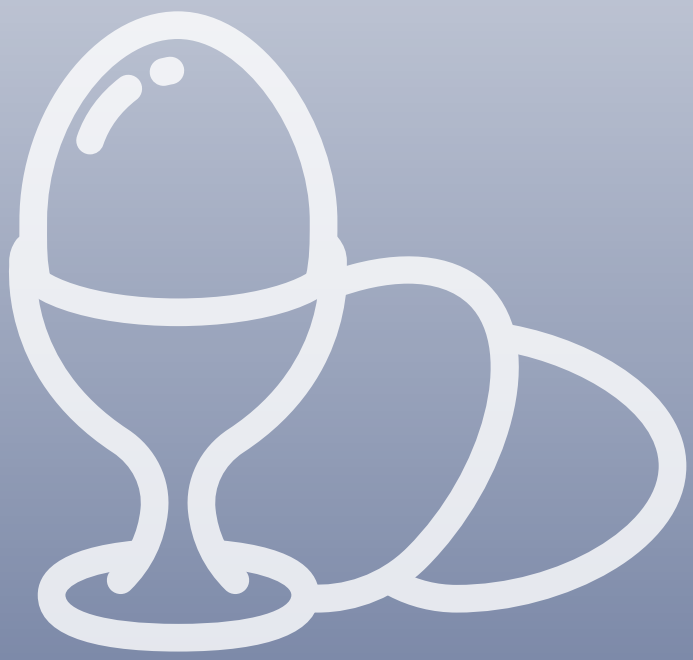
Summary of Evidence

Heart Foundation

Eggs & Cardiovascular Health



Summary of Evidence

This Summary of Evidence presents contemporary evidence relating to eggs and cardiovascular health and underpins the Heart Foundation's position statement: *Eggs and Heart Healthy Eating*[1].

Contents

Summary

The recent evidence surrounding egg consumption and risk of cardiovascular disease is mixed. However, the weight of evidence suggests that eggs have a neutral relationship with heart health neither remarkably increasing nor decreasing risk. This suggests eggs can be included as part of a heart healthy eating pattern and can be chosen as one of a variety of protein foods- including fish and seafood, legumes, nuts and seeds, and poultry – recommended in preference to unprocessed red meat.

Consumption of dietary cholesterol in eggs increases blood levels of low density lipoprotein cholesterol (LDL-C), along with high density lipoprotein cholesterol (HDL-C) and the LDL:HDL cholesterol ratio, but does not increase triglycerides.

This suggests caution for people with cardiovascular disease who require LDL-C lowering interventions and it is recommended they limit their consumption of eggs to 7 per week due to the LDL-C raising effect of eggs.

There is consistent evidence for an increased risk of cardiovascular disease in people living with Type 2 Diabetes Mellitus (T2DM). People living with T2DM should limit their consumption of eggs to 7 per week due to this increased risk.

Background

Eggs are a complete source of protein, containing all 11 essential amino acids, along with Vitamin A, E and B12, selenium, choline and iron.[2,3] Eggs contain around 6g protein per 60g egg, and are also a source of saturated fat (3g/100g), monounsaturated fat (5g/100g) and polyunsaturated fat (1.6g/100g) including omega-3 (170mg/100g) primarily DHA and ALA.[3,4] Egg yolks are high in cholesterol (approximately 200mg per egg yolk) and are a major source of dietary cholesterol in Australia.[5] Dietary cholesterol increases blood cholesterol concentrations, although the rise in most people is minimal.[6] Foods high in saturated and trans-fat are responsible for the greatest impact on plasma cholesterol levels.[7,8]

Given the relationship between elevated plasma cholesterol and cardiovascular disease, global dietary guidelines and recommendations have previously recommended limiting food sources of cholesterol including eggs. Thus the role of eggs in cardiovascular disease has widely been debated, with continued discussion about the amount of eggs which can be included in a heart healthy eating pattern.

Given the current understanding of dietary patterns,[9] and the relationship between different components in food (including saturated, trans and unsaturated fats, and fibre) and dyslipidaemia, the Heart Foundation sought to determine the role of egg consumption in a heart healthy eating pattern through a review of systematic reviews and meta-analyses. This Summary of Evidence summarises the available evidence and informs the Heart Foundation's position on eggs and the Heart Foundation's broader position on healthy eating.

Method

The following steps were taken to produce this *Summary of Evidence*:

1. A systematic review of meta-analyses published between 2013 – 2018 was undertaken using key words "egg*" and "cardiovascular disease", "type 2 diabetes", "cholesterol"
2. This was supplemented with handsearching reference lists and key reports, to identify reviews, trials and meta-analyses published since 2009 (i.e. the cut-off point for the Evidence Review informing the current Australian Dietary Guidelines).

Summary of evidence

The evidence base mainly consists of observational studies for cardiovascular outcomes and some randomised controlled trials (RCTs) investigating blood cholesterol. For brevity, only meta-analyses of cohorts and RCTs, and pooled analyses of cohorts are reported in this Summary of Evidence.

Egg consumption and cardiovascular risk factors and outcomes

Cardiovascular disease

Various systematic reviews and meta-analyses have investigated the association of egg consumption and risk of CVD, with the majority finding no association. In a meta-analysis of observational studies, each 50g increase in egg consumption (approximately one egg) was not associated risk with CHD (RR= 1.00, 95% CI=0.95-1.06).[10]

In a dose response meta-analysis of prospective cohort studies consumption of 1 egg/day was not associated with an increased risk of CHD (RR= 0.99, 95% CI=0.85-1.15, p=0.88).[11] In another meta-analysis of prospective cohort studies, egg consumption was not associated with the risk of CVD or cardiac mortality among the general population. (HR= 0.96, 95% CI=0.88-1.05).[12] A further meta-analysis concluded that egg consumption had no association with CVD risk (RR= 0.97, 95% CI=0.88-1.07).[13]

In contrast a meta-analysis of cohort, case-control and cross-sectional studies compared low and high egg consumption (more than one egg/day) and found increased risk of CVD (RR= 1.19, 95% CI=1.02-1.38, p=0.0001).[14] This was further strengthened by a dose-response analysis which increased the risk of CVD by 6% at 4 eggs/week. However, the association was more prominent in patients with diabetes and in Western populations other than the USA and was the only meta-analysis that used case-control and cross-sectional studies which are weaker study designs. Another meta-analysis of prospective cohorts found 4 studies with deleterious effects and 9 with a neutral relationship between eggs and CVD, resulting in a 19% increase in risk for every 100g consumed (about 2 eggs).[15]

A recent observational cohort study in more than 28,000 adults in China looked at egg consumption and risk of CVD and found after 9.8 years of follow-up there was no significant difference in risk of CVD and all-cause mortality between those consuming more than 7 eggs/week and those consuming less than 1 egg/week.[16] In another recent Chinese cohort, half a million participants were followed up after 8.9 years and egg consumption of 1 egg/day was significantly associated with lower risk of CVD, ischaemic heart disease, major coronary events, as well as haemorrhagic and ischaemic stroke.[17]

Stroke

Egg consumption has also been linked to a lower risk of hypertension. In a meta-analysis of prospective cohort studies, regular egg consumption was associated with a lower risk of hypertension (RR=0.79, 95% CI=0.68-0.91, p=0.001).[18] A smaller meta-analysis also found an inverse association between the highest and lowest egg intake category with risk of hypertension (RR=0.54, 95% CI=0.32-0.91), and for every additional 50g intake (approximately 1 egg) a further reduction (RR=0.25, 95% CI=0.08-0.74).[19] Given the small number of studies in this analysis, the results should be interpreted with caution.

Heart Failure

High compared to low egg consumption was associated with an increased risk for heart failure (RR= 1.16, 95% CI=1.03-1.31) with the risk of heart failure increasing by approximately 50% with increasing intake of egg up to 100 g/d (2 eggs).[10] These findings are also strengthened by the results of the Physicians Health Study from 2008, a cohort of 21,275 physicians followed up for an average of 20.4 years. Egg consumption up to 6 times per week was not associated with heart failure, while egg consumption of > or = 7 per week was associated with an increased risk.[20]

Egg consumption and blood cholesterol

Elevated serum cholesterol is a long-established risk factor for heart disease, first demonstrated by the Framingham Heart Study.[21] However the relationship between this and dietary cholesterol has not always been evident. The consumption of dietary cholesterol and its impact on serum cholesterol varies between individuals and this is likely responsible for the observed discrepancies in studies.

Historically the majority of the evidence base investigating eggs and cardiovascular disease has focused around dietary cholesterol and lipid changes. Very few studies in the past 5 years have focused on this particular area, instead looking at CVD mortality and risk. An earlier meta-analysis of RCTs investigated the effect of dietary cholesterol on the ratio of total cholesterol and HDL cholesterol.[22] They concluded that for every additional egg consumed in a day, the ratio was predicted to increase 0.04 units, which would predict a small increased risk of coronary heart disease. A recent meta-regression analysis of RCTs found dietary cholesterol (as found in eggs) do increase LDL cholesterol along with HDL concentrations and the LDL to HDL cholesterol ratio, and don't increase triglycerides.[6]

Egg consumption and risk of diabetes

Many of the studies identified for cardiovascular outcomes also investigated the risk of diabetes linked to egg consumption, with many showing an increase in the risk of diabetes with higher egg consumption. One meta-analysis of prospective cohorts found that compared to those who never eat eggs, those who eat 1 egg/day or more are 42% more likely to develop type 2 diabetes (HR=1.42, 95% CI=1.09-1.86).[12] Another meta-analysis found the highest egg consumers compared to the lowest had a 66% raised risk of diabetes. (RR= 1.66, 95% CI=1.41-2.00, p=0.000).[14]

A systematic review reported 5 of the 9 studies located found a statistically significant association between diabetes risk and egg consumption.[23] Two studies did not find a statistically significant association, and of these one had an older population and a lower egg intake and the other was based on self-report of diabetes. In a systematic review and meta-analysis investigating the association of foods on chronic disease, every increment increase in egg consumption of 100g (about 2 eggs) increased the risk for type 2 diabetes by 68%.[15] There seems to be a growing body of evidence linking egg consumption and risk of developing diabetes. However, more research is needed to better understand this relationship.

Risk of Cardiovascular Disease in people living with type 2 Diabetes (T2DM)

In contrast to the mixed evidence between eggs and CVD in populations without diabetes, there is consistent evidence of an increased risk of CVD for people living with T2DM consuming more than 7 eggs/week.

One meta-analysis of prospective cohorts observed egg consumption of greater than 7 per week is associated with 69% more CVD events in men and women living with type 2 diabetes.[12] A dose-response sub group analysis with diabetic patients in another meta-analysis found that every increase in egg consumption of 4 per week was associated with a 40% increase in CVD risk.[14] Another subgroup analysis suggested that consumption of up to 1 egg/day was associated with a statistically significant elevated risk of CHD in diabetic populations.[11] A systematic review of prospective cohort studies also found a statistically significant increase in CVD risk and egg consumption in diabetic individuals.[23]

In contrast, an intervention trial, supported by a research grant from the Australian Egg Corporation, found no adverse effects on two key cardiovascular risk factors: lipids or weight.[24,25] This RCT investigated high egg diets in individuals with diabetes and the risk of CVD. Participants who went on a high-egg diet (defined as eating more than 12 eggs/week) or a low-egg diet (no more than one egg/week) during a 3-month weight-loss period lost the same 3.1 kg of weight over a subsequent 6-month follow-up period. Furthermore, in another publication from the same study, no adverse effect of dietary cholesterol on lipids over a three-month period was found between diabetics or pre-diabetics consuming 12 eggs/ week and those eating 2 eggs/week.

Another study investigated the link between egg consumption and CVD in diabetics using the PREDIMED cohort of 7216 participants of 55-80 years old.[26] Not withstanding the recent retraction of the PREDIMED study, this particular investigation has uniquely been able to analyse the association between egg consumption and CVD in diabetics because half of the population had diabetes. In this study higher egg consumption was not linked with a higher risk of CVD in patients with diabetes and those without, although these results should potentially be treated with caution.

Commentary on characteristics of the evidence base

Gaps in the literature

There are some significant gaps in the literature surrounding eggs and cardiovascular disease. As cardiovascular disease is progressive with many co-morbidities it is important that further research looks into the links between egg consumption in individuals who are overweight/obese, insulin resistant or with metabolic syndrome, all which increase the risk of CVD. There is also a gap in the research in populations who are at high risk of CVD. None of the most recent meta-analyses investigated specific populations including those at high risk or with existing heart disease, including those with hyperlipidaemia. Previous dietary advise has recommended the restriction of eggs for those at high risk of CVD. However, the research to support this is scarce as these populations are often experiencing some form of heart disease and are therefore on medication, often disguising or masking the benefits/harms of eggs.

Limitations

The majority of the evidence available for the association of egg consumption and cardiovascular disease is observational in nature. Observational studies cannot prove cause and effect and instead point towards a correlation. The potential for bias in these studies is higher and the meta-analyses utilising these study designs are not immune to the limitations. Many of the studies and resulting meta-analyses do not adequately report on how many eggs are consumed, instead referring to highest vs lowest intakes, which is often collected through the use of non-validated food frequency questionnaires. There is also little to no information on how eggs are consumed, how they are cooked and the background diet or dietary pattern they are consumed with. It should also be noted that many of the studies do not account properly for confounders, general nutrition status and background diet along with positive lifestyle factors and habits which may be common amongst egg consumers and could be influencing the results.

Industry funding

Many of the studies investigating eggs are funded or part funded by the egg industry. Industry funding can skew the evidence-base available from the published literature not only by invariably reporting results favourable to the sponsors interests but also by the sheer amount of studies undertaken, giving the appearance of a stronger evidence base.[27,28] Of the 13 studies investigated, 4 had some funding by the egg industry. Of note are the 3 studies suggesting very high egg consumption (up to 14 per week) does not impact upon CVD in diabetics which were all funded in some way by industry.

Conclusions

Studying the relationship between a food or nutrient and health outcomes is complex. The evidence base is mainly observational studies, primarily prospective cohorts, with a small number of randomised controlled trials (RCT) for outcomes including weight gain, blood pressure and blood lipids. These studies bring inherent limitations to understanding the relationships between a food and health outcomes. A food cannot be studied in isolation without considering the effect of the food replacing it, observational studies are not able to determine causation, and most trials can only feasibly investigate short-term outcomes.

With these limitations in mind, the following conclusions can be made:

- The recent evidence surrounding the association between egg consumption and risk of cardiovascular disease is mixed. However, the weight of evidence suggests that eggs have a neutral relationship with heart health, neither remarkably increasing nor decreasing risk.
- There is consistent evidence for an increased risk of cardiovascular disease in people living with type 2 Diabetes Mellitus (T2DM), and an emerging evidence base for the increased risk of T2DM with higher egg intake.
- Consumption of dietary cholesterol in eggs increases blood levels of low density lipoprotein cholesterol (LDL-C), along with high density lipoprotein cholesterol (HDL-C) and the LDL:HDL cholesterol ratio, but does not increase triglycerides.

Given this evidence, there is not enough evidence to suggest a limit on egg consumption for people without CVD or T2DM. For this population, eggs can be included as one of a variety of protein foods in a healthy eating pattern – including fish and seafood, legumes, nuts and seeds, and poultry – in preference to unprocessed red meat.

However, there is evidence to limit egg consumption to <7 per week as part of a healthy eating pattern for those with T2DM and those with cardiovascular disease who require LDL-C lowering interventions.

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