



Position Statement for Healthcare Professionals

Eggs and Risk of Cardiovascular Disease

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As eggs contain dietary cholesterol, which has a small effect on serum cholesterol levels, it has been assumed that a limit on egg consumption will reduce the risk of coronary heart disease (CHD) [1, 2]. However, more recent scientific evidence indicates little association between restricting egg intake and a reduced risk of CHD and stroke in most people [3].

Overview of Epidemiological Studies

Seventeen epidemiological and case-control studies have assessed egg intake and subsequent development of CHD, as summarised in table 1.

The Atherosclerosis Risk in Communities (ARIC) study [4] of 15,792 African-American and white men and women aged 45 – 64 years showed a 23% increased risk of heart failure for each extra serving of eggs consumed per day. Note however the authors did not adjust for dietary variables such as total fat intake, saturated fat intake, and fibre intake, which may have influenced the results/conclusions. Additionally this study did not look at the association between consuming < 7 eggs per week and heart failure. *The Physician's Health study* [5] reported data from 21,327 male participants aged 40 years and over at entry. The results showed that infrequent egg consumption did not increase the risk of CVD, however consumption of ≥ 7 eggs per week was associated with a 23% increased risk of death. Consumption of ≤ 6 eggs per week did not increase the risk of dying. Refer to the Egg Nutrition Council's position statement on Eggs and diabetes for more details in this area. In a separate study of the same cohort, it was found that infrequent egg consumption was not associated with increased risk of heart failure, however greater than or equal to one a day was associated with a 28% increased risk [6]. *The Nurses Health Study* (80,082 women) and the *Health Professionals Follow Up Study* (37,851 men) showed no association between levels of egg consumption of up to one a day and risk of CHD or stroke in both men and women [7]. However, in a sub-group analysis of both cohorts, higher egg consumption appeared to be associated with increased risk of CHD in people with diabetes. Despite this result, further analysis of the study showed that no figures were reported for the number of cases of type 1 or type 2 diabetes and the criteria used to determine diabetes were not reported. Relative risk of CHD in men and women with diabetes progressively increased with increasing egg consumption but absolute risk was not reported and there was no interaction between egg consumption and the presence of diabetes [7]. In a sub-group analysis of 1013 people with diabetes who were enrolled in the Greek arm of the *European Prospective Investigation into Cancer and Nutrition (EPIC)*, a positive association was found between egg intake and diabetic mortality [8]. In a Finnish cohort of 5,133 men and women, there was no difference in egg consumption between individuals who developed fatal coronary heart disease and those who did not [9]. *The Framingham Study* also found no association between egg intake and subsequent development of CHD in a sub-sample of 912 people [10]. Similarly a prospective study of 90,735 subjects in the Japan Public Health Centre-based study showed that although total cholesterol levels were significantly related to an increased risk of CHD, consumption of eggs almost daily was not associated with CHD risk in middle-aged Japanese men and women [11]. Another Japanese study (*NIPPON DATA80*) showed no effect of egg consumption on risk of fatal CHD events, stroke and cancer in men consuming up to two or more eggs a day, however in contrast, found an increased risk in women eating one egg a day or more [12]. *The Oxford Vegetarian Study* (11,140 vegetarians and meat eating study participants) showed a positive association between egg intakes of 6 or more a week and mortality from ischemic heart disease [13]. In contrast, the *Adventist Health Study* (34,192 vegetarian and non-vegetarian Seventh Day Adventists) found individuals consuming more than 2 eggs per week were at no different risk of



developing CHD compared to those consuming less than one egg a week [14]. A recent study using data from the *First National Health and Nutrition Examination Survey (NHANES1)* in the US showed that among 9734 adults aged 25 to 74, no significant difference was observed between persons who consumed greater than 6 eggs per week compared to those who consumed none or less than 1 egg per week in regards to any stroke, ischemic stroke, or coronary artery disease over a 20-year follow-up. In a subgroup analysis among people with diabetes, consumption of greater than 6 eggs per week was associated with an increased risk of coronary artery disease [15]. The SUN Project[16] was a cohort study of 14,185 Spanish university graduates. During a median follow-up of 6.1 years, 91 new confirmed cases of CVD were observed. No association was found between egg consumption and the incidence of CVD for the highest (>4eggs per week) versus the lowest category (0 eggs per week) of egg consumption after adjusting for age, sex, total energy intake, adherence to the Mediterranean food pattern and other cardiovascular risk factors. The ABC Health Study[17] was a long term population study of 1941 older adults aged 70-79 years, aimed to assess the association between dietary fats, cholesterol, and eggs and cardiovascular disease risk. During a 9 year follow up period, 203 cases of cardiovascular disease were reported, including heart attacks, coronary death and stroke. The study found no significant associations between dietary fats and cardiovascular disease risk. No association was found between egg intake, dietary cholesterol and cardiovascular disease risk in any group other than those with type 2 diabetes. Higher intakes of dietary cholesterol and egg intakes greater than 3 per week were associated with increased risk of cardiovascular disease.

Case-control studies

The *INTERHEART study* [18] is a global study which includes 12,461 patients who have had a heart attack and 14,637 controls free of heart disease. From the food intake data, three types of dietary patterns were identified based on the number of times certain foods were eaten: Oriental (characterised by higher intakes of tofu, soy and other sauces), Western (characterised by higher intakes of fried foods, salty snacks and meat) and Prudent (characterised by higher intakes of fruit and vegetables). The prudent dietary pattern was shown to be associated with a lower risk of developing a heart attack while the Western dietary pattern was shown to be associated with an increased risk. There was no association shown between the Oriental dietary pattern and heart attack risk. While higher intake of eggs was included as a characteristic factor in the Western dietary pattern, there was no association reported between eggs as an individual food and heart attack risk. A case-control study of Italian women (287 cases, 649 controls) (found no association between egg consumption of greater than two serves a week and non-fatal myocardial infarction [19]. A Japanese case-control study (660 cases, 1,277 controls) that examined the relationship of selected foods to nonfatal acute myocardial infarction (AMI) found no association between egg intakes up to four or more a week and incidence of AMI [20].

Most of the above studies adjusted the data for non-dietary coronary risk factors, including hyperlipidaemia.

No data is available on the effect of eggs on recurrent coronary events in those with existing CHD.

Table 1: Summary of epidemiological evidence regarding egg intake and CVD

Study	Design	Results
Atherosclerosis Risk in Communities (ARIC) [4]	11 year follow up of 15,792 African-American and white men and women aged 45-64	23% increased risk of heart failure for each extra serving of eggs consumed per day (7 eggs/week)
Physician's Health [5, 6]	20 year follow up of 21,327 male participants aged 40 years and over	Egg consumption did not increase CVD risk, but consumption of ≥ 7 eggs per week was associated with a 23% increased risk of all cause mortality and in a separate study of the same cohort, increased risk of heart failure by 28%. Consumption of ≤ 6 eggs per week did not increase the risk of death from all causes.
NHANES I [15]	20 year follow up of 9734 adults aged 25 to 74	No significant difference between consuming greater than 6 eggs per week compared to less than 1 egg per week in regards to any stroke, ischemic stroke, or coronary artery disease; consumption of greater than 6 eggs per week was associated with an increased risk of CHD in people with diabetes
Japan Public Health Centre-based study [11]	21 year follow up of 90,735 male and female subjects aged 40-69	Total cholesterol levels were significantly related to an increased risk of CHD, however consumption of eggs almost daily was not associated with CHD risk in middle-aged Japanese men and women
Greek EPIC diabetic subgroup [8]	11 year follow up of 1013 Greek adults with diabetes	Positive association with daily egg intake and cardiovascular mortality in people with diabetes
NIPPON DATA80 [12]	14 year follow up of 5186 women and 4077 men aged 30 years and over	No effect of egg consumption on risk of fatal CHD events, stroke and cancer in men or women consuming two or more eggs a day; increased risk of all cause mortality in women eating one egg or more a day
Nurses' Health [7]	14 year follow up of 80,082 women aged 39-54	No association between consumption of up to one a day and risk of CHD or stroke; possible increased CHD risk in people with diabetes
Health Professionals Follow-up [7]	14 year follow up of 37,851 men aged 40-75	No association between consumption of up to one a day and risk of CHD or stroke; possible

		increased CHD risk in people with diabetes
Oxford Vegetarian Study [13]	14 year follow up of 11,140 vegetarians and meat eating study participants	>6 eggs per week associated with increased mortality from ischemic heart disease
Adventist Health Study [14]	6 year follow up of 34,192 vegetarian and non-vegetarian Seventh Day Adventists found individuals	Consuming more than 2 eggs per week presents no difference in risk of developing CHD compared to consuming less than one egg a week
Finnish Study [9]	14 year follow up of 5,133 men and women aged 30-69	No difference in egg consumption between individuals who developed fatal coronary heart disease and those who did not
Framingham Study [10]	24 year follow up of a 912 person sub-sample	No association between egg intake and subsequent development of CHD
INTERHEART [18]	Global study reporting on 5,761 patients who have had a heart attack and 10,646 controls free of heart disease, recruited over 4 years	Western dietary pattern (characterised by higher intakes of fried foods, salty snacks and meat) was shown to be associated with an increased risk of heart attack; no association between eggs and heart attack risk
Italian case-control study [19]	287 cases and 649 controls, all women, conducted over 5 years	No association between egg consumption of greater than two serves a week and non-fatal myocardial infarction
Japanese case-control study [20]	660 cases and 1,277 controls aged 40-79 years	No association between egg intakes up to four or more a week and incidence of acute myocardial infarction
The SUN Project[16]	6 year follow up of 14,185 university students	No association was found between egg consumption and the incidence of CVD for the highest versus the lowest category of egg consumption.
Health ABC Study[17]	9 year follow up of 1941 70-79 year olds	No association was found between egg intake, dietary cholesterol and cardiovascular disease risk in any group other than those with type 2 diabetes. In this group higher intakes of dietary cholesterol and egg intakes greater than 3 per week were associated with increased risk of cardiovascular disease



Randomised Trials

A 2008 randomised trial that examined the effect of egg consumption on inflammatory markers found that consumption of three eggs daily made a significant contribution to the anti-inflammatory effects of a weight loss intervention using a kilojoule-controlled diet [21]. Subjects consuming the eggs had decreased plasma CRP levels, a marker of inflammation, and increased plasma adiponectin levels, a marker of insulin sensitivity. Taken together, these results indicate a lower risk of CVD in subjects consuming the eggs.

Risk Factors for CHD

The lack of a consistent association between egg intake and risk of CHD as outlined above may be explained by the small increase in plasma cholesterol levels following egg consumption that has been observed in experimental studies. Having an elevated plasma cholesterol level is, however, a major risk factor for CHD. HDL cholesterol, in particular, is an independent risk factor for cardiovascular disease and higher levels are found to be cardio-protective[22]. Further information on the effect of eggs on plasma lipids and lipoproteins can be found in the Egg Nutrition Council statement on Eggs, Plasma Cholesterol and Lipoproteins.

Using the results of a meta-analysis of 17 human experimental studies (Weggemans *et al*), McNamara has predicted that the increase in risk of myocardial infarction associated with a 100mg increase in dietary cholesterol from eggs, equivalent to half a 60gram egg or 3-4 eggs a week, has been estimated to range from 0.5% to 1.5% [23]. However as the level of saturated fat in the background diet may attenuate the rise in serum cholesterol levels from eggs, these figures are likely to represent maximal estimates [24]. The effect of adding eggs to a diet already low in saturated fat may therefore be clinically insignificant.

The theoretical increase in risk predicted by McNamara is considered minimal compared to other risk factors for CHD including the 72% increase in risk associated with increased body mass index [25], the 42% decrease in risk associated with replacement of 5% of energy from saturated fat with unsaturated fat [26] and the 51% decrease in risk associated with 90 minutes of vigorous walking one day a week [27].

An in depth review [28] of evidence from epidemiologic, clinical and mechanistic studies assessed the relationship between saturated fats and CVD. Researchers concluded the risk of CVD is reduced when saturated fatty acids (SFAs) are replaced with polyunsaturated fatty acids (PUFAs). In populations who consume a Western diet, the replacement of 1% of energy from SFAs with PUFAs lowers LDL-C and reduces the incidence of heart disease by more than 2-3%. However the researchers state the effect of a particular food, for example eggs, on CVD cannot be predicted solely by their total SFA content because individual SFAs have different effects.

A Canadian study [29] found proteins in boiled or fried eggs can generate angiotensin converting enzyme (ACE) inhibitory peptides in vitro, which work to improve blood flow and blood pressure. As hypertension is a major risk factor for heart disease, these findings show another mechanism by which eggs may reduce heart disease risk, however clinical studies are needed to confirm these results.



International recommendations

The American Heart Association (AHA) revised their dietary guidelines for the general population in 2006, which acknowledges that dietary cholesterol can increase LDL cholesterol, although to a lesser extent than saturated and trans fat [31].

The National Heart Foundation of Australia's 2009 Position Statement on Dietary Fats and Dietary Sterols for Cardiovascular Health [32, 33] states saturated fatty acid intake is associated with CHD, and that dietary cholesterol increases total cholesterol and LDL-C but substantially less so than saturated and trans fatty acids. They recommended that all Australians may consume six eggs per week within a cardio-protective, reduced saturated fat eating pattern without increasing their risk of CVD.

Nutritional Value of Eggs

Eggs provide nutrients that may be associated with protection from CHD or its risk factors. For example, a serve of eggs provides 16-32% of the suggested dietary target (SDT) value to reduce chronic disease risk for folate and 19-27% of the SDT for long chain omega-3 fatty acids for adults, nutrients that have been associated with a lower risk of CHD. Eggs also provide arginine, a precursor to nitric oxide, which in turn plays a central role in endothelial function [34]. The National Heart Foundation of Australia also recognised eggs as a nutritious food, with regular eggs becoming eligible for the healthy eating Tick of approval.

Refer to the Egg Nutrition Council's position statements on *The Role of Eggs in a Healthy Diet* and *Eggs and Fat* for more details in these areas.

Conclusions

Scientific evidence shows little association between egg intake and CHD. The Egg Nutrition Council therefore concludes the following:

- In a healthy Western population, there is insufficient evidence to excessively restrict egg intake as part of a healthy diet. Eggs should be considered in a similar way as other protein rich foods and selected as part of a varied diet that is low in saturated fat and contains a variety of cardio-protective foods such as fish, wholegrains, fruit, vegetables, legumes and nuts.
- Research supports the inclusion of around 6 eggs a week as part of a healthy diet which is in line with the National Heart Foundation of Australia's recommendations.
- In individuals at high risk, such as people with diabetes and those with hyperlipidemia, there is little data to guide recommendations for egg consumption. However, prudent advice is that the inclusion of eggs in the context of a diet low in saturated fat and containing known cardio-protective foods is not associated with increased risk.

This statement is for healthcare professionals only.

**One serve = 2x60g eggs (104g edible portion)*

As diet-induced changes in total cholesterol and lipoproteins vary considerably between individuals, the Egg Nutrition Council recommends individual discussion of the recommendations regarding egg intake with their healthcare professional.



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