 to 0.80 [16].

The diet pattern of Koreans is becoming more Westernized due to increased consumption of animal products and fat [17]. However, Koreans still have an insufficient energy ratio acquired from fat. A revised diet quality index for Koreans is necessary in order to evaluate dietary intake and nutrition promotion activities for the Korean population.

In this study, we examined the association of all-cause mortality with the diet quality index for Koreans (DQI-K). We hypothesize that low diet quality is associated with increased risk of mortality. This assumption is based on evidence from association studies between individual foods as well as nutrients and mortality.

SUBJECTS AND METHODS

Study design and population

This study was based on a large-scale genomic cohort study known as the Health Examinees (HEXA) study. For the baseline study, a total of 169,718 subjects aged between 40-69 years old were recruited from 38 general hospitals and health examination centers throughout Korea between 2004 and 2013. HEXA data are publicly available for use. The Institutional Review Board of the Seoul National University Hospital, Seoul, Korea approved its use for statistical analysis (IRB No. E-1503-103-657). The HEXA study design has been described in detail in previous studies [18,19].

Updated from previously published HEXA studies, the current study used the Health Examinees-Gem (HEXA-G) participant sample, which includes additional eligibility criteria on participating sites (i.e., health examination centers and general hospitals). The HEXA-G criteria selected 21 sites from the 38 original sites based on the following exclusion criteria: pilot study participants in 2004-2006 (eight sites, $n = 9,345$); unsuitable HEXA biospecimen quality control criteria (eight sites, $n = 12,232$); participated in the HEXA study for less than 2 years (five sites, $n = 8,799$). Except for those who did not comply with the HEXA-G criteria, 139,342 participants remained [20]. From the HEXA-G population, we excluded subjects who were missing information in

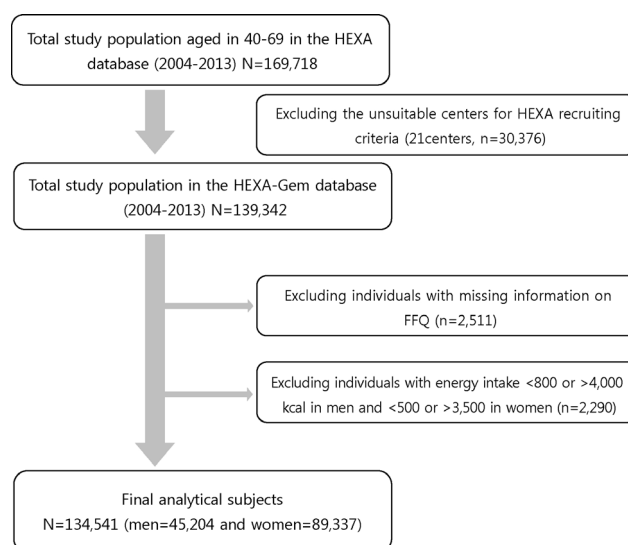


Fig. 1. Flow diagram of sample selection criteria: the HEXA-G study (2004-2013). HEXA, health examinees study; FFQ, food frequency questionnaire.

the food frequency questionnaire (FFQ) ($n = 2,511$) and who reported implausible energy intakes (outside the range of 800-4,000 kcal for men or 500-3,500 kcal for women, $n = 2,290$). A total of 134,541 subjects remained eligible (Fig. 1).

Mortality data were obtained from Statistics Korea by matching with HEXA-G subjects until December 2015. In total, 99.5% of the HEXA-G participants were successfully linked with mortality data.

Components of diet quality index for Koreans (DQI-K)

For the current study, DQI-K was developed based on the original DQI and a literature review. Among diet quality scores, the HEI, DQI, and HDI are widely used to examine the association between various outcomes and diet quality. The purpose of the HEI is to promote health guidelines, whereas the DQI and HEI were devised to assess health-related outcomes. The DQI-K has adapted the components of these indicators, which are based on American dietary recommendations, to the Korean model. The index is based on Korean dietary recommendations and dietary reference intakes for Koreans. As shown in Table 1, the DQI-K consists of eight components from the original DQI and replaces carbohydrates with whole grains.

The DQI-K is calculated based on eight components: 1) daily protein intake, 2) percent of energy from fat, 3) percent of energy from saturated fat, 4) daily cholesterol intake, 5) daily whole-grain intake, 6) daily fruit intake, 7) daily vegetable intake, and 8) daily sodium intake (Table 1). DQI-K scores of 0, 1, and 2 or 0 and 1 were assigned to each component, and scores for individual components were summed to determine each participant's overall DQI-K score, which ranged from 0 to 9; a lower DQI-K score reflects a higher quality diet.

Our subjects were divided into low DQI-K (total DQI-K score of 0-4) and high DQI-K (total DQI-K score of 5-9) groups. We further divided the DQI-K scores into four groups for detailed analysis (0-2, 3-4, 5-6, and 7-9).

Table 1. Components and cut-points in of DQI and DQI-K

DQI			DQI-K			
Components	Score	Cut-point	Components	Score	Cut-point	Construction of score
Daily protein intake	0	≤ 100% RDA1	Daily protein intake	0	≤ 100% RNI ¹⁾	KDRIs
	1	100-150% RDA		1	100-150% RNI ¹⁾	
	2	> 150% RDA		2	> 150% RNI ¹⁾	
Percent of energy from fat	0	≤ 30%	Percent of energy from fat	0	< 22.5%	KDRIs
	1	30-40%		1	≥ 22.5%	
	2	> 40%				
Percent of energy from saturated fat	0	≤ 10%	Percent of energy from saturated fat	0	< 7%	KDRIs
	1	10-13%		1	≥ 7%	
	2	> 13%				
Daily cholesterol intake	0	≤ 300 mg	Daily cholesterol intake	0	< 300 mg	Previous indices and KDRIs
	1	300-400 mg		1	≥ 300 mg	
	2	> 400 mg				
Daily of breads, cereals, and legumes	0	Starches and other complex CHO + 6 svg	Daily whole-grain intake	0	Daily	To divide consumer and non-consumer for rice with whole-grain
	1	4-5 svg		1	None	
	2	0-3 svg				
Daily of a combination of vegetables and fruits	0	5+ svg	Daily vegetables intake	0	≥ 200 g	Korean dietary HP 2020 for Koreans
	1	3-4 svg		1	< 200 g	
	2	0-2 svg				
Daily sodium intake	0	≤ 2,400 mg	Daily sodium intake	0	< 2,000 mg	KDRIs
	1	2,400-3,400 mg		1	≥ 2,000 mg	
	2	> 3,400 mg				
Adequate calcium intake	0	≥ DRI				
	1	2/3 DRI ≤ DRI				
	2	< 2/3 DRI				

DQI, diet quality index; DQI-K, diet quality index for Koreans; RDA, recommended daily allowance; RNI, recommended nutrition intake; CHO, carbohydrate; DRI, dietary reference intake; KDRIs, dietary reference intakes for Koreans.

¹⁾The RNI for protein among people aged < 65 years is 60 g for men and 50 g for women, ≥ 65 years is 55 g for men and 45 g for women.

Statistical analysis

Chi-square tests (for categorical variables) and linear regressions (for continuous variables) were used to analyze the selected characteristics of the study population based on DQI-K scores.

Person-months of follow-up were calculated from the enrollment date at recruitment until the date of death for cases or the last date of follow-up (December 31, 2015). To assess the association between the DQI-K and all-cause mortality, hazard ratios (HRs) and 95% confidence intervals (95% CI) were estimated via Cox proportional hazard regression models [21]. We tested the Cox proportional hazards assumption using visual evaluation of log[log(survival)] plots [22].

The first multivariable model was adjusted for age (continuous), gender, income (< 2,000,000 and ≥ 2,000,000 won), smoking (never and ever), alcohol drinking (never, past, and current), BMI (continuous, kg/m²), and total calories (continuous, kcal). We additionally analyzed the incidence of diabetes, which may have altered dietary habits.

All statistical analyses were performed using SAS statistical software version 9.4 (SAS Institute, Cary, NC). Statistical significance was determined as $P < 0.05$.

RESULTS

General characteristics

In our study, 2,165 subjects died during the 6.6-year follow-up period (1,309 men and 856 women). The mean age at enrolment was 53.6 years in men and 52.3 years in women.

The baseline characteristics of the study subjects are summarized in Table 2. In this study, subjects with high scores were more likely to have ever been smokers and drinkers, were less likely to be physically active, and more likely to have higher energy intake compared to those with low scores.

Association between the DQI-K and mortality in study participants

To compare diet quality, the participants were divided into two groups based on their DQI-K (scores 0-4 and 5-9). A high DQI-K score indicates poor diet quality. The associations between the DQI-K and mortality in the HEXA-G are shown in Table 3. Poor diet quality (score 5-9) was associated with an increased risk of all-cause mortality (HR = 1.22, 95% CI = 1.06-1.40; multivariable-adjusted HR = 1.31, 95% CI = 1.08-1.91). We also examined the DQI-K as a continuous variable and observed a 6% increase in multivariable-adjusted all-cause mortality (multivariable-adjusted HR = 1.06, 95% CI = 1.02-1.11). The highest DQI-K

Table 2. Selected characteristics by DQI-K, the Health Examinees-Gem (HEXA-G) study, 2004-2013

	DQI-K score										P-value ²⁾
	0	1	2	3	4	5	6	7	8	9	
N	623	7,635	36,172	42,951	29,761	11,413	4,263	1,417	288	18	
Age (yrs) ¹⁾	53.9 ± 7.1	53.5 ± 7.4	53.5 ± 7.8	53 ± 8	52.3 ± 8.1	51.2 ± 8.2	50.5 ± 8	49.5 ± 7.9	48.4 ± 7.8	50.6 ± 7.3	< .0001
BMI (kg/m ²) ¹⁾	23.4 ± 2.7	23.6 ± 2.8	23.8 ± 2.8	23.9 ± 2.9	24 ± 2.9	24 ± 3	24 ± 3	24.1 ± 3.1	24.4 ± 2.9	24.9 ± 2.8	< .0001
College or above, n (%) ¹⁾	179 (28.7)	1,952 (25.6)	8,551 (23.6)	10,439 (24.3)	7,733 (26.0)	3,190 (28.0)	1,275 (29.9)	459 (32.4)	93 (32.3)	5 (27.8)	< .0001
Income ≥ 2,000,000, n (%) ¹⁾	408 (65.5)	4,692 (61.5)	21,021 (58.1)	25,002 (58.2)	17,820 (59.9)	7,189 (63.0)	2,799 (65.7)	954 (67.3)	196 (68.1)	14 (77.8)	< .0001
Ever smokers, n (%) ¹⁾	98 (15.7)	1,191 (15.6)	8,182 (22.6)	11,418 (26.6)	8,600 (28.9)	3,415 (29.9)	1,423 (33.4)	572 (40.4)	137 (47.6)	9 (50.0)	< .0001
Ever drinkers, n (%) ¹⁾	222 (35.6)	2,917 (38.2)	16,006 (44.2)	20,748 (48.3)	15,459 (51.9)	6,174 (54.1)	2,447 (57.4)	877 (61.9)	202 (70.1)	15 (83.3)	< .0001
Regular exercisers, n (%) ¹⁾	413 (66.3)	4,569 (59.8)	19,900 (55.0)	22,421 (52.2)	15,278 (51.3)	5,828 (51.1)	2,174 (51.0)	670 (47.3)	122 (42.4)	7 (38.9)	< .0001
Energy intake (kcal) ¹⁾	1,427.4 ± 286.2	1,473.4 ± 340.2	1,495.9 ± 382.5	1,684.7 ± 432	1,911.8 ± 461.7	2,136.8 ± 494.1	2,272.2 ± 506.6	2,347.5 ± 495.7	2,413 ± 462.7	2,270.5 ± 529.9	< .0001

DQI-K, diet quality index for Koreans; BMI, body mass index.

¹⁾ Values are n (%) or mean ± SD.

²⁾ P-values for differences among DQI-K scores were calculated by chi-square tests for categorical variables and linear regression for continuous variables.

Table 3. Association between the DQI-K and mortality in the Health Examinees-Gem (HEXA-G), 2004-2013 (N = 134,541)

DQI-K	No. of death	Person-month	HR (95% CI) ¹⁾	HR (95% CI) ²⁾
0-4	1,888	9,279,711	Ref.	Ref.
5-9	277	1,381,992	1.15 (1.01-1.31)	1.23 (1.06-1.43)
1-unit increase (trend)	2,165	10,661,703	1.06 (1.02-1.10)	1.06 (1.02-1.11)

DQI-K, diet quality index for Koreans; HR, hazard ratios; CI, confidence interval.

¹⁾ Adjusted for age (continuous) HR

²⁾ Adjusted for age (continuous), gender, income (<2,000,000 and ≥ 2,000,000 won), smoking (never and ever), alcohol drinking (never, past, and current), body mass index (continuous, kg/m²), and total energy intake (continuous, kcal)

scores (7-9) were associated with an increased risk of mortality compared to the lowest scores (0-2) (multivariable-adjusted HR = 1.69, 95% CI = 1.15-2.48). Among the components of the DQI-K, the percentage of energy from fat was the most influential factor on the results.

We also conducted analyses to include the prevalence of diabetes into the first multivariable model, and this association was still significant (HR = 1.23, 95% CI = 1.06-1.43).

DISCUSSION

In the present study, the DQI-K was modified based on the original DQI as well as Korean dietary recommendations and dietary reference intakes for Koreans. In previous studies, older participants had higher diet quality than younger participants [23-28] and non-drinkers [26,29,30]. Regarding food intake, diet quality has been shown to be positively associated with consumption of fruits and vegetables [5,31,32]. Our findings, which parallel those of previous research, support that poor diet quality significantly increases the risk of all-cause mortality [9-13,15,33-37].

The DQI-K captures overall diet quality by reflecting the dietary patterns of the Korean population as well as variations within individual components. On the other hand, single diet component measures such as intake of daily cholesterol, high sodium consumption, and low fruit intake are limited in explaining overall diet behaviors.

This study has several limitations. One recognized limitation is that the dietary data were collected by a single FFQ at recruitment for assessment of overall diet quality. However, adult dietary patterns appear to remain relatively stable over time [38-43]. Although the FFQ cannot be used to evaluate the details of sodium intake in individuals, it is still used to measure sodium intake to assess its relationship to chronic diseases, especially in large epidemiologic studies. Further, the FFQ is a useful tool for measuring typical intakes of ingredients to assess their relationships with chronic diseases, especially in large epidemiologic studies [44]. Second, there is the probability of dietary measurement errors. However, we used an FFQ that has shown considerable validity and reliability [45]. Third, the subjects were asked about their dietary intake for the year preceding the diagnosis using the FFQ. Thus, measurement errors likely occurred due to poor recall despite the validity and reproducibility evidence of the questionnaire.

This study also has several strengths. The diet pattern of Koreans is distinct from those of Western and other Asian people. The DQI-K, which is based on the diet guidelines for Koreans, can serve as a simple scoring system that enables rapid

evaluation of an individual's diet quality. Additionally, scoring one's own diet quality can help increase awareness of the importance of a healthy diet. The DQI-K can also serve as a basis for education and counseling programs for those who need guidance. Other advantages of the present study include its prospective design with a sufficient number of subjects, which takes into account plausible confounders. This large prospective study supports the important effect that diet quality based on diet guidelines has on risk of mortality. Our results support the health benefits of compliance with diet guidelines to achieve improved health outcomes. Furthermore, the DQI-K and Dietary Reference Intakes for Koreans are closely interrelated and can be used to complement one another in establishing Korean diet guidelines.

In our study, poor diet quality (higher DQI-K scores) according to the DQI-K was associated with an increased risk of all-cause mortality. The DQI-K in the present study can be used to assess the diet quality of Koreans. It is possible to examine the effect of compliance with diet guidelines for Koreans on health outcomes using the DQI-K.

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CONFLICT OF INTEREST

The authors declare no potential conflicts of interests.

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REFERENCES

- Lachat C, Otchere S, Roberfroid D, Abdulai A, Seret FM, Milesevic J, Xuereb G, Candeias V, Kolsteren P. Diet and physical activity for the prevention of noncommunicable diseases in low- and middle-income countries: a systematic policy review. *PLoS Med* 2013;10: e1001465.

2. Basiotis PP, Guthrie JF, Bowman SA, Welsh SO. Construction and evaluation of a diet status index. *Fam Econ Rev* 1995;8:2-13.
3. Jacobs DR Jr, Steffen LM. Nutrients, foods, and dietary patterns as exposures in research: a framework for food synergy. *Am J Clin Nutr* 2003;78 Suppl:508S-513S.
4. Willett W. *Nutritional epidemiology*. Third edition. Oxford: Oxford University Press; 2013. p.ix, 529.
5. Patterson RE, Haines PS, Popkin BM. Diet quality index: capturing a multidimensional behavior. *J Am Diet Assoc* 1994;94:57-64.
6. Gil Á, Martínez de Victoria E, Olza J. Indicators for the evaluation of diet quality. *Nutr Hosp* 2015;31 Suppl 3:128-44.
7. McCullough ML, Feskanich D, Stampfer MJ, Giovannucci EL, Rimm EB, Hu FB, Spiegelman D, Hunter DJ, Colditz GA, Willett WC. Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am J Clin Nutr* 2002;76: 1261-71.
8. Wroblewski MM, Parker EA, Hurley KM, Oberlander S, Merry BC, Black MM. Comparison of the HEI and HEI-2010 diet quality measures in association with chronic disease risk among low-income, African American urban youth in Baltimore, Maryland. *J Am Coll Nutr* 2018;37:201-8.
9. Osler M, Schroll M. Diet and mortality in a cohort of elderly people in a north European community. *Int J Epidemiol* 1997;26:155-9.
10. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, Gnardellis C, Lagiou P, Polychronopoulos E, Vassilakou T, Lipworth L, Trichopoulos D. Diet and overall survival in elderly people. *BMJ* 1995;311:1457-60.
11. Russell J, Flood V, Rochtchina E, Gopinath B, Allman-Farinelli M, Bauman A, Mitchell P. Adherence to dietary guidelines and 15-year risk of all-cause mortality. *Br J Nutr* 2013;109:547-55.
12. Huijbregts P, Feskens E, Räsänen L, Fidanza F, Nissinen A, Menotti A, Kromhout D. Dietary pattern and 20 year mortality in elderly men in Finland, Italy, and The Netherlands: longitudinal cohort study. *BMJ* 1997;315:13-7.
13. Knuops KT, Groot de LC, Fidanza F, Alberti-Fidanza A, Kromhout D, van Staveren WA. Comparison of three different dietary scores in relation to 10-year mortality in elderly European subjects: the HALE project. *Eur J Clin Nutr* 2006;60:746-55.
14. Reedy J, Krebs-Smith SM, Miller PE, Liese AD, Kahle LL, Park Y, Subar AF. Higher diet quality is associated with decreased risk of all-cause, cardiovascular disease, and cancer mortality among older adults. *J Nutr* 2014;144:881-9.
15. Buckland G, Agudo A, Travier N, Huerta JM, Cirera L, Tormo MJ, Navarro C, Chirlaque MD, Moreno-Iribas C, Ardanaz E, Barricarte A, Etxeberria J, Marin P, Quirós JR, Redondo ML, Larrañaga N, Amiano P, Dorronsoro M, Arriola L, Basterretxea M, Sanchez MJ, Molina E, González CA. Adherence to the Mediterranean diet reduces mortality in the Spanish cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC-Spain). *Br J Nutr* 2011;106:1581-91.
16. Schwingshackl L, Bogensberger B, Hoffmann G. Diet quality as assessed by the healthy eating index, alternate healthy eating index, dietary approaches to stop hypertension score, and health outcomes: an updated systematic review and meta-analysis of cohort studies. *J Acad Nutr Diet* 2018;118:74-100.e11.
17. Yun S, Kim HJ, Oh K. Trends in energy intake among Korean adults, 1998-2015: results from the Korea National Health and Nutrition Examination Survey. *Nutr Res Pract* 2017;11:147-54.
18. Health Examinees Study Group. The Health Examinees (HEXA) study: rationale, study design and baseline characteristics. *Asian Pac J Cancer Prev* 2015;16:1591-7.
19. Kim Y, Han BG; KoGES group. Cohort profile: The Korean Genome and Epidemiology Study (KoGES) consortium. *Int J Epidemiol* 2016;46:1350.
20. Shin S, Lee HW, Kim CE, Lim J, Lee JK, Lee SA, Kang D. Egg consumption and risk of metabolic syndrome in Korean adults: results from the Health Examinees Study. *Nutrients* 2017;9:E687.
21. Kom EL, Graubard BI, Midthune D. Time-to-event analysis of longitudinal follow-up of a survey: choice of the time-scale. *Am J Epidemiol* 1997;145:72-80.
22. Hess KR. Graphical methods for assessing violations of the proportional hazards assumption in Cox regression. *Stat Med* 1995;14: 1707-23.
23. McNaughton SA, Ball K, Crawford D, Mishra GD. An index of diet and eating patterns is a valid measure of diet quality in an Australian population. *J Nutr* 2008;138:86-93.
24. Shannon J, Shikany JM, Barrett-Connor E, Marshall LM, Bunker CH, Chan JM, Stone KL, Orwoll E; Osteoporotic Fractures in Men (MrOS) Research Group. Demographic factors associated with the diet quality of older US men: baseline data from the Osteoporotic Fractures in Men (MrOS) study. *Public Health Nutr* 2007;10:810-8.
25. Reeves MM, Healy GN, Owen N, Shaw JE, Zimmet PZ, Dunstan DW. Joint associations of poor diet quality and prolonged television viewing time with abnormal glucose metabolism in Australian men and women. *Prev Med* 2013;57:471-6.
26. Tobias DK, Hu FB, Chavarro J, Rosner B, Mozaffarian D, Zhang C. Healthful dietary patterns and type 2 diabetes mellitus risk among women with a history of gestational diabetes mellitus. *Arch Intern Med* 2012;172:1566-72.
27. InterAct Consortium. Adherence to predefined dietary patterns and incident type 2 diabetes in European populations: EPIC-InterAct Study. *Diabetologia* 2014;57:321-33.
28. Azadbakht L, Mirmiran P, Esmailzadeh A, Azizi F. Dietary diversity score and cardiovascular risk factors in Tehranian adults. *Public Health Nutr* 2006;9:728-36.
29. George SM, Ballard-Barbash R, Manson JE, Reedy J, Shikany JM, Subar AF, Tinker LF, Vitolins M, Neuhauser ML. Comparing indices of diet quality with chronic disease mortality risk in postmenopausal women in the Women's Health Initiative Observational Study: evidence to inform national dietary guidance. *Am J Epidemiol* 2014;180:616-25.
30. Fung TT, McCullough M, van Dam RM, Hu FB. A prospective study of overall diet quality and risk of type 2 diabetes in women. *Diabetes Care* 2007;30:1753-7.
31. Verger EO, Mariotti F, Holmes BA, Paineau D, Huneau JF. Evaluation of a diet quality index based on the probability of adequate nutrient intake (PANDiet) using national French and US dietary surveys. *PLoS One* 2012;7:e42155.
32. Osler M, Heitmann BL, Gerdes LU, Jørgensen LM, Schroll M. Dietary patterns and mortality in Danish men and women: a prospective observational study. *Br J Nutr* 2001;85:219-25.
33. Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *Am J Clin Nutr* 1993;57:434-40.
34. Kant AK, Schatzkin A, Graubard BI, Schairer C. A prospective study of diet quality and mortality in women. *JAMA* 2000;283:2109-15.
35. Seymour JD, Calle EE, Flagg EW, Coates RJ, Ford ES, Thun MJ. Diet quality index as a predictor of short-term mortality in the American

- Cancer Society Cancer Prevention Study II Nutrition Cohort. *Am J Epidemiol* 2003;157:980-8.
36. Sjögren P, Becker W, Warensjö E, Olsson E, Byberg L, Gustafsson IB, Karlström B, Cederholm T. Mediterranean and carbohydrate-restricted diets and mortality among elderly men: a cohort study in Sweden. *Am J Clin Nutr* 2010;92:967-74.
 37. Jankovic N, Geelen A, Streppel MT, de Groot LC, Orfanos P, van den Hooven EH, Pikhart H, Boffetta P, Trichopoulou A, Bobak M, Bueno-de-Mesquita HB, Kee F, Franco OH, Park Y, Hallmans G, Tjønneland A, May AM, Pajak A, Malyutina S, Kubinova R, Amiano P, Kampman E, Feskens EJ. Adherence to a healthy diet according to the World Health Organization guidelines and all-cause mortality in elderly adults from Europe and the United States. *Am J Epidemiol* 2014;180:978-88.
 38. Jain M, Howe GR, Harrison L, Miller AB. A study of repeatability of dietary data over a seven-year period. *Am J Epidemiol* 1989;129:422-9.
 39. Jensen OM, Wahrendorf J, Rosenqvist A, Geser A. The reliability of questionnaire-derived historical dietary information and temporal stability of food habits in individuals. *Am J Epidemiol* 1984;120:281-90.
 40. Lindsted KD, Kuzma JW. Long-term (24-year) recall reliability in cancer cases and controls using a 21-item food frequency questionnaire. *Nutr Cancer* 1989;12:135-49.
 41. Mursu J, Steffen LM, Meyer KA, Duprez D, Jacobs DR Jr. Diet quality indexes and mortality in postmenopausal women: the Iowa Women's Health Study. *Am J Clin Nutr* 2013;98:444-53.
 42. Sijtsma FP, Meyer KA, Steffen LM, Shikany JM, Van Horn L, Harnack L, Kromhout D, Jacobs DR Jr. Longitudinal trends in diet and effects of sex, race, and education on dietary quality score change: the Coronary Artery Risk Development in Young Adults study. *Am J Clin Nutr* 2012;95:580-6.
 43. Thompson FE, Metzner HL, Lamphiear DE, Hawthorne VM. Characteristics of individuals and long term reproducibility of dietary reports: the Tecumseh Diet Methodology Study. *J Clin Epidemiol* 1990;43:1169-78.
 44. Strazzullo P, D'Elia L, Kandala NB, Cappuccio FP. Salt intake, stroke, and cardiovascular disease: meta-analysis of prospective studies. *BMJ* 2009;339:b4567.
 45. Ahn Y, Kwon E, Shim JE, Park MK, Joo Y, Kimm K, Park C, Kim DH. Validation and reproducibility of food frequency questionnaire for Korean genome epidemiologic study. *Eur J Clin Nutr* 2007;61:1435-41.