Published in final edited form as:

J Am Coll Nutr. 2016 ; 35(3): 217–223. doi:10.1080/07315724.2014.971193.

Ready-to-Eat Cereal Consumption with Total and Cause-Specific Mortality: Prospective Analysis of 367,442 Individuals

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Abstract

Background—Intakes of ready-to-eat cereal (RTEC) have been inversely associated with risk factors of chronic diseases such as cardiovascular disease (CVD), type 2 diabetes, and certain cancers; however, their relations with total and cause-specific mortality remain unclear.

Objective—To prospectively assess the associations of RTEC intakes with all causes and disease-specific mortality risk.

Design—The study included 367,442 participants from the prospective National Institutes of Health (NIH)–AARP Diet and Health Study. Intakes of RTEC were assessed at baseline.

Results—Over an average of 14 years of follow-up, 46,067 deaths were documented. Consumption of RTEC was significantly associated with reduced risk of mortality from all-cause mortality and death from CVD, diabetes, all cancer, and digestive cancer (all p for trend < 0.05). In multivariate models, compared to nonconsumers of RTEC, those in the highest intake of RTEC had a 15% lower risk of all-cause mortality and 10%–30% lower risk of disease-specific mortality. Within RTEC consumers, total fiber intakes were associated with reduced risk of mortality from all-cause mortality and deaths from CVD, all cancer, digestive cancer, and respiratory disease (all p for trend < 0.005).

Conclusions—Consumption of RTEC was associated with reduced risk of all-cause mortality and mortality from specific diseases such as CVD, diabetes, and cancer. This association may be mediated via greater fiber intake.

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Clinical Trial Registration Information: [ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT00340015) number NCT00340015.

Author Contributions

The authors' responsibilities were as follows: S.C. and L.Q. designed the research; A.L., M.X., T.H., S.C., and L.Q. conducted the research; S.C. and L.Q. analyzed data; L.Q. wrote the article; S.C. and A.L. provided materials; L.Q. had primary responsibility for the final content of the article; and all authors read and approved the final article.

Conflict of Interest

L. Qi declares funding from NutraSource. No other authors declare a conflict of interest.

Keywords

ready-to-eat cereals; fiber; CVD; mortality

INTRODUCTION

Ready-to-eat cereals (RTECs) are major sources of dietary fiber (mainly cereal fiber) and other nutrients, such as minerals and antioxidants [1, 2], which have shown beneficial effects on human health, such as improvement of weight loss and lipid profile, as well as inhibition of systemic inflammation [3–6]. In epidemiology studies, consumption of RTEC or cereal fiber has been associated with reduced levels of a variety of risk factors for cardiovascular disease (CVD), type 2 diabetes, and certain cancers [4, 7–12]. In addition, breakfast cereal intake has been associated with reduced mortality in American males [13]. In our recent analyses, we found that intake of cereal fiber (fiber from grains) was inversely related to all-cause mortality and death from cancer, CVD, infectious disease, and respiratory disease in the study cohort (L.Q. et al., <http://www.biomedcentral.com/1741-7015/13/59>). However, few studies have comprehensively assessed the associations between RTEC intake and total or cause-specific mortality, especially in large prospective cohorts.

In the present study, we used data from a large-scale cohort, the National Institutes of Health (NIH)–AARP Diet and Health Study ([ClinicalTrials.gov](https://clinicaltrials.gov) number, NCT00340015) and prospectively examined the associations of RTEC intakes with risk of all-cause mortality and mortality from CVD, type 2 diabetes, cancers, and other chronic diseases in U.S. men and women. We also analyzed the associations between RTEC intakes and mortality according to fiber intakes in RTEC consumers.

METHODS

Study Population

The NIH–AARP Diet and Health Study included 566,399 AARP members aged 50 to 71 years from 6 U.S. states (California, Florida, Louisiana, New Jersey, North Carolina, and Pennsylvania) and 2 metropolitan areas (Atlanta, Georgia, and Detroit, Michigan). Participants responded to questionnaires mailed in October 1995 and December 1997. Details of the NIH–AARP Study have been previously described [14]. Among participants who returned the questionnaires with satisfactory dietary data, we excluded individuals who indicated that they were proxies for the intended respondent ($n = 15,760$) as well as those who had cancer ($n = 50,591$), heart disease ($n = 80,254$), stroke ($n = 12,812$), diabetes ($n = 52,647$), or self-reported end-stage renal disease at baseline ($n = 1,299$). We also excluded those who reported extreme consumption (>2 times the interquartile ranges of Box-Cox transformed intake) of total energy ($n = 3771$) and dietary fiber ($n = 3324$). After exclusions ($n = 198,957$), the analytic cohort included 367,442 individuals. The NIH–AARP Diet and Health study was approved by the Special Studies Institutional Review Board of the U.S. National Cancer Institute.

Assessment of Exposure

At baseline, dietary intakes were assessed with a self-administered 124-item food frequency questionnaire, which was an early version of the Diet History Questionnaire developed at the National Cancer Institute [15]. Participants were asked to report their usual frequency of intake and portion size over the past 12 months using 10 predefined frequency categories ranging from never to 6+ times per day for beverages and from never to 2+ times per day for solid foods with 3 categories of portion size. The food items, portion sizes, and nutrient database were constructed using the U.S. Department of Agriculture's 1994–1996 Continuing Survey of Food Intakes by Individuals [16].

The nutrient database for dietary fiber was based on AOAC method 991.43 [17]. In specifying numbers of deaths by intake quartile, the number of deaths is determined by the energy-adjusted intake quartile for the entire population; when deaths are specific to a sex, we used the quartiles within the sex. We also collected demographic, anthropometric, and lifestyle information, including history of smoking, physical activity, family history of cancers, menopausal hormone therapy use in women, and some medical conditions at baseline.

The performance of the food frequency questionnaire was evaluated by using 2 nonconsecutive 24-hour recalls among a subgroup of the cohort consisting of 2053 persons. According to evaluation on 26 nutrients, when adjusted for reported energy intake, performance improved; estimated correlations with true intake ranged from 0.36 to 0.76 [18].

Ascertaining Mortality

The AARP data set denotes date of death (dod) and cause of death (cod). There are 22 broad categories for cod. Subcategories, such as digestive system, female breast, and prostate cancer, can be identified by underlying *International Classification of Diseases* (ICD) codes. The dod field is completed through 2009, with some dods entered after 2009. The cod field is complete through 2008, with some cods entered after 2008. Most cod and dod values were not entered simultaneously after 2008. Some cod values are missing for dods in 2008 or earlier. The modeling analysis for specific causes of death is done with the study end date of 2008. For total mortality, we did models for study end dates in 2008 and 2009. Subjects with dod after the study's end date are treated as alive at the end of the study, with no death or cause of death in the model. When the study end date is 2008 and there is a dod but no cod for 2008 or earlier, the subject is not included in the modeling for cod but only total mortality. Thus, when specifying numbers of deaths it depends on both the study end date and whether the cod field is missing.

We determined vital status through a periodic linkage of the cohort to the Social Security Administration Death Master File and follow-up searches of the National Death Index Plus for participants who matched the Social Security Administration Death Master File, cancer registry linkage, questionnaire responses, and responses to other mailings. We used the *International Classification of Diseases*, Ninth Revision, and the *International Statistical Classification of Diseases*, 10th Revision to define death as follows: cancer (ICD-9, 140–

239; ICD-10, C00–C97 and D00–D48), heart disease (ICD-9, 390–398, 401–404, 410–429, and 440–448; ICD-10, I00–I13, I20–I51, and I70–I78), stroke (ICD-9, 430–438; ICD-10, I60–I69), infections (ICD-9, 001–139; ICD-10, A00–B99), diabetes (ICD-9, 250; ICD-10, E10–E14), respiratory disease (ICD-9, 480–487 and 490–496; ICD-10, J10–J18 and J40–J47), and all other causes. CVD death included death from heart disease and stroke.

Statistical Analysis

We used the Cox proportional hazards model to estimate hazard ratios (HRs) and 2-sided 95% confidence intervals (CIs) using the SAS PROC PHREG procedure (Version 9.1; SAS Institute Inc., Cary, NC). Person-years of follow-up were calculated from the date of the baseline questionnaire until the date of death or the end of follow-up (December 31, 2009), whichever occurred first. We evaluated the proportional hazards assumption and confirmed it by modeling interaction terms consisting of the cross product of time and dietary RTEC intake. Because there was no statistically significant interaction by sex ($p > 0.05$), we primarily reported data from the combined cohort. Intakes of RTEC and fiber were adjusted for total energy intake using the residual method [16] and were categorized into quartiles. We estimated the HRs for quartiles of dietary RTEC or fiber intake. We presented an age-adjusted model and 2 multivariate models. Multivariate model 1 was adjusted for age, gender, smoking status, smoking dose, and time since quitting smoking. In multivariate model 2, we also adjusted for race/ethnicity, education, marital status, self-rated health status, body mass index, physical activity, use of menopausal hormone therapy, and intake of alcohol, red meat, fruits, vegetables, and total energy. For missing data in each covariate, we created indicator variables. Generally, missing data was less than 5%. The model results summary includes the results of statistical tests for trend in the response for the risk variable. Quartiles trend p denotes the p value when the median value within the risk variable quartile is included in the hazard model as linear.

RESULTS

Table 1 shows baseline characteristics of study participants ($N = 367,442$). During an average of 14 years of follow-up (total person-years, 5,148,760), we documented 46,067 deaths, among which 11,283 were from CVD; 19,043 were from cancer, 371 were from diabetes, 3796 were from respiratory disease, 922 were from infection, and 5223 were from other causes. At baseline, intakes of RTEC were inversely correlated with prevalence of overweight, obesity, and current smoking as well as intake of red meat. The levels of moderate and vigorous physical activity were higher among participants with higher intakes of RTEC than those with lower intakes.

RTEC Intake with Total Mortality

In age-adjusted analysis, we found that intake of RTEC was inversely associated with all-cause mortality (p for trend < 0.0001 ; Table 2). Compared to nonconsumers of RTEC, the HRs (95% CI) across increasing quartiles of RTEC intake were 0.94 (0.91–0.97), 0.85 (0.82–0.87), 0.75 (0.72–0.77), and 0.67 (0.65–0.69). Further adjustment for gender and smoking status and time since quitting smoking (model 1) did not appreciably change the results. In multivariate analysis (model 2) with additional adjustment for race/ethnicity,

education, marital status, self-rated health status, obesity (underweight, overweight, and obesity), physical activity, use of menopausal hormone therapy, and intake of alcohol, red meat, fruits, vegetables, and total energy (model 2), the HRs (95% CIs) across increasing quartiles of RTEC were 0.94 (0.92–0.97), 0.92 (0.89–0.95), 0.88 (0.86–0.91), and 0.85 (0.83–0.88) compared to nonconsumers (p for trend < 0.0001). Within RTEC consumers, total fiber intake was significantly related to reduced risk of total mortality (multivariate-adjusted p for trend < 0.0001). Compared to the lowest quartile, total mortality was reduced by 14% in the highest consumers of total fiber (Table 3).

RTEC Intake with Cause-Specific Mortality

We next tested the associations for cause-specific mortalities. In multivariate-adjusted analyses (model 2), intakes of RTEC were inversely associated with risk of deaths from CVD, diabetes, all cancer, and digestive cancer (all p for trend < 0.05 ; Table 2). Compared to nonconsumers of RTEC, people in the highest quartile of RTEC intake had 10% (all cancer) to 30% (type 2 diabetes) reduced risk of mortality. Within RTEC consumers, consumption of total fiber was significantly associated with reduced risks of deaths from CVD, all cancer, digestive cancer, respiratory disease (all multivariate-adjusted p for trend < 0.005 ; Table 3).

DISCUSSION

In this large prospective cohort study of U.S. population, we found significant inverse associations between intakes of RTEC with risk of all-cause mortality and from CVD, type 2 diabetes, cancer, and respiratory and infectious disease. Compared to individuals with the lowest intake of RTEC, those in the highest intake group had a 15% lower risk of all-cause mortality and 10%–30% lower risk of disease-specific mortality. Breakfast cereal intake was inversely associated with total and CVD-specific mortality [13]. Previous reports also found that cereal fiber intake was related to all-cause and cause-specific mortality (cancer, CVD, respiratory and infectious disease) [10, 20]. This is the first time that consumption of RTEC, as a whole, has been demonstrated to be associated with lower risks of total mortality and deaths from CVD, diabetes, cancer, and other chronic diseases.

To the best of our knowledge, the present study included thus far the largest number of deaths in a prospective setting. Our findings are concordant with previously observed protective effects of RTEC intake on risk factors for CVD, diabetes, and certain cancers [2, 21–24]. In several epidemiological studies, intake of RTEC has also been related to weight control [22, 25], which may be linked to lower risks of CVD, diabetes, and cancer. In a previous analysis among our study samples, we found that intake of cereal fiber (fiber from grains) was inversely related to all-cause mortality and death from cancer, CVD, infectious disease, and respiratory disease (L.Q. et al., <http://www.biomedcentral.com/1741-7015/13/59>). In the present study, we found that within RTEC consumers, high fiber intake showed more protective effects against total mortality and deaths from CVD, all cancer, digestive cancer, and respiratory disease. The data suggest contents of fiber in RTEC may play a key role in contributing to the observed protective effects.

Our study has several limitations that deserve mention. RTEC intakes were evaluated by self-report at a single time point. It is likely dietary habits might change during the 14 years of follow-up period, and such temporal patterns were not reflected in our analysis. However, the measurement errors might bias the associations toward null. Similar to other analyses in existing cohorts, confounding due to correlations between RTEC consumption and other lifestyle and social economic factors might influence the associations. However, we have carefully adjusted for the dietary, lifestyle, and social economic covariates in analyses, though we are aware that unmeasured variables might still affect our analyses. The presented analysis was not a preplanned goal of the cohort, which may increase the possibility that the results reflect type I error. Moreover, the observational nature of our study limits causality inference between intake of RTEC and mortality, and randomized controlled trials are needed to justify the causality.

In summary, data from our study indicate that intake of RTEC may reduce the risk of all-cause mortality and death from chronic diseases such as CVD, diabetes, and cancer. Within RTEC consumers, high fiber intake showed more protective effects against all-cause mortality and death from chronic diseases, suggesting that cereal fiber may play a role in RTEC actions. The findings lend support to recommendation of increased consumption of RTEC, in particular cereal fiber-rich RTEC, to prevent chronic disease and optimize human health.

Acknowledgments

We thank all of the participants in the NIH–AARP study. We also thank Dr. YiKyung Park at the National Cancer Institute for her guidance throughout the study and Dr. David Hasza for statistical assistance.

FUNDING

This study is funded by an unrestricted research fund from NutraSource. Dr. Qi was supported by grants from the National Heart, Lung, and Blood Institute (HL071981), the National Institute of Diabetes and Digestive and Kidney Diseases (DK091718), the Boston Obesity Nutrition Research Center (DK46200), and United States–Israel Binational Science Foundation Grant 2011036. Dr. Qi was a recipient of the American Heart Association Scientist Development Award (0730094N).

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Table 1

Baseline Clinical Characteristics of the Participants

	Total Population	Nonconsumer of RTEC	RTEC Consumers			
			Q1	Q2	Q3	Q4
Subjects	367,442	51,352	79,022	79,023	79,022	79,023
Age (mean years)	61.66	61.60	60.98	61.49	62.01	62.23
Male (%)	56.13	57.80	51.97	54.67	56.10	60.70
Race						
White (%)	92.94	89.72	90.22	92.76	94.64	96.18
Black (%)	3.59	4.64	5.30	3.83	2.78	1.77
Other (%)	3.48	5.64	4.48	3.41	2.58	2.04
Education						
<High school (%)	5.35	6.16	6.21	5.57	4.92	4.20
High school grad (%)	29.86	29.87	31.18	30.57	29.74	27.95
Some college (%)	23.80	24.21	25.15	24.65	23.58	21.58
College grad (%)	40.98	39.75	37.45	39.21	41.76	46.28
Married (%)	68.09	64.50	65.84	68.18	69.80	70.87
Physical activity low (%)	31.04	34.70	36.15	31.57	27.57	26.54
1–2 Times/week (%)	22.47	20.94	22.57	23.67	22.83	21.81
3–4 Times/week (%)	27.30	24.35	24.29	27.32	29.55	29.94
5 Times/week (%)	19.18	20.02	16.99	17.44	20.05	21.70
BMI						
<18.5 (%)	1.10	1.57	1.14	0.97	0.95	1.04
18.5–25 (%)	36.95	39.47	34.94	33.77	36.70	40.77
25–30 (%)	42.37	41.15	41.38	42.60	43.35	42.92
30 (%)	19.58	17.81	22.54	22.66	19.00	15.26
Health status						
Excellent (%)	21.21	22.41	19.85	19.55	21.08	23.58
Very good (%)	40.17	38.29	38.94	40.07	41.36	41.55
Good (%)	31.74	31.59	33.20	33.19	31.22	29.43
Fair (%)	6.23	6.94	7.24	6.50	5.75	4.96

	Total Population	Nonconsumer of RTEC	RTEC Consumers			
			Q1	Q2	Q3	Q4
Poor (%)	0.65	0.77	0.77	0.69	0.59	0.48
Energy intake (kcal/d)	1805.56	1745.07	1860.51	1879.43	1893.74	1627.85
Alcohol intake (g/d)	14.74	20.83	18.52	14.42	13.06	8.99
Red meat intake (oz/d)	1.99	2.08	2.21	2.15	2.00	1.52
Total fruit intake (cup eq/d)	1.99	1.89	1.87	2.02	2.16	2.00
Total vegetable intake (cup eq/d)	1.92	1.94	1.97	2.00	2.00	1.69

RTEC = ready-to-eat cereal, BMI = body mass index.

Table 2

Hazard Ratios of Mortality According to Intakes of RTEC^a

	Nonconsumers of RTEC	RTEC Consumers				p Trend
		Q1	Q2	Q3	Q4	
RTEC (g/d)	0.0	0.67	3.48	9.33	22.48	
All-cause mortality						
No. of deaths	7686	10,394	9965	9318	8704	
Age adjusted	1.00	0.94 (0.91, 0.97)	0.85 (0.82, 0.87)	0.75 (0.72, 0.77)	0.67 (0.65, 0.69)	<0.0001
Model 1	1.00	0.94 (0.91, 0.97)	0.90 (0.87, 0.93)	0.84 (0.82, 0.87)	0.80 (0.77, 0.82)	<0.0001
Model 2	1.00	0.94 (0.92, 0.97)	0.92 (0.89, 0.95)	0.88 (0.86, 0.91)	0.85 (0.83, 0.88)	<0.0001
CVD mortality						
No. of deaths	1960	2488	2492	2328	2015	<0.0001
Age adjusted	1.00	0.90 (0.85, 0.96)	0.84 (0.79, 0.89)	0.73 (0.68, 0.77)	0.60 (0.56, 0.63)	<0.0001
Model 1	1.00	0.90 (0.85, 0.95)	0.88 (0.83, 0.94)	0.81 (0.76, 0.86)	0.70 (0.66, 0.75)	<0.0001
Model 2	1.00	0.90 (0.85, 0.95)	0.90 (0.85, 0.95)	0.86 (0.81, 0.91)	0.76 (0.71, 0.81)	<0.0001
Diabetes mortality						
No. of deaths	113	79	100	75	50	
Age adjusted	1.00	0.98 (0.70, 1.38)	1.16 (0.84, 1.61)	0.95 (0.68, 1.32)	0.52 (0.36, 0.77)	<0.0001
Model 1	1.00	0.98 (0.69, 1.37)	1.20 (0.87, 1.67)	1.01 (0.72, 1.42)	0.58 (0.39, 0.85)	<0.001
Model 2	1.00	0.96 (0.68, 1.36)	1.22 (0.87, 1.69)	1.14 (0.81, 1.61)	0.70 (0.47, 1.03)	<0.05
All cancer mortality						
No. of deaths	3043	4393	4105	3863	3639	
Age adjusted	1.00	0.99 (0.95, 1.04)	0.88 (0.84, 0.92)	0.79 (0.75, 0.82)	0.71 (0.68, 0.75)	<0.0001
Model 1	1.00	0.99 (0.94, 1.04)	0.94 (0.90, 0.99)	0.90 (0.86, 0.94)	0.86 (0.82, 0.91)	<0.0001
Model 2	1.00	0.98 (0.94, 1.03)	0.95 (0.90, 0.99)	0.92 (0.88, 0.97)	0.90 (0.86, 0.95)	<0.0001
Digestive cancer mortality						
No. of deaths	721	1035	1037	982	895	
Age adjusted	1.00	1.00 (0.91, 1.10)	0.94 (0.86, 1.04)	0.84 (0.77, 0.93)	0.73 (0.67, 0.81)	<0.0001
Model 1	1.00	1.00 (0.91, 1.10)	0.97 (0.89, 1.07)	0.90 (0.82, 0.99)	0.81 (0.73, 0.89)	<0.0001
Model 2	1.00	1.00 (0.91, 1.10)	1.00 (0.91, 1.10)	0.95 (0.86, 1.05)	0.87 (0.79, 0.97)	<0.001
Respiratory disease mortality						

	Nonconsumers of RTEC	RTEC Consumers				p Trend
		Q1	Q2	Q3	Q4	
No. of deaths	1114	1539	1343	1161	1026	
Age adjusted	1.00	0.95 (0.88, 1.03)	0.79 (0.73, 0.85)	0.64 (0.59, 0.70)	0.55 (0.50, 0.60)	<0.0001
Model 1	1.00	0.94 (0.87, 1.02)	0.90 (0.84, 0.98)	0.87 (0.80, 0.94)	0.74 (0.67, 0.82)	<0.0001
Model 2	1.00	0.95 (0.88, 1.03)	0.94 (0.87, 1.02)	0.91 (0.84, 0.99)	0.91 (0.83, 0.99)	0.06
Infectious disease						
No. of deaths	56	79	100	86	197	
Age adjusted	1.00	0.96 (0.78, 1.18)	0.78 (0.63, 0.97)	0.71 (0.57, 0.88)	0.76 (0.62, 0.94)	<0.01
Model 1	1.00	0.95 (0.77, 1.17)	0.81 (0.66, 1.01)	0.77 (0.62, 0.96)	0.86 (0.70, 1.07)	NS
Model 2	1.00	0.97 (0.79, 1.20)	0.85 (0.68, 1.06)	0.84 (0.68, 1.05)	0.97 (0.78, 1.21)	NS

RTEC = ready-to-eat cereal, CVD = cardiovascular disease.

^aMultivariate model 1: adjusted for age, gender, smoking status, smoking dose, and time since quitting smoking. Multivariate model 2, adjusted for covariates in model 1 and race/ethnicity, education, marital status, self-rated health status, body mass index, physical activity, use of menopausal hormone therapy, and intake of alcohol, red meat, fruits, vegetables, and total energy.

Table 3
Hazard Ratios of Mortality According to Fiber Intake (in Quartiles) within RTEC Consumers^a

	Q1	Q2	Q3	Q4	P
Fiber intake (g/d)	9.54	15.50	19.1	26.2	
All-cause mortality					
No. of deaths	12,428	9676	8368	7909	
Age adjusted	1.00	0.74 (0.72, 0.76)	0.62 (0.61, 0.64)	0.58 (0.56, 0.59)	<0.0001
Model 1	1.00	0.88 (0.86, 0.90)	0.80 (0.78, 0.82)	0.78 (0.76, 0.80)	<0.0001
Model 2	1.00	0.93 (0.91, 0.96)	0.88 (0.85, 0.91)	0.86 (0.82, 0.89)	<0.0001
CVD mortality					
No. of deaths	3007	2379	2032	1905	
Age adjusted	1.00	0.76 (0.72, 0.80)	0.63 (0.60, 0.67)	0.75 (0.72, 0.77)	<0.0001
Model 1	1.00	0.89 (0.84, 0.94)	0.80 (0.75, 0.85)	0.84 (0.82, 0.87)	<0.0001
Model 2	1.00	0.95 (0.89, 1.01)	0.87 (0.82, 0.94)	0.88 (0.86, 0.91)	<0.0001
Diabetes mortality					
No. of deaths	103	91	58	63	
Age adjusted	1.00	0.86 (0.65, 1.14)	0.54 (0.39, 0.87)	0.57 (0.41, 0.78)	<0.0001
Model 1	1.00	0.94 (0.70, 1.25)	0.61 (0.44, 0.85)	0.66 (0.48, 0.92)	<0.01
Model 2	1.00	1.04 (0.76, 1.43)	0.74 (0.51, 1.09)	0.87 (0.56, 1.35)	NS
All cancer mortality					
No. of deaths	5167	3982	3513	3338	
Age adjusted	1.00	0.74 (0.71, 0.77)	0.64 (0.61, 0.66)	0.59 (0.57, 0.62)	<0.0001
Model 1	1.00	0.89 (0.85, 0.93)	0.84 (0.80, 0.88)	0.83 (0.79, 0.87)	<0.0001
Model 2	1.00	0.93 (0.89, 0.98)	0.90 (0.86, 0.95)	0.90 (0.85, 0.96)	<0.005
Digestive cancer mortality					
No. of deaths	1197	992	880	880	
Age adjusted	1.00	0.82 (0.75, 0.89)	0.71 (0.65, 0.78)	0.70 (0.64, 0.77)	<0.0001
Model 1	1.00	0.89 (0.82, 0.97)	0.81 (0.74, 0.89)	0.82 (0.75, 0.90)	<0.0001
Model 2	1.00	0.91 (0.82, 0.99)	0.83 (0.75, 0.93)	0.83 (0.73, 0.94)	<0.005
Respiratory disease mortality					
No. of deaths	2026	1295	931	817	

	Q1	Q2	Q3	Q4	<i>p</i>
Age adjusted	1.00	0.60 (0.56, 0.65)	0.42 (0.39, 0.45)	0.36 (0.33, 0.39)	<0.0001
Model 1	1.00	0.90 (0.84, 0.97)	0.78 (0.72, 0.84)	0.78 (0.72, 0.85)	<0.0001
Model 2	1.00	0.96 (0.89, 1.04)	0.87 (0.79, 0.95)	0.90 (0.80, 1.01)	<0.005
Infectious disease					
No. of deaths	250	191	176	152	
Age adjusted	1.00	0.71 (0.58, 0.85)	0.62 (0.51, 0.76)	0.53 (0.43, 0.65)	<0.0001
Model 1	1.00	0.80 (0.66, 0.96)	0.74 (0.61, 0.91)	0.65 (0.53, 0.81)	<0.001
Model 2	1.00	0.88 (0.71, 1.09)	0.87 (0.69, 1.10)	0.75 (0.57, 1.00)	0.05

RTEC = ready-to-eat cereal, CVD = cardiovascular disease.

^aMultivariate model 1: adjusted for age, gender, smoking status, smoking dose, and time since quitting smoking. Multivariate model 2, adjusted for covariates in model 1 and race/ethnicity, education, marital status, self-rated health status, body mass index, physical activity, use of menopausal hormone therapy, and intake of alcohol, red meat, fruits, vegetables, and total energy.