NIH Public Access
Author Manuscript
Nutr Metab Cardiovasc Dis. Author manuscript; available in PMC 2012 June 1.

Published in final edited form as:
Nutr Metab Cardiovasc Dis. 2011 June ; 21(6): 430–437. doi:10.1016/j.numecd.2009.11.007.

Dietary Fat and Cholesterol and Risk of Cardiovascular Disease in Older Adults: the Health ABC Study

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Abstract

BACKGROUND AND AIMS—Although dietary fats and cholesterol have previously been associated with risk of cardiovascular disease (CVD) in middle aged populations, less is known among older adults. The purpose of this study was to determine the association between dietary fats, cholesterol, and eggs and CVD risk among community-dwelling adults aged 70–79 in the Health, Aging and Body Composition Study.

METHODS AND RESULTS—Diet was assessed using an interviewer-administered 108-item food frequency questionnaire (n=1,941). CVD events were defined as a confirmed myocardial infarction, coronary death, or stroke. Relative rates of CVD over 9 years of follow-up were estimated using Cox proportional hazards models. During follow-up, there were 203 incident cases of CVD. There were no significant associations between dietary fats and CVD risk. Dietary cholesterol (HR (95% CI): 1.47 (0.93, 2.32) for the upper vs. lower tertile; *P* for trend, 0.10) and egg consumption (HR (95% CI): 1.68 (1.12, 2.51) for 3+/week vs. <1/week); *P* for trend, 0.01) were associated with increased CVD risk. However, in subgroup analyses, dietary cholesterol and egg consumption were associated with increased CVD risk only among older adults with type 2 diabetes (HR (95% CI): 3.66 (1.09, 12.29) and 5.02 (1.63, 15.52), respectively, for the upper vs. lower tertile/group).

CONCLUSIONS—Dietary cholesterol and egg consumption were associated with increased CVD risk among older, community-dwelling adults with type 2 diabetes. Further research on the biological mechanism(s) for the increased CVD risk with higher dietary cholesterol and frequent egg consumption among older adults with diabetes is warranted.

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INTRODUCTION

Approximately one in three American adults has cardiovascular disease (CVD). Of those, almost half are estimated to be age 60 and older (1). Elevated LDL cholesterol is a major risk factor for CVD; thus, dietary guidelines recommend limiting the amount of saturated and *trans* fat, and cholesterol in the diet (2). Previous observational studies have shown an association between specific types of dietary fats and CVD risk (3). However, much of the evidence comes from studies conducted in middle aged populations with relatively few studies of dietary fat intake and CVD risk conducted in older populations. Furthermore, cardiovascular risk factors, such as blood lipids (4–7), appear to be less potent at older ages, and there is some evidence suggesting that the association between dietary fats and CVD risk differs by age (8–12).

Observational studies examining the association between dietary cholesterol and CVD risk have been inconsistent (3). Limiting egg consumption is often recommended as part of a heart-healthy diet because eggs are a major source of dietary cholesterol. However, several studies have not found an association between egg consumption and CVD risk in the general population (13–15). A caveat to the apparent lack of association between dietary cholesterol and egg consumption and CVD risk are studies suggesting that people with diabetes may have an elevated risk of CVD with higher intakes of dietary cholesterol and eggs (13;16–18). It has been hypothesized that dietary cholesterol may be more detrimental in people with diabetes because of dyslipidemia and increased insulin resistance.

The primary objective of this study was to examine the association between dietary fats, cholesterol, and eggs and the risk of incident CVD over 9 years of follow-up among older, community-dwelling adults to determine if the associations observed in middle-aged populations extend to older adults. A secondary objective was to determine if the association between dietary cholesterol and eggs and risk of cardiovascular disease differed among older adults with and without type 2 diabetes.

METHODS

Study Population

Data for this analysis are from the Health, Aging and Body Composition (Health ABC) study, a prospective cohort study investigating the associations between body composition, weight-related health conditions, and incident functional limitations in older adults. The Health ABC study enrolled 3,075 community-dwelling black and white men and women aged 70–79 years between April 1997 and June 1998. Participants were recruited from a random sample of white and all black Medicare eligible residents in the Pittsburgh, PA, and Memphis, TN, metropolitan areas. Participants were eligible if they reported no difficulty walking one-fourth of a mile, climbing up 10 steps, or performing basic activities of daily living, and were free of life-threatening illness, planned to remain in the geographic area for at least three years, and were not enrolled in life-style intervention trials. All participants provided written informed consent and all protocols were approved by the institutional review boards at both study sites.

Participants with prevalent cardiovascular disease at year 2 were excluded (n=769) as well as those who were missing the food frequency questionnaire at year 2 (n=257), those with serious errors (skipped >15% of items or reported <3 or >20 foods/day) on the food frequency questionnaire (n=36), and those who reported energy intakes less than 500 kcal/d or greater than 3,500 kcal/d in women and less than 800 kcal/d or greater than 4,000 kcal/d in men (n=41). Participants missing other pertinent covariates were also excluded (n=31). The final analysis sample included 1,941 participants.

Dietary Assessment

To estimate usual nutrient intake over the previous year, participants completed a 108-item interviewer-administered food frequency questionnaire (FFQ) at year 2. The Health ABC FFQ food list was developed specifically for Health ABC by Block Dietary Data Systems (Berkeley, CA) using 24-hour recalls obtained in NHANES III from older (>65 years) non-Hispanic white and black adults residing in the Northeast or Southern United States. Trained interviewers used wood blocks, food models, standard kitchen measures, and flash cards to help participants estimate portion sizes for each food. Interviews were periodically monitored throughout the study to ensure the quality and consistency of the data collection procedures. The Health ABC FFQ was analyzed for micro- and macronutrient content by Block Dietary Data Systems. Egg consumption was ascertained from a single question, "How often do you eat eggs, including biscuit sandwiches, and Egg McMuffins?", with possible responses of never, 1–11 times per year, once per month, 2–3 times per month, once per week, twice per week, 3–4 times per week, 5–6 times per week, and everyday.

Ascertainment of Incident Cardiovascular Disease

Major health events are identified every 6 months, alternating between annual in-person clinic exams and semi-annual phone interviews. Medical records of all hospitalizations (≥24 hours) are abstracted and adjudicated for the occurrence of targeted health events (including myocardial infarction, stroke, and mortality). Date and causes of death were obtained from the death certificate. Causes of death were adjudicated based on the review of medical records, proxy information and autopsy report (when performed). Incident CVD events (n=203) were defined as a confirmed nonfatal myocardial infarction, coronary death, or stroke that occurred after the year 2 clinic visit (when the FFQ was administered).

Potential Confounders

Demographic characteristics (age, gender, race, education, and field center), smoking status, alcohol use, and physical activity were ascertained by an interviewer-administered questionnaire at study baseline. Physical activity was based on the reported time spent walking for exercise or other walking (e.g., for transportation) over the past seven days. Body mass index (BMI; kg/m^2) was calculated from measured weight and height. Fasting blood glucose and total serum cholesterol were measured at the clinic visit in year 2. The prevalence of type 2 diabetes was determined using algorithms based on self-report, medication use and fasting blood glucose levels of ≥6.99 mmol/L [≥126 mg/dL]. The prevalence of hypertension was determined using algorithms based on self-report and medication use. Specific medication use including statins, aspirin, and oral estrogen (females only) and dietary supplements including multivitamin and vitamin E were identified.

Statistical Analyses

Descriptive characteristics of the study population were done using SAS statistical software (v. 9.1; SAS Institute, Cary, NC). Differences in the frequencies and means of covariates by tertiles of dietary fat and cholesterol intake were examined using chi-square and analysis of variance (ANOVA). Multivariate Cox proportional hazard models were used to calculate the hazard ratios (HR) and 95% confidence intervals (CI) of CVD by tertiles of total and specific types of dietary fat and cholesterol and categories of egg consumption (<1/week, 1–2/week, 3+/week). Person years of follow-up were accumulated from the date of the year 2 visit until the first occurrence of a CVD event or the end of follow-up. Analyses were adjusted for age, gender, race, education, field center, smoking status, alcohol consumption, physical activity, BMI, energy intake, percent of energy from protein and other dietary fats, dietary cholesterol, fiber intake, statin and oral estrogen (females only) use, multivitamin and vitamin E use, and prevalent diabetes and hypertension. Tests for linear trends across tertiles of total and specific types of dietary fat and cholesterol were conducted using the median value in each tertile as a continuous variable in the model.

RESULTS

The mean age of the analysis sample (n=1,941) was 74.5 years, 55.5% were women, and 37.8% were black. Participants who were excluded from the analysis sample (n=1,134) were older and more likely to be male, black, and have less than a high school education (P<0.0001). Participant characteristics by tertiles of total fat intake are shown in Table 1. Participants with higher total fat intake were more likely to be black and current smokers. Use of statins, aspirin, multivitamins, and vitamin E tended to be higher among participants with lower total fat intake. Intake of total energy and specific types of dietary fat and cholesterol tended to be higher among participants with higher total fat intake while dietary fiber intake tended to be lower.

Approximately 10.4% of the analysis sample (203 participants) had a confirmed CVD event (76 with nonfatal myocardial infarctions, 93 strokes, and 34 coronary deaths) over 9 years of follow-up, with 11.5% of men and 9.5% of women reporting a confirmed CVD event. The number of CVD events in each of the three tertiles for total and specific dietary fats and dietary cholesterol ranged from a minimum of 55 to a maximum of 82 events. In age-adjusted analyses, only dietary cholesterol was associated with increased risk of CVD (P for trend, 0.005; Table 2). The association between dietary cholesterol and CVD risk remained after multivariate adjustment (HR (95% CI): 1.52 (1.00, 2.31) for the upper vs. lower tertile; P for trend, 0.05); however, after further adjustment for other fats, the strength of the association between dietary cholesterol and CVD risk was diminished (P for trend, 0.10). No significant associations were found between total, saturated, monounsaturated, polyunsaturated, or *trans* fat, or polyunsaturated:saturated fat (P:S) ratio and CVD risk.

Approximately 37.8% of participants consumed eggs less than once per week, 40.4% consumed eggs 1–2 times per week, and 21.8% consumed eggs 3 or more times per week. Only 5.3% of participants consumed eggs daily. In age-adjusted analyses, egg consumption was associated with increased risk of CVD (HR (95% CI) for increasing egg consumption: <1/week, 1.00; 1–2/week, 1.22 (0.88–1.70); ≥3/week, 1.85 (1.30–2.64); P for trend, 0.0009). Consuming eggs 3 or more times per week remained associated with increased CVD risk after multivariate adjustment (HR (95% CI): 1.72 (1.16–2.54); P for trend, 0.008) as well as after further adjustment for saturated fat intake (HR (95% CI): 1.68 (1.12–2.51); P for trend, 0.01) or other breakfast foods high in fat (e.g., sausage or bacon) (P for trend, <0.05). Egg consumption was moderately correlated with dietary cholesterol and saturated fat intake (r = 0.58 and r = 0.31, respectively; P<0.0001). However, egg consumption and dietary cholesterol were inversely correlated with total serum cholesterol ($r < -0.10$, P<0.05). Individuals who reported being on a low cholesterol diet (12.7%) were less likely to consume eggs 3 or more times per week (13.4% vs. 23.0%, P=0.003) but had similar total serum cholesterol levels (5.49 vs. 5.38 mmol/L, P=0.11) compared to those who did not report being on a low cholesterol diet.

Based on results of previous studies showing a strong diabetes effect between dietary cholesterol and eggs and CVD risk (13;16–18), we tested two-way interactions between type 2 diabetes status and dietary cholesterol and eggs in order to determine if the association between dietary cholesterol and eggs and risk of CVD differed among older adults with and without type 2 diabetes. Two-way interactions between type 2 diabetes status and eggs was significant (P=0.02) and there was a trend for dietary cholesterol (P=0.08). Thus, we further examined the associations in models stratified by type 2 diabetes status. There were no significant associations between dietary cholesterol or egg consumption and CVD risk among participants without type 2 diabetes at study baseline (n=1,600). However, in analyses adjusted for age, dietary cholesterol and egg consumption were associated with increased risk of CVD among those with type 2 diabetes (n=341; Table 3; *P* for trend, <0.01). In multivariate adjustment including other fats, the association between dietary cholesterol and egg consumption and risk of CVD remained significant (*P* for trend, <0.05). Further adjustment for other breakfast foods high in fat did not substantially change the association between egg consumption and increased risk of CVD (*P* for trend, <0.05).

DISCUSSION

Dietary cholesterol and egg consumption were associated with increased risk of CVD over 9 years of follow-up among older, community-dwelling adults in the Health ABC cohort. However, in sub-group analyses, these findings were limited to participants with type 2 diabetes. Among participants with type 2 diabetes, participants in the upper tertile of dietary cholesterol intake had greater than a 3-fold increased risk of CVD. Consuming eggs three or more times per week was associated with approximately a 5-fold greater risk of incident CVD among those with type 2 diabetes. These associations remained after also accounting for other dietary fats or foods high in saturated fat and cholesterol. However, dietary intakes of total, saturated, monounsaturated, polyunsaturated, or *trans* fat, and P:S ratio were not significantly associated with CVD risk.

Previous observational studies have shown an association between dietary fats, such as saturated and *trans* fat, and CVD risk in middle aged and older populations (3;9–12;19;20). However, in age stratified analyses, studies have found associations between dietary fats and CVD risk in middle aged adults but not in older adults (8–12). Consistent with other studies in which analyses were limited to older adults, we did not find an association between dietary fats and risk of CVD among adults aged 70 years and older in the Health ABC study. Possible reasons for these age differences include differences in baseline CVD risk between younger and older adults; selective survivorship of older adults leading to a population sample less vulnerable to environmental factors such as diet; and an attenuated association between blood lipids and CVD risk among older adults (4–6).

The association between dietary cholesterol and risk of CVD in observational studies has been inconsistent with many studies finding no association (3). In the current study, participants in the upper tertile of dietary cholesterol had a 1.5-fold greater risk of CVD in the entire cohort. Because previous studies have shown an increased risk of CVD with dietary cholesterol and egg consumption among adults with diabetes (13;16–18), we further analyzed the association stratified by type 2 diabetes. Participants with type 2 diabetes in the upper tertile of dietary cholesterol intake had greater than a 3-fold increased risk of CVD; however, dietary cholesterol was not significantly associated with increased risk of CVD among participants without type 2 diabetes. Tanasescu and colleagues also found an association between dietary cholesterol and increased risk of CVD among women with diabetes (16).

Eggs provide an excellent source of high-quality protein as well as significant amounts of several other vitamins and minerals, such as vitamins D and B_{12} (21), which are often low among older adults. Although eggs are a major source of dietary cholesterol, they are relatively low in saturated fat and, thus, have a small effect on total and LDL cholesterol levels (22). In the current study, egg consumption was positively associated with higher saturated fat and cholesterol intake. However, egg consumption was inversely associated with total serum cholesterol, possibly because those with higher serum cholesterol had been advised to eat a low cholesterol diet. Although the association between egg consumption and

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risk of CVD in the general population has been inconsistent (3), the current study as well as a number of previous studies have shown an association between egg consumption and increased risk of CVD among individuals with diabetes (13;16–18). In the Physicians' Health Study, however, there was no association between egg consumption and CVD risk; but there was a 1.2-fold greater risk of all-cause mortality among frequent egg consumers in the entire cohort and a 2-fold greater risk of mortality among those with diabetes (23). Daily consumption of eggs has recently been associated with an increased risk of type 2 diabetes, independent of traditional type 2 diabetes risk factors, in both men and women (24).

Dyslipidemia is an important risk factor for CVD among people with diabetes and is characterized by an increase in highly atherogenic small dense LDL particles, a decrease in HDL, and elevated triglycerides. In a trial among healthy older volunteers, however, egg consumption was associated with an increase in large LDL particles, considered less atherogenic, as well as an increase in HDL (25). The anticipated increase in cardiovascular risk as a result of dietary cholesterol and egg consumption on serum cholesterol is much smaller than that observed in the current study among older adults with type 2 diabetes and suggests an alternative explanation beyond the role of lipids on cardiovascular health. One possible explanation is non-adherence to dietary recommendations such as those from the American Diabetes Association or the American Heart Association. Among older adults with type 2 diabetes, the consumption of high cholesterol foods and eggs could be considered a "non-adherent" behavior and confound the association between dietary cholesterol and eggs and CVD risk because of other behavioral factors associated with both non-adherence and increased risk of CVD (26). In NHANES 1999–2000, adherence to the 1997 American Diabetes Association dietary recommendations for saturated fat (<10% of energy intake) and cholesterol (<300 mg) among adults with diabetes was low (40.2% and 48.8%, respectively) (27). Although individuals with type 2 diabetes in the current study were more likely to report being on a low-fat diet compared to individuals without type 2 diabetes (27.0% vs. 18.1%, P=0.0002), individuals with type 2 diabetes reported higher total fat intake (34.4% vs. 33.3%, P=0.01) but similar saturated fat intake (9.8% vs. 9.6%, P=0.15). Individuals with type 2 diabetes were no more likely to report being on a low cholesterol diet than those without type 2 diabetes (13.2% vs. 12.6%, P=0.75) but did report higher dietary cholesterol intakes (120 vs. 107 mg/1000 kcals, P<0.0001) and were less likely to report consuming eggs less than once per week (29.7% vs. 39.6%, P=0.002).

Strengths of the current study include the large study sample of older, community-dwelling black and white men and women, the long follow-up duration (9 years), the careful adjustment for potential confounders including other dietary and lifestyle factors, confirmed type 2 diabetes status based on medication use and fasting blood glucose levels, and adjudicated CVD events. A limitation of this study is the methodology used to assess dietary intake. A single, 108-item food frequency questionnaire was used to characterize usual intake of food. A food frequency questionnaire provides an imprecise means of ranking nutrient intakes among individuals. The imprecision of the dietary data, along with the relatively small number of CVD events, may have reduced the ability of this study to detect associations between dietary fats, in particular *trans* fat, and CVD risk. Also, assessment of dietary intake at just one period of time may be inadequate to capture important dietary exposures and may not reflect changes in the nutrient content of the food supply over the 9 years, e.g., *trans* fat, thereby limiting our ability to detect an association if one existed. Although CVD events were adjudicated, there is still a possibility of event misclassification which most likely would result in an underestimate of the true association between dietary fat and cholesterol and CVD risk. Analyses were adjusted for smoking, alcohol consumption, physical activity and other important potential confounders; however, diet may serve as a proxy measure for other relevant behavioral factors. Finally, the observational nature of our study does not allow us to evaluate a causal association between dietary fats and cholesterol and CVD risk.

In conclusion, we found that dietary fats were not associated with increased risk of CVD among older, community-dwelling adults. However, higher dietary cholesterol and frequent egg consumption were significantly associated with increased risk of CVD among older adults with type 2 diabetes. Given the consistency of observational findings among individuals with type 2 diabetes, further research on the biological mechanism behind the increased CVD risk with higher dietary cholesterol and frequent egg consumption is warranted.

Acknowledgments

This research was supported in part by the Intramural Research Program of the NIH, National Institute on Aging; National Institute on Aging contracts N01-AG-6-2101, N01-AG-6-2103, and N01-AG-6-2106; the Wake Forest University Claude D. Pepper Older Americans Independence Center (P30-AG21332); and the American Egg Board/Egg Nutrition Center.

REFERENCES

1. Rosamond W, Flegal K, Furie K, Go A, Greenlund K, Haase N, et al. Heart disease and stroke statistics--2008 update: a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation. 2008; 117:e25–e146. [PubMed: 18086926]
2. Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA, et al. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. Circulation. 2006; 114:82–96. [PubMed: 16785338]
3. Hu FB, Manson JE, Willett WC. Types of dietary fat and risk of coronary heart disease: a critical review. J Am Coll Nutr. 2001; 20:5–19. [PubMed: 11293467]
4. Krumholz HM, Seeman TE, Merrill SS, Mendes de Leon CF, Vaccarino V, Silverman DI, et al. Lack of association between cholesterol and coronary heart disease mortality and morbidity and all-cause mortality in persons older than 70 years. JAMA. 1994; 272:1335–1340. [PubMed: 7772105]
5. Psaty BM, Furberg CD, Kuller LH, Bild DE, Rautaharju PM, Polak JF, et al. Traditional risk factors and subclinical disease measures as predictors of first myocardial infarction in older adults: the Cardiovascular Health Study. Arch Intern Med. 1999; 159:1339–1347. [PubMed: 10386510]
6. Simons LA, Simons J, Friedlander Y, McCallum J. Cholesterol and other lipids predict coronary heart disease and ischaemic stroke in the elderly, but only in those below 70 years. Atherosclerosis. 2001; 159:201–208. [PubMed: 11689222]
7. Abbott RD, Curb JD, Rodriguez BL, Masaki KH, Yano K, Schatz IJ, et al. Age-related changes in risk factor effects on the incidence of coronary heart disease. Ann Epidemiol. 2002; 12:173–181. [PubMed: 11897175]
8. Posner BM, Cobb JL, Belanger AJ, Cupples LA, D'Agostino RB, Stokes J III. Dietary lipid predictors of coronary heart disease in men. The Framingham Study. Arch Intern Med. 1991; 151:1181–1187. [PubMed: 2043019]
9. Esrey KL, Joseph L, Grover SA. Relationship between dietary intake and coronary heart disease mortality: Lipid Research Clinics Prevalence Follow-up Study. J Clin Epidemiol. 1996; 49:211–216. [PubMed: 8606322]
10. Jakobsen MU, Overvad K, Dyerberg J, Schroll M, Heitmann BL. Dietary fat and risk of coronary heart disease: possible effect modification by gender and age. Am J Epidemiol. 2004; 160:141–149. [PubMed: 15234935]
11. Oh K, Hu FB, Manson JE, Stampfer MJ, Willett WC. Dietary fat intake and risk of coronary heart disease risk in women: 20 years of follow-up of the Nurses' Health Study. Am J Epidemiol. 2005; 161:672–679. [PubMed: 15781956]
12. Xu J, Eilat-Adar S, Loria C, Goldbourt U, Howard BV, Fabsitz RR, et al. Dietary fat intake and risk of coronary heart disease: the Strong Heart Study. Am J Clin Nutr. 2006; 84:894–902. [PubMed: 17023718]

13. Hu FB, Stampfer MJ, Rimm EB, Manson JE, Ascherio A, Colditz GA, et al. A prospective study of egg consumption and risk of cardiovascular disease in men and women. JAMA. 1999; 281:1387–1394. [PubMed: 10217054]
14. Fraser GE. Diet and coronary heart disease: beyond dietary fats and low-density-lipoprotein cholesterol. Am J Clin Nutr. 1994; 59:1117S–1123S. [PubMed: 8172111]
15. Dawber TR, Nickerson RJ, Brand FN, Pool J. Eggs, serum cholesterol, and coronary heart disease. Am J Clin Nutr. 1982; 36:617–625. [PubMed: 7124663]
16. Tanasescu M, Cho E, Manson JE, Hu FB. Dietary fat and cholesterol and the risk of cardiovascular disease among women with type 2 diabetes. Am J Clin Nutr. 2004; 79:999–1005. [PubMed: 15159229]
17. Trichopoulou A, Psaltopoulou T, Orfanos P, Trichopoulos D. Diet and physical activity in relation to overall mortality amongst adult diabetics in a general population cohort. J Intern Med. 2006; 259:583–591. [PubMed: 16704559]
18. Qureshi AI, Suri FK, Ahmed S, Nasar A, Divani AA, Kirmani JF. Regular egg consumption does not increase the risk of stroke and cardiovascular diseases. Med Sci Monit. 2007; 13:CR1–CR8. [PubMed: 17179903]
19. Ascherio A, Rimm EB, Giovannucci EL, Spiegelman D, Stampfer M, Willett WC. Dietary fat and risk of coronary heart disease in men: cohort follow up study in the United States. BMJ. 1996; 313:84–90. [PubMed: 8688759]
20. Hu FB, Stampfer MJ, Manson JE, Rimm E, Colditz GA, Rosner BA, et al. Dietary fat intake and the risk of coronary heart disease in women. N Engl J Med. 1997; 337:1491–1499. [PubMed: 9366580]
21. Song WO, Kerver JM. Nutritional contribution of eggs to American diets. J Am Coll Nutr. 2000; 19:556S–562S. [PubMed: 11023007]
22. Fernandez ML. Dietary cholesterol provided by eggs and plasma lipoproteins in healthy populations. Curr Opin Clin Nutr Metab Care. 2006; 9:8–12. [PubMed: 16340654]
23. Djousse L, Gaziano JM. Egg consumption in relation to cardiovascular disease and mortality: the Physicians' Health Study. Am J Clin Nutr. 2008; 87:964–969. [PubMed: 18400720]
24. Djousse L, Gaziano JM, Buring JE, Lee IM. Egg consumption and risk of type 2 diabetes in men and women. Diabetes Care. 2009; 32:295–300. [PubMed: 19017774]
25. Greene CM, Waters D, Clark RM, Contois JH, Fernandez ML. Plasma LDL and HDL characteristics and carotenoid content are positively influenced by egg consumption in an elderly population. Nutr Metab (Lond). 2006; 3:6. [PubMed: 16398934]
26. Kritchevsky SB. "Adherence bias" in nutritional epidemiology. Am J Clin Nutr. 2008; 88:1448–1449. [PubMed: 18996883]
27. Eilat-Adar S, Xu J, Zephier E, O'Leary V, Howard BV, Resnick HE. Adherence to dietary recommendations for saturated fat, fiber, and sodium is low in American Indians and other U.S. adults with diabetes. J Nutr. 2008; 138:1699–1704. [PubMed: 18716172]

Table 1

Baseline participant characteristics by tertiles of total fat intake: the Health ABC Study, 1997–1998.[a]

	Total fat			
	Tertile 1	Tertile 2	Tertile 3	P-value
Age, years	74.6 (2.9)	74.5 (2.9)	74.4 (2.8)	0.53
Female gender (%)	55.0	58.7	52.7	0.09
Black race (%)	33.7	40.8	39.0	0.02
< High school education (%)	19.0	22.6	24.4	0.06
Current smoker (%)	6.2	7.7	11.9	0.0007
Current alcohol consumer (%)	52.4	50.7	49.3	0.54
Sedentary (0 minutes/week, %)	37.4	41.0	40.6	0.35
BMI (kg/m^2)	27.1 (4.8)	27.3 (4.8)	27.2 (5.1)	0.63
Diabetes (%)	15.2	17.6	19.9	0.08
Hypertension (%)	51.6	54.7	49.3	0.15
Serum total cholesterol (mmol/L)	208.0 (37.7)	208.5 (38.5)	209.4 (38.3)	0.80
Statin use (%)	14.1	11.6	9.4	0.03
Aspirin use (%)	34.6	27.5	28.0	0.008
Oral estrogen use (%)[b]	27.8	22.6	22.3	0.16
Multivitamin use (%)	43.0	33.8	34.6	0.0008
Vitamin E use (%)	27.5	22.4	20.6	0.009
Dietary intake				
Total energy (kcals/d)	1698 (574)	1848 (606)	2011 (686)	<0.0001
Carbohydrate (% energy)	60.6	53.0	45.6	<0.0001
Protein (% energy)	15.0	14.4	14.0	<0.0001
Total fat (% energy)	25.4	33.4	41.6	<0.0001
Saturated fat (% energy)	7.3	9.7	11.9	<0.0001
Monounsaturated fat (% energy)	9.2	12.3	15.4	<0.0001
Polyunsaturated fat (% energy)	6.6	8.8	11.3	<0.0001
Trans fat (% energy)	2.6	3.4	3.8	<0.0001
Cholesterol (mg/1000 kcal)	90.4 (37.4)	110.7 (48.3)	127.9 (57.5)	<0.0001
Fiber (g/d)	19.0 (7.7)	17.4 (6.7)	16.5 (7.0)	<0.0001

[a]Means (SD) or frequencies with ANOVA or Chi-square tests used to evaluate the distribution.

N=1,941.

[b]For women only.

Table 2

Hazard ratios (95% CI) of CVD according to tertiles of total and specific types of dietary fat and cholesterol: the Health ABC study, 9 years of follow-up.[a]

	Tertile 1	Tertile 2	Tertile 2	P for trend
Total fat				
Median (% of energy)	26.4	33.5	40.8	
HR (95% CI): Age-adjusted	1.00	1.14 (0.80–1.62)	1.35 (0.96–1.89)	0.08
Multivariate[b + c]	1.00	1.10 (0.76–1.59)	1.26 (0.85–1.86)	0.24
Saturated fat				
Median (% of energy)	7.2	9.6	11.9	
HR (95% CI): Age-adjusted	1.00	1.10 (0.78–1.56)	1.30 (0.93–1.82)	0.12
Multivariate[b + d]	1.00	1.07 (0.72–1.61)	1.22 (0.73–2.02)	0.44
Monounsaturated fat				
Median (% of energy)	9.4	12.2	15.2	
HR (95% CI): Age-adjusted	1.00	0.99 (0.70–1.40)	1.19 (0.86–1.67)	0.29
Multivariate[b + e]	1.00	0.94 (0.62–1.40)	1.07 (0.64–1.79)	0.76
Polyunsaturated fat				
Median (% of energy)	6.3	8.7	11.4	
HR (95% CI): Age-adjusted	1.00	1.18 (0.84–1.66)	1.13 (0.80–1.59)	0.52
Multivariate[b + f]	1.00	1.12 (0.78–1.62)	1.07 (0.71–1.62)	0.78
Trans fat				
Median (% of energy)	2.1	3.1	4.4	
HR (95% CI): Age-adjusted	1.00	1.10 (0.79–1.54)	1.00 (0.71–1.41)	0.95
Multivariate[b + g]	1.00	1.05 (0.74–1.49)	0.97 (0.65–1.44)	0.85
P:S Ratio				
Median	0.69	0.93	1.22	
HR (95% CI): Age-adjusted	1.00	0.85 (0.61–1.18)	0.79 (0.56–1.11)	0.17
Multivariate[b + h]	1.00	0.89 (0.64–1.25)	0.84 (0.59–1.20)	0.34
Cholesterol				
Median (mg/1000 kcals)	67.3	100.7	147.2	
HR (95% CI): Age-adjusted	1.00	1.22 (0.86–1.75)	1.62 (1.15–2.28)	0.005
Multivariate[b + i]	1.00	1.22 (0.82–1.79)	1.47 (0.93–2.32)	0.10

[a]N=1,941. CVD = confirmed myocardial infarction, coronary death, or stroke; HR = hazard ratio; MUFA = monounsaturated fat; PUFA = polyunsaturated fat; P:S ratio = polyunsaturated:saturated fat ratio.

[b]Multivariate models adjusted for age, gender, race, education, field center, smoking, alcohol use, physical activity, BMI, total energy intake, protein intake, fiber intake, multivitamin use, supplemental vitamin E use, statin use, aspirin use, oral estrogen use (women only), and prevalent diabetes or hypertension.

Models additionally adjusted for:

[c]dietary cholesterol;

[d]MUFA, PUFA, *trans* fat, and cholesterol;

[e] saturated fat, PUFA, *trans* fat, and cholesterol;

[f] saturated fat, MUFA, *trans* fat, and cholesterol;

[g] saturated fat, MUFA, PUFA, and cholesterol; and

[h] MUFA, *trans* fat and cholesterol;

[i] saturated fat, MUFA, PUFA, and *trans* fat.

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Table 3

Hazard ratios (95% CI) of CVD stratified by type 2 diabetes status according to tertiles of dietary cholesterol and frequency of egg consumption: the Health ABC study, 9 years of follow-up.[a]

	Diabetes (n=341)				No Diabetes (n=1,600)			
Cholesterol	Tertile 1	Tertile 2	Tertile 3	P for trend	Tertile 1	Tertile 2	Tertile 3	P for trend
Incident CVD cases	6	12	27		49	54	55	
HR (95% CI)								
Age-adjusted	1.00	1.79 (0.67–4.77)	2.96 (1.22–7.18)	0.009	1.00	1.14 (0.78–1.68)	1.35 (0.92–1.99)	0.12
Multivariate[b + c]	1.00	2.37 (0.79–7.12)	3.66 (1.09–12.29)	0.04	1.00	1.14 (0.75–1.73)	1.30 (0.78–2.16)	0.31
Eggs	<1/wk	1–2/wk	3+/wk	P for trend	<1/wk	1–2/wk	3+/wk	P for trend
Frequency	29.7%	43.8%	26.5%		39.6%	39.7%	20.8%	
Incident CVD cases	5	20	20		57	61	40	
HR (95% CI)								
Age-adjusted	1.00	2.86 (1.07–7.61)	5.10 (1.91–13.59)	0.0005	1.00	1.05 (0.73–1.51)	1.46 (0.97–2.18)	0.09
Multivariate[b + d]	1.00	3.33 (1.18–9.41)	5.02 (1.63–15.52)	0.005	1.00	1.03 (0.71–1.49)	1.38 (0.88–2.16)	0.21

[a]CVD = confirmed myocardial infarction, stroke or coronary death; MUFA = monounsaturated fat; PUFA = polyunsaturated fat.

[b]Multivariate model adjusted for age, gender, race, education, field center, smoking, alcohol use, physical activity, BMI, total energy intake, protein intake, fiber intake, multivitamin use, supplemental vitamin E use, statin use, aspirin use, oral estrogen use (women only), and prevalent hypertension.

Models additionally adjusted for:

[c]saturated fat, MUFA, PUFA, and *trans* fat;

[d]saturated fat.