

Cholesterol in Egg and Cardiovascular Disease: No More Panic-An Overview

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Abstract

Egg is a balanced food containing high quality protein, minerals and vitamins. It is also a rich source of dietary cholesterol and because of its high cholesterol content, there has always been a controversy regarding its association with cardiovascular disease (CVD) or coronary heart disease (CHD). Though eggs are important sources of cholesterol, data available on the effects of egg consumption on the risk of CVD and mortality are inconsistent. Therefore, the review was conducted to depict, role of egg consumption in cardiovascular disease.

Keywords: Cardiovascular disease (CVD), Cholesterol, Egg.

Introduction

Eggs represent an inexpensive and low calorie source of high quality protein, minerals such as iodine phosphorous and selenium and vitamins such as A, B₂ (riboflavin), B₉ (folate), B₁₂ (cobalamin), choline, D, and K. However, because of the high cholesterol content, it has always been associated with CVD (Thomas *et al.*, 1982). At the other site interest in cholesterol has fallen for consumers as they become tired and confused by conflicting information. The health conscious consumers demand for the wholesome, healthy and nutritious food products (including eggs) free from harmful residues. They are ready to pay for the products which are more beneficial, wholesome and health promoting in order to improve their well being (Sahoo and Jena, 2014). To date, the majority of prospective studies have found no significant association between egg consumption and risk of CVD or stroke (Dawber *et al.*, 1982). Moreover, there has been a lack of consistent literature to support the notion that regular or near-regular egg eating leads to substantial elevation in serum lipids and total cholesterol levels.

CVD is now a public health issue, affecting millions of people in both developed and developing countries. In low and middle income countries, the prevalence of CVD has increased dramatically. By 2020, the disease is forecasted to be the major cause of morbidity and mortality in most developing nations (Celermajer *et al.*, 2012). Restricted egg consumption is widely recommended in efforts to lower blood cholesterol and mitigate risk of heart disease. However, there has been little, if any evidence that egg consumption is directly related to CVD risk (Song and

Kerver, 2000). The pioneering work (Keys *et al.*, 1980) stimulated many subsequent studies of diet and CVD, which have since evaluated the effects of numerous dietary nutrients, foods and dietary patterns on CVD risk. It has been observed that for most people, cholesterol in food has a much smaller effect on blood levels of total cholesterol and harmful low density lipoprotein (LDL) cholesterol than does the mixing of fats in the diet. It has been found that moderate egg consumption; up to one a day does not increase heart disease risk in healthy individuals and can be part of a healthy diet (Fernandez, 2006).

Cholesterol: Utility and Metabolism

The relative importance of dietary cholesterol to CVD risk, and the association between dietary and serum cholesterol are both subject to ongoing debate. Cholesterol is essential as a precursor of steroid hormones which include both sex steroids and corticosteroids. It is also essential for the synthesis of bile acids apart from being a compulsory constituent of cell membranes. Cholesterol plays a vital function being a constituent of myelin and maintains the brain cell membrane stability. 75% of circulating cholesterol is actually synthesised in liver and not directly eaten. Cholesterol level less than 100 mg/dl may cause death (Kaminski, 2000). Human body requires cholesterol and liver manufactures cholesterol of almost 12 eggs/day. Egg contains near about 210-230 mg of cholesterol which is high on absolute terms but, when calculated per unit weight of fat, it is comparable to most of the other animal products. Liver has twice the amount of cholesterol compared to eggs. Low fat, high-carbohydrate diets have been widely recommended as a

way to reduce the risk of CVD. Populations with low intake of saturated and total fat tend to be at low risk, as saturated fat increases LDL cholesterol levels (Grundy *et al.*, 1982). However, low-fat, high-carbohydrate diets also reduce high-density lipoprotein (HDL) cholesterol levels and raise fasting levels of triglycerides. Replacing saturated fat and trans-unsaturated fat with unhydrogenated unsaturated fats has clear beneficial effects on blood lipids (Mensink and Katan, 1992) and thus provides an alternative strategy for reducing the risk of CHD. An equation developed (Mensink and Katan, 1992) predicts that substituting fatty acids from 1 egg for carbohydrates would raise HDL cholesterol by about 2% (assume HDL level of 1.03mmol/L [40 mg/dL]) and decrease triglycerides also by about 2% (assume triglyceride level of 2.82 mmol/L [250 mg/dL]). The effects of egg consumption on raising HDL levels have been observed in some metabolic studies but not in others. Several metabolic studies have suggested a hypocholesterolemic effect of decholesterolized eggs (i.e., egg beaters) on blood cholesterol levels compared with whole eggs (Roberts *et al.*, 1981). One egg has about 5 grams of fat, but most of this is the “good” unsaturated fat that you need to be healthy. An egg contains only about 1.5 grams of saturated fat and no trans fat at all. The cholesterol in eggs has only a small insignificant effect on LDL cholesterol, especially when compared with the much greater effects that saturated and trans-fats in our diet have on LDL cholesterol. Some people are more sensitive to dietary cholesterol. This means that their LDL cholesterol levels rise from eating foods containing cholesterol more than other people’s do.

Risk Factors for CHD or CVD

CHD or arteriosclerosis is a patchy focal disease of the arterial wall. Coronary arteries are at high risk. Sub-endothelial accumulation of lipids attracts macrophages into endothelial space which ultimately leads to uncontrolled entry of lipoproteins into the vessel wall. Consequently, the lumen will be narrowed and after a cascade of events there occurs intra vascular thrombosis (Massie and Granger, 2005).

About 200 risk factors for heart diseases have been listed. Among the known risk factors for CVD, levels of LDL cholesterol have aroused particular attention. Though diet is an important determinant of serum cholesterol, dietary cholesterol has only a modest contribution to plasma concentrations of LDL cholesterol. Apart from dietary cholesterol, saturated fat and dietary patterns might also influence blood cholesterol levels (Spady *et al.*, 1993). Besides, other important factors include elevated blood pressure, smoking and obesity. Ancestry, sex, age, lifestyle and

diabetes mellitus are different determining factors for this lethal heart disease. Regular egg consumption tends to be associated with unhealthy lifestyle factors such as smoking and physical inactivity. Higher consumption of eggs is also likely to be associated with increased consumption of red and processed meats. These confounding factors tend to exaggerate rather than mask the association between egg consumption and cardiovascular disease risk. Egg consumption was positively associated with smoking, lower physical activity, and a generally unhealthy eating pattern (i.e. more whole milk, red meat, and bacon and less skim milk, vegetables and fruits) in men. Confounding due to these factors would artifactually produce elevated risk for egg consumption. Insulin resistance, hypertension, impaired glucose tolerance, elevated fasting plasma glucose (FPG), dyslipidemia, abdominal adiposity, obesity, inactivity and genetic characteristics are among the complex web of risk factors that can indicate risk for future development of type 2 diabetes mellitus. Many of the risk factors for type 2 diabetes mellitus are also CVD risk factors (American Diabetes Association, 2011). As expected, an apparent positive association with higher egg consumption in the age-adjusted analysis in men was attenuated after adjustment for smoking and other covariates. This speaks to the importance of considering overall eating patterns when examining the effects of egg consumption (Frank *et al.*, 1999). However a cohort study from Japan found that increased consumption of animal products (including eggs) was associated with reduced risk of total and hemorrhagic stroke death (Sauvaget *et al.*, 2003). A wealth of epidemiologic studies has evaluated associations between dietary exposures and CVD. The general consensus from the evidence currently available is that a reduced consumption of saturated and trans fatty acids and a higher intake of fruits and vegetables, polyunsaturated fatty acids including ω -3 fatty acids, and whole grains are likely beneficial (Lichtenstein *et al.*, 2006). Numerous studies have shown that dietary cholesterol can increase serum LDL-cholesterol, but the size of this effect is highly variable between individuals and, according to over 30 years of prospective epidemiology, has no clinically significant impact on CVD risk. Variation in response to dietary cholesterol is a real phenomenon and we can now identify nutrient–gene interactions that give rise to this variation through differences in cholesterol homeostasis (Lee and Griffin, 2006). Large epidemiological studies have found that consumption of one egg per day is unlikely to have any substantial effect on cardiovascular disease risk in healthy subjects (Dawber *et al.*, 1982). Although several metabolic ward studies showed that dietary cholesterol is a major

determinant of serum cholesterol concentrations (Mattson *et al.*, 1972), other studies failed to detect changes in serum total cholesterol concentration when egg was added to diets that already contained moderate amounts of cholesterol (Kummerow *et al.*, 1977). Furthermore, epidemiologic studies in the United States did not detect any associations between egg consumption and serum cholesterol concentrations or cardiovascular events (Hu *et al.*, 1999)

Egg Intake and Coronary Outcomes

Several studies have examined egg intake and its relationship with coronary outcomes. After adjustment for dietary confounders were considered, no association was seen between consumption of one egg or greater per day and the risk of CHD in non-diabetic men and women (Qureshi *et al.*, 2007). However, when one considers the effect of diet on CVD risk, the effect of cholesterol intake on CVD risk is less consistent than is that of saturated and *trans* fatty acid intakes (Kratz, 2005). According to a meta-analysis, egg consumption is not associated with the risk of CVD and cardiac mortality in the general population. However, egg consumption may be associated with an increased incidence of type 2 diabetes among the general population and CVD co-morbidity among diabetic patients (Shin *et al.*, 2013). Several meta-analyses of observational studies and randomized controlled trials have found that a reduction in concentrations of LDL cholesterol could significantly reduce the risk of CHD and stroke incidence and mortality. In another study (Chakrabarty *et al.*, 2002) eighteen healthy young volunteers on alacto-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. An experiment also stated that cholesterol-rich foods such as egg yolks that are relatively low in saturated fatty acid content have small effects on LDL cholesterol levels (Krauss *et al.*, 2000). The association between dietary cholesterol and coronary events and mortality is generally positive but rather weak, and derived largely from ecological and prospective cohort studies with variable follow-up (Keys, 1970). In large prospective cohort studies of men and women, no overall significant association between egg consumption (up to one egg per day) and risk of CVD or stroke was found. There was no evidence for a significant increase in risk with either recent or relatively long-term (over the past decade) egg consumption. Despite somewhat different patterns

of egg consumption in men and women, the results from the 2 cohorts were remarkably consistent, but in subgroup analyses, egg consumption appeared to be associated with increased risk of CVD among individuals with diabetes (Frank *et al.*, 1999). Based on the 116 food items in the 1984 food frequency questionnaire in National Health Service (NHS) of United Kingdom (UK), estimation was made that egg consumption contributed to 32% of total dietary cholesterol. Eggs also made contributions to dietary intakes of many other nutrients, including vitamin D (5%), retinol (4%), folate (4%), monounsaturated fat (3%), vitamin B₁₂ (3%), vitamin B₂ (3%), protein (3%), saturated fat (2.5%), linoleic acid (2%), calcium (1.3%), vitamin B₁ (1.2%), and vitamin B₂ (1.2%). It is conceivable that the small adverse effect of cholesterol in an egg on plasma LDL levels is counter balanced by potential beneficial effects on HDL and triglycerides, and of other nutrients including antioxidants, folate, other B vitamins, and unsaturated fats (Frank *et al.*, 1999). Ultimately, consumption of greater than six eggs per week or one 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 (Qureshi *et al.*, 2007). The apparent increased risk of CVD associated with higher egg consumption among diabetics warrants further research. In the aggregate, the evidence supports an important role for internal metabolic control over serum cholesterol levels, with dietary fat (quality and quantity) influencing plasma cholesterol far more than dietary cholesterol (McNamara *et al.*, 1987). Finally, eggs are less rich in saturated fat than many other protein foods; hence, they may have only a minor effect on cholesterol levels (Kritchevsky and Kritchevsky, 2000)

Conclusion

Egg is a major source of dietary cholesterol with an average egg containing approximately 210 mg cholesterol. On the other hand, eggs contain other nutrients such as minerals, B vitamins, proteins, and monounsaturated fatty acids that could reduce the risk of CVD. Though eggs are a major source of dietary cholesterol, the need to limit egg consumption becomes necessary only if the intake of other foods high in cholesterol is not restricted. How much the cholesterol in your diet can increase your blood cholesterol varies from person to person. Cholesterol is an unavoidable component of human diet and egg is a good source of it. As far as cardiac diseases are concerned egg cholesterols are never a threat. Rather, it can be better utilised as a source of required cholesterol besides its optimum biological value, if it is taken according to a standardised protocol prepared by nutritionists. However, diabetic and fatty persons with high blood

pressure can consume egg under the guidance of

physicians and nutritionists.

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