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## Regular egg consumption does not increase the risk of stroke and cardiovascular diseases

**Authors' Contribution:**

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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**Background:**

We performed this study to examine the association between egg consumption and risk of cardiovascular diseases and mortality in a nationally representative cohort of 9734 adults aged 25 to 74 years.

**Material/Methods:**

Egg consumption was categorized into no or less than 1 egg, 1 to 6 eggs, or greater than 6 eggs per week. Cox proportional hazards analysis was used to identify the relative risk (RR) of incident stroke, ischemic stroke, coronary artery disease and mortality over a 20-year follow-up in all participants and subsequently in diabetic participants.

**Results:**

After adjusting for differences in age, gender, race, serum cholesterol level, body mass index, diabetes mellitus, systolic blood pressure, educational status and cigarette smoking, no significant difference was observed between persons who consumed greater than 6 eggs per week compared to those who consume none or less than 1 egg per week in regards to any stroke (RR, 0.9; 95% confidence interval (CI), 0.7 to 1.1), ischemic stroke (RR, 0.9; 95% CI, 0.7 to 1.1), or coronary artery disease (RR, 1.1; 95% CI, 0.9 to 1.3). In subgroup analysis among diabetics, consumption of greater than 6 eggs per week was associated with an increased risk of coronary artery disease (RR 2.0, 95% CI 1.0–3.8).

**Conclusions:**

Consumption of greater than 6 eggs per week (average of 1 egg or greater per day) does not increase the risk of stroke and ischemic stroke. The increased risk of coronary artery disease associated with higher egg consumption among diabetics warrants further investigations.

**key words:**

**stroke • cardiovascular diseases • eggs • national survey • coronary artery disease**

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## BACKGROUND

Eggs represent an inexpensive and low calorie source of high quality protein, folate, riboflavin, selenium, choline, and vitamins A, B-12, D, and K [1]. However, because of the high cholesterol content, American Heart Association (AHA) guidelines in 1993 recommended to restrict egg consumption and dietary intake to  $\leq 300$  mg/day [2]. A subsequent statement in 2000 [3] stated that cholesterol-rich foods such as egg yolks that are relatively low in saturated fatty acid content have small effects on low-density-lipoproteins (LDL) cholesterol levels. However, epidemiological data have suggested that increased dietary cholesterol intake is associated with an increase in coronary disease risk independent of plasma cholesterol levels. The AHA continues to recommend dietary cholesterol intake of  $< 300$  mg per day on average. This target can be readily achieved, even with periodic consumption of eggs and shellfish. Reduction in cholesterol intake ( $< 200$  mg per day) from all dietary sources of cholesterol including eggs is advised for individuals with elevated LDL cholesterol levels, diabetes, and/or cardiovascular disease. In the Third National Health and Nutrition Examination (NHANES III) [4], egg consumption within the last 24 hours prior to the interview was reported by 6551 (24%) of the 27378 persons screened as representative of United States (US) population. A higher proportion of men, African American, and Mexican American persons reported consumption of eggs within the last 24 hours. Estimate for overall egg consumption was not reported. In the present study, we sought to determine the long-term risk of cardiovascular diseases associated with egg consumption in a nationally representative cohort.

## MATERIAL AND METHODS

We used the data from First National Health and Nutrition Examination Survey (NHANES-I) for the analysis. NHANES-I was conducted by the National Center for Health Statistics during 1971–1975 to collect health-related information on a probability sample of the civilian, noninstitutionalized population in the United States [5–8]. The NHEFS comprised a series of follow-up studies to provide follow-up data on these NHANES-I participants who were between the ages of 25 and 74 years (at the time of the baseline survey). The NHEFS included 4 periods of follow-up: 1982–1984, 1986, 1987, and 1992. The 1982–1984 follow-up included tracing the cohort using unique identifying information; conducting personal interviews with subject or proxy; measuring pulse rate, weight, and blood pressure of surviving participants; collecting hospital and nursing home records of overnight stay; and collecting death certificates of decedents. Subsequent follow-up of the NHEFS was conducted with the same design and data collection procedures except that a 30-minute computer-assisted telephone interview was administered in place of a personal interview and no physical measurements were made. Tracing and data collection in the NHEFS were very high, with 94% of the study population traced for each completed wave of follow-up. The interview rates ranged from 91% to 96% of the participants traced. By the end of the 1992 NHEFS survey period, 90% of the 11,195 subjects not reported dead in previous surveys had been successfully traced [9]. Approximately 32% of the NHEFS cohort was known to be deceased, with a death certificate available for 98% of the 4604 NHEFS decedents.

## Definitions of stroke and coronary artery disease events

Participants were considered to have experienced a stroke event if they were hospitalized or died during the 20-year follow-up period with primary diagnoses categorized by codes 430, 431 to 434.9 or 437.0, 437.1 according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*. Our definition of stroke event included both ischemic and hemorrhagic events but not transient ischemic events (*ICD-9-CM* code 435). *ICD-9-CM* codes were assigned on the basis of the underlying cause of death listed on the participant's death certificate. Stroke events were further classified as ischemic stroke in those with *ICD-9-CM* codes 433 to 434.9 or 437.0 to 437.1. Coronary artery disease was defined by presence of *ICD-9-CM* code 410-414. The definitions of stroke and cardiovascular diseases were consistent with previous reports [3,4].

## Definitions of egg consumption

At baseline interview, a detailed questionnaire was used to inquire regarding nutritional habits. Egg consumption included eggs eaten as in the form of fried, boiled, poached, deviled, or egg salad. Eggs in cooked or baked dishes (as custards, puddings) were not included. Egg consumption was divided into three groups i.e. no or less than 1 egg per week, 1 to 6 eggs per week, and greater than 6 eggs per week.

## Study variables

Known cardiovascular risk factors that were identified as potential confounding variables in our study of the association between egg consumption and incident stroke and coronary artery disease were age, gender, race/ethnicity (black, white, others), systolic blood pressure, serum cholesterol level, body mass index (BMI) (calculated as weight in kilograms divided by the square of the height in meters), diabetes mellitus, and cigarette smoking (never, current, former and unknown), and educational attainment ( $< 12$  years, 12, and  $> 12$  years). All measurements were obtained prospectively during the NHANES-I baseline interview. Information regarding the status of cigarette smoking was obtained from the 1982 follow-up. Socioeconomic data and smoking status were self-reported. Diabetes mellitus was determined from the patient's report of a physician's diagnosis. Trained examiners measured the height and weight of each participant during the NHANES-I physical examination.

## Statistical analyses

Because the duration of follow-up varied among the participants, Cox proportional hazard analysis was used to estimate the relative risk (RR) for stroke, ischemic stroke, coronary artery disease, and mortality. We included all patients in the analysis and censored the data for patients who died from noncardiovascular causes. RR for stroke, ischemic stroke, coronary artery disease and mortality for various categories of egg consumption was estimated after adjustment for the established cerebrovascular risk factors. A separate analysis was performed for subsets of interest comparing the effect of egg consumption on risk of stroke, ischemic stroke, coronary artery disease and mortality. The subsets included patients with hypertension defined by blood pressure great-

**Table 1.** Factors associated with weekly egg consumption. NHANES- I\* Epidemiologic Follow-up Study, Baseline evaluation 1971–1975.

Characteristics	Egg consumption					
	No or less than 1 egg per week (N=1628)		1 to 6 eggs per week (N=6139)		Greater than 6 eggs per week (N=1967)	
Age (years ±standard deviation)	50.2±16.1		48.1±15.6**		51.9±15.3**	
Age group						
Less than 45 years	716	(44.0%)	2947	(48.0%)	744	(37.8%)
45 to 64 years	395	(24.3%)	1584	(25.8%)	542	(27.6%)**
65 years and greater	517	(31.7%)	1608	(26.2%)**	681	(34.6%)**
Gender						
Men	531	(32.6%)	2305	(37.5%)	920	(46.8%)
Women	1097	(67.4%)	3834	(62.5%)*	1047	(53.2%)*
Race/ethnicity						
White	1328	(81.6%)	5219	(85.0%)	1524	(77.5%)
Black/other	300	(18.4%)	920	(15.0%)*	443	(22.5%)**
Diabetes						
No	1581	(97.1%)	5965	(97.2%)	1839	(93.5%)
Yes	47	(2.9%)	174	(2.8%)	128	(6.5%)**
Smoking Status						
Never/Unknown	1066	(65.5%)	3998	(65.1%)	1217	(61.9%)
Current/Past	562	(34.5%)	2141	(34.9%)	750	(38.1%)**
Body Mass Index	25.6±5.0		25.7±5.1		25.8±5.2	
Serum cholesterol level (mg/dL)	222.1±51.7		219.8±48.1		223.0±49.7	
Education (years)						
<12	813	(49.9%)	2617	(42.6%)	1207	(61.3%)
12	495	(30.4%)	2088	(34.0%)**	450	(22.9%)**
>12	320	(19.7%)	1434	(23.4%)**	310	(15.8%)**
All stroke (p=0.298)	128		368		159	
Ischemic stroke (p=0.00184)	259		942		383	
Coronary artery disease (p=0.002)	120		331		140	
Mortality (p=0.0010)	583		1808		786	
Cholesterol intake mg	23328±19976		34867±27307		657301±30140	
Cholesterol intake mg [group based on quartiles]						
0 to 15805	672	(41.4%)	1613	(26.4%)	139	(7.1%)
15806 to 30012	566	(34.9%)	1729	(28.3%)	130	(6.6%)
30013 to 51825	257	(15.8%)	1501	(24.5%)	666	(34.0%)
51826 to 367932	127	(7.8%)	1272	(20.8%)	1025	(52.3%)

\* First National Health and Nutrition Examination Survey;

\*\* Significant difference (p<0.025) from comparison with persons with no or less than 1 egg consumed per week.

Cholesterol level Vs Cholesterol intake:

≤200 mg dL – 37161±29091 (Cholesterol intake mg)

>200 mg – 37644±28860 (Cholesterol intake mg)

and

	Cholesterol level ≤200 mg dL		Cholesterol level >200 mg dL	
Cholesterol intake mg [group based on quartiles]				
0 to 15805	893	(25.8%)	1531	(24.6%)
15806 to 30012	867	(25.0%)	1558	(25.0%)
30013 to 51825	862	(24.9%)	1562	(25.1%)
51826 to 367932	844	(24.4%)	1580	(25.4%)

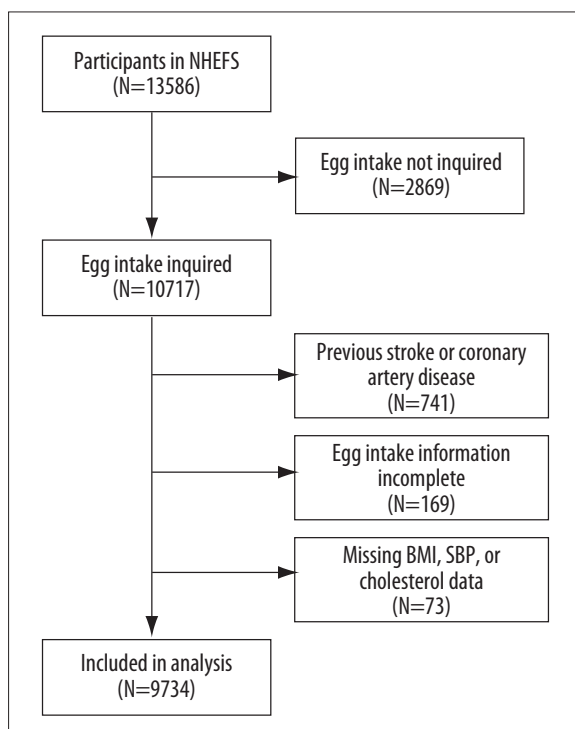
**Table 2.** Weekly egg consumption and risk for stroke, coronary artery disease, and mortality in NHANES-I\* Epidemiologic Follow-up Study, 1982–1992.

Categories according to weekly egg consumption	Total number/per person-years	Event/per person-years	Event rate	Age adjusted RR (95% CI)	Multivariate adjusted** RR (95% CI)
<b>All stroke</b>					
No or less than 1 egg	1628 (26732.2) yr	128 (1425.0) yr	7.9	Referent	Referent
1 to 6 eggs	6139 (103981.0) yr	368 (3953.8) yr	6.0	0.9 (0.7–1.1)	0.9 (0.7–1.0)
Greater than 6 eggs	1967 (31225.4) yr	159 (1620.3) yr	8.1	1.0 (0.8–1.3)	0.9 (0.7–1.1)
p=0.61181					
<b>Ischemic stroke</b>					
No or less than 1 egg	1628 (26732.2) yr	120 (1332.1) yr	7.4	Referent	Referent
1 to 6 eggs	6139 (103981.0) yr	331 (3502.8) yr	5.4	0.8 (0.7–1.0)	0.8 (0.7–1.0)
Greater than 6 eggs	1967 (31225.4) yr	140 (1470.5) yr	7.1	1.0 (0.8–1.2)	0.9 (0.7–1.1)
p=0.96959					
<b>Coronary artery disease</b>					
No or less than 1 egg	1628 (26732.2) yr	259 (2644.4) yr	15.9	Referent	Referent
1 to 6 eggs	6139 (103981.0) yr	942 (10025.5) yr	15.3	1.1 (0.9–1.2)	1.0 (0.9–1.1)
Greater than 6 eggs	1967 (31225.4) yr	383 (3680.3) yr	19.5	1.2 (1.1–1.5)	1.1 (0.9–1.3)
p=0.00861					
<b>Mortality</b>					
No or less than 1 egg	1628 (26732.2) yr	583 (6730.2) yr	35.8	Referent	Referent
1 to 6 eggs	6139 (103981.0) yr	1808 (20736.8) yr	29.5	0.9 (0.8–1.0)	0.9 (0.8–1.0)
Greater than 6 eggs	1967 (31225.4) yr	786 (8537.6) yr	40.0	1.1 (1.0–1.2)	1.0 (0.9–1.1)
p=0.02147					

\* First National Health and Nutrition Examination Survey;

\*\* Multivariate model is adjusted for age, gender, race/ethnicity, systolic blood pressure, diabetes mellitus, serum cholesterol, cigarette smoking, body-mass index, and educational status.

RR – indicates relative risk. CI indicates confidence interval.



**Figure 1.** The reasons for exclusion of NHEFS participants from the analysis. Abbreviations used: NHEFS, National Health and Nutrition Examination Survey Epidemiologic Follow-up Study; BMI, Body-mass index; SBP – systolic blood pressure.

er than 140/90 mm Hg or use of antihypertensive medication, diabetes mellitus, hyperlipidemia defined by serum cholesterol greater than 200 mg/dL, and current cigarette smokers. All analyses were performed with the use of SPSS version 9.0 (SPSS, Inc, Chicago IL).

**RESULTS**

A total of 13586 persons were followed in the NHEFS. Figure 1 demonstrates the reasons for exclusion of participants from the analysis. Dietary questions regarding egg intake were inquired in 10717 persons. However, 983 persons were excluded because of previous history of stroke or MI (n=741), unknown daily egg consumption (n = 169), or missing BMI, serum cholesterol or systolic blood pressure (n=73). Of the 9734 persons included in the analysis, 6139 (63%) and 1967 (20%) reported weekly consumption of 1 to 6 eggs and greater than 6 eggs, respectively; 1628 (17%) reported no or less than 1 egg per week consumption. Persons reporting an average intake of greater than 6 eggs per week were older and those reporting an egg intake of 1 to 6 eggs per week were younger than those with no or less than 1 egg intake per week (Table 1). Persons reporting an average intake of greater than 6 eggs per week were less likely to be white and more likely to be previous or current cigarette smokers. Persons reporting no or less than 1 egg per week were more likely to be women. We did not observe any significant difference in regards to mean values of body-mass index, and serum cholesterol. We did not observe any significant differences between total dai-

**Table 3.** Weekly egg consumption and risk for stroke, coronary artery disease, and mortality among persons with diabetes mellitus in NHANES-I\* Epidemiologic Follow-up Study, 1982–1992.

Categories according to weekly egg consumption	Total number/per person-years	Event/per person-years	Event rate	Age adjusted RR (95% CI)	Multivariate adjusted** RR (95% CI)
<b>All stroke</b>					
No or less than 1 egg	47 (576.7) yr	8 (104.4) yr	17.0	Referent	Referent
1 to 6 eggs	174 (2218.0) yr	37 (427.4) yr	21.3	1.1 (0.5–2.3)	1.1 (0.5–2.5)
Greater than 6 eggs	128 (1493.7) yr	12 (110.8) yr	9.4	0.6 (0.2–1.4)	0.6 (0.2–1.5)
p=0.08663					
<b>Ischemic stroke</b>					
No or less than 1 egg	47 (576.7) yr	8 (74.3) yr	17.0	Referent	Referent
1 to 6 eggs	174 (2218.0) yr	32 (308.0) yr	18.4	0.9 (0.4–2.0)	1.1 (0.4–2.1)
Greater than 6 eggs	128 (1493.7) yr	11 (88.0) yr	8.6	0.5 (0.2–1.3)	0.5 (0.2–1.4)
p=0.08212					
<b>Coronary artery disease</b>					
No or less than 1 egg	47 (576.7) yr	13 (94.2) yr	27.7	Referent	Referent
1 to 6 eggs	174 (2218.0) yr	63 (581.8) yr	36.2	1.2 (0.7–2.2)	1.2 (0.7–2.3)
Greater than 6 eggs	128 (1493.7) yr	56 (469.1) yr	43.8	1.9 (1.1–3.5)	1.9 (1.0–3.5)
p=0.16783					
<b>Mortality</b>					
No or less than 1 egg	47 (576.7) yr	33 (318.9) yr	70.2	Referent	Referent
1 to 6 eggs	174 (2218.0) yr	128 (1348.7) yr	73.6	0.9 (0.6–1.4)	1.0 (0.7–1.5)
Greater than 6 eggs	128 (1493.7) yr	92 (847.4) yr	71.9	1.2 (0.8–1.8)	1.3 (0.9–1.9)
p=0.98392					

\* First National Health and Nutrition Examination Survey;

\*\* Multivariate model is adjusted for age, gender, race/ethnicity, systolic blood pressure, diabetes mellitus, serum cholesterol, cigarette smoking, body-mass index, and educational status.

RR – indicates relative risk. CI indicates confidence interval.

ly dietary cholesterol intakes among strata defined by egg consumption. There was no difference in total daily dietary cholesterol intake between participants with serum cholesterol  $\leq 200$  mg/dL compared with those with  $>200$  mg/dL ( $371.61 \pm 290.91$  mg versus  $376.44 \pm 288.60$  mg).

A total of 655 strokes and 1584 MI were observed during the follow-up period (mean  $\pm$  standard deviation) of  $15.9 \pm 5.6$  years. A univariate analysis demonstrated a trend for increased rates of coronary artery disease and all cause mortality with intake of greater than 6 eggs per week.

In the multivariate analysis (Table 2), we did not observe any relationship with consumption of greater than 6 eggs per week and risk of stroke (RR 0.9, 95% confidence interval [CI] 0.7–1.1) or ischemic stroke (RR 0.9, 95% CI 0.7–1.1) after adjusting for age, gender, race/ethnicity, systolic blood pressure, diabetes mellitus, serum cholesterol, cigarette smoking, educational status and body-mass index. Compared with persons without any egg intake or less than 1 egg per week, there was no significant difference in RR for persons with intake of greater than 6 eggs for risk of MI (RR 1.0, 95% CI 0.9–1.3) or all cause mortality (RR 1.0, 95% CI 0.9–1.1). We did not observe any significantly different risk associated with daily egg consumption in subgroups defined by systolic blood pressure, serum cholesterol, and cigarette smoking. Among 349 diabetic persons (Table 3), we observed an increase risk for myocardial infarction associated weekly egg consumption of greater than 6 eggs per week (RR

2.0, 95% CI 1.0–3.8). The increased risk was not observed for stroke or ischemic stroke. These relationships were not significant among non-diabetic patients.

## DISCUSSION

We did not observe an increased risk for stroke, ischemic stroke, or coronary artery disease with weekly consumption of greater than 6 eggs per week or 1 egg or greater per day. Although previous studies have analyzed this association (Table 4), present results are derived from a nationally representative probability sample of the US civilian non-institutionalized population. Therefore the results potentially lack the biases observed with longitudinal studies conducted on selected population samples. In a previous analysis [10], the association between egg consumption and risk of coronary artery disease and stroke in men and women was examined using data from two prospective cohort studies, the Health Professionals Follow-up Study and the Nurses Health Study. A total of 37851 men aged 40 to 75 years and 80082 women aged 34 to 59 years free of cardiovascular disease, diabetes, hypercholesterolemia, or cancer were followed in this study. A total of 866 incident cases of coronary artery disease and 258 incident cases of stroke in men during 8 years of follow-up and 939 incident cases of coronary artery disease and 563 incident cases of stroke in women during 14 years of follow-up. There was no association between egg consumption and risk of coronary artery disease or stroke in either men or women after adjustment for age,

**Table 4.** A review of previous studies evaluating the effect of egg consumption on cardiovascular events in longitudinal studies.

Studies	End points	Egg consumption of less than 1 per day	Event rate (%)	Egg consumption of 1 or greater per day	Event rate (%)	Multivariate analysis
Hiroshima/Nagasaki study [22]	Stroke	23113	878 (4%)	10977	329 (3%)	No difference in risk after adjusted for age, sex, diabetes, hypertension
NIPPON DATA80 study [23]	Ischemic heart disease	6288	60 (1%)	2975	20 (1%)	Difference in risk after adjusted for age, sex, BMI, total cholesterol
NIPPON DATA80 [23]	Stroke	6288	151 (2%)	2975	68 (2%)	Difference in risk after adjusted for age, sex, BMI, total cholesterol
Men in health professional study [10]	Coronary heart disease	33195	777 (2%)	4656	89 (2%)	Difference in risk after adjusted for age, hypertension, BMI
Men in health professional study [10]	Stroke	33195	223 (1%)	4656	35 (1%)	Difference in risk after adjusted for age hypertension, BMI
Women in nurses health study [10]	Coronary heart disease	65832	866 (1%)	14520	73 (1%)	Difference in risk after adjusted for age hypertension, BMI
Women in nurses health study [10]	Stroke	65832	493 (1%)	14520	70 (0%)	Difference in risk after adjusted for age hypertension, BMI
Oxford vegetarian study [24]	Ischemic heart disease	4555	8 (0%)	6247	56 (1%)	No difference in risk after adjusted for age sex, diabetes, social class

BMI – Body Mass Index

smoking, and other potential coronary artery disease risk factors. In subgroup analyses, higher egg consumption appeared to be associated with increased risk of coronary artery disease only among diabetic subjects. This was similar to the association between egg consumption and myocardial infarction in diabetics observed in our study.

Another study studied a cohort of 27,529 adults who completed questionnaires in 1960 and were followed for mortality between 1960 and 1980 [11]. Within this population, egg consumption was positively associated with mortality because of all causes combined and coronary heart disease in women [11]. A review of epidemiologic data [12] relating dietary cholesterol and eggs to coronary disease risk reported that cholesterol intake was associated with a modest increase in the risk of coronary events. After confounding factors were considered, the association between cholesterol intake and heart disease risk was small (6% increase in risk for 200mg/1,000kcal per day difference in cholesterol intake). Several

studies have examined egg intake and its relationship with coronary outcomes (Table 4). After adjustment for dietary confounders were considered, no association was seen between consumption of 1 egg or greater per day and the risk of coronary heart disease in non-diabetic men and women.

The lack of relationship between egg consumption and cardiovascular diseases may be attributable to lack of association between serum cholesterol and egg consumption. Dawber and colleagues [13] were unable to demonstrate any relationship between 912 men and women participants of the Framingham cohort. In the analysis of 27378 participants from NHANES III, there was no association between egg consumption and serum cholesterol after adjusting for demographic and lifestyle variables. Another study [14] examined the effect of increased egg consumption on serum high-density-lipoprotein (HDL) cholesterol in healthy individuals. After 6 weeks of extra egg consumption, serum HDL cholesterol increased by 10% and total cholesterol increased by 4%, whereas the se-

rum triglycerides and LDL cholesterol were unchanged. In another study [15], eighteen healthy young volunteers on a lacto-vegetarian diet were given one boiled egg per day for 8 weeks in a randomized controlled cross-over study. Compared to the values obtained after 8 weeks of egg-free period, the mean serum total cholesterol, LDL cholesterol, HDL cholesterol, total cholesterol/HDL ratio, very-low-density-lipoproteins (VLDL) cholesterol and triglycerides were not significantly different after 8 weeks of egg consumption. Another study [16] studied the influence of whole fresh eggs on the serum cholesterol level in hospitalized patients. The patients were fed two eggs or the equivalent of two eggs in a custard base or milk shake in addition to the foods that were consumed in their diet pattern. The serum cholesterol level was determined before and at periods varying from 5 hr to 54 days after the consumption of the eggs. In the majority of patients, the serum cholesterol level did not change significantly 5 hours after the consumption of 465 mg of cholesterol in an egg custard base or milk shake or after up to 54 days of continued consumption of two whole eggs per day.

Egg consumption also has not shown to adversely affect other cardiovascular risk factors. Egg consumption may be associated with the reduction of blood pressure [17]. In a cross-sectional study was conducted for 473 [18] middle-aged Japanese men, after adjustment for age, residence, occupation, body mass index and alcohol consumption, mean systolic and diastolic blood pressure were inversely associated with intake frequency of eggs. The investigators attributed the reduction of blood pressure possibly through the intake of protein and potassium. Another controlled cross-over trial was conducted to determine the effects of egg ingestion on endothelial function [19]. Nine healthy adults (mean age 56 years, 40% females) underwent a baseline brachial artery reactivity study, and were assigned to two eggs or oats daily for 6 weeks in random sequence with a 4-week washout. A vasoreactivity test was done at the end of each treatment phase, measuring flow-mediated vasodilation in the brachial artery using a high-frequency ultrasound. Flow mediated vasodilation was stable in both groups, and between-treatment differences were not significant.

We observed an increased risk of myocardial infarction and egg consumption among diabetic patients similar to a previous study. In the Zutphen Study, an oral glucose tolerance test was carried out in 394 non-diabetic men aged 50–70 [20]. Egg consumption was detrimental to glucose tolerance. Diets containing eggs have been shown to produce larger glycemic and insulin responses compared to isocaloric breakfasts in non-insulin-dependent diabetic subjects [21]. Therefore, the detrimental effect of egg consumption on glycemic control in diabetics may account for the increased risk of coronary artery disease [10].

We used primary ICD-9-CM codes from discharge documents and death certificates to identify patients with stroke and stroke subtypes admitted to the hospital. A previous study [25] reported a true positive rate of 83% for primary discharge diagnoses of ICD-9-CM codes 430 to 436 in a population based study. In another study, positive predictive values for the death certificate diagnosis were 100% for all types of stroke and 97% for ischemic stroke compared to a standardized physician diagnosis [26]. On the basis of results of previous studies, we think that hospital discharge or death certificate diagnoses

are sufficiently accurate to justify their use in present studies. Probably more important, the validity of ICD-9 diagnoses does not differ by strata defined by egg consumption.

## CONCLUSIONS

Our study demonstrated that consumption of greater than 6 eggs per week or 1 egg or greater per day did not increase the risk of coronary artery disease, ischemic stroke, or all strokes in a cohort representative of US population.

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