

Position Statement for Healthcare Professionals

Eggs and Diabetes

Updated June 2012

Reports indicate that currently, one million Australians have diabetes, predominantly type 2¹. More recent data from the National Health Survey indicates that almost 700,000 people (or 3.6% of the population) reported they had diabetes². This increase coincides with the increasing prevalence of overweight and obesity³. Previously thought to only occur in adulthood, type 2 diabetes is now increasingly being identified in younger age groups. Alarming, a 2009 Australian study found that unless trends in diabetes incidence are reversed there will be at least 2 million Australian adults with diabetes by 2025. If obesity and diabetes incidence trends continue upwards, and mortality continues to decline, up to 3 million people will have diabetes by 2025, rising to 3.5 million by 2033.⁴ Diabetes is a strong risk factor for the development of cardiovascular disease, and if current rates continue to rise, it is possible the recent decline in heart disease may be reversed.

Serum cholesterol levels are an important risk factor and aggressively treated in people with diabetes. 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)^{5,6}. And while recent scientific evidence indicates little association between restricting egg intake and a reduced risk of CHD and stroke in most people⁷, research conducted in the area of eggs, dietary cholesterol and diabetes management is limited in quantity and quality and there is only one clinical trial that has directly investigated the impact of egg consumption in people with type 2 diabetes.

Summary of Epidemiological Studies Involving Egg Consumption

Two epidemiological studies have examined the risk of developing type 2 diabetes based on levels of egg consumption⁸. Five epidemiological studies have examined the association between egg consumption and coronary heart disease (CHD) risk or mortality in people with type 2 diabetes. Of these studies, one was conducted only in people with diabetes and showed an increased risk of cardiovascular mortality with consumption of one or more eggs a day⁹. Three studies were larger investigations that involved subgroups of people with diabetes, and have shown a possible increase in risk in those consuming 6-7 eggs per week^{10,11}. One, more recent study found that higher intakes of dietary cholesterol and egg intakes greater than 3 per week were associated with increased risk of cardiovascular disease¹².

While epidemiological studies provide insight into possible associations, they do not necessarily conclude causal relationships due to the many confounding factors. The studies involving eggs and diabetes are outlined in table 1.

Table 1: Summary of epidemiological evidence regarding egg intake in people with diabetes

Study	Details	Results	Comment
Physicians' Health Study I (PHS I) and the Women's Health Study (WHS) ⁸	20,703 men aged 40 years and over from 1982-2007 and 36,295 women aged 45 years and over from 1992-2007	Men who ate 5-6 eggs per week had a 46% higher risk of developing type 2 diabetes than no eggs; 58% higher for 7 or more eggs per	Did not adjust for baseline dietary cholesterol intake, glycemic index or intake of wholegrains or fibre, known factors that reduce

		<p>week.</p> <p>Women who ate 2-4 eggs a week had a 19% higher risk; 77% higher for 7+ eggs a week.</p> <p>In both groups, a significant statistical trend showed an increased type 2 diabetes risk with increased egg consumption.</p>	<p>the risk of type 2 diabetes and/or affect blood glucose responses. Other dietary variables and family history of diabetes were not considered in the analyses which may have influenced the results. Family history alone results in a five times greater risk of developing diabetes.</p>
Case-control study ¹³	234 cases aged 35-86 years with a newly confirmed diagnosis of type 2 diabetes according to WHO criteria. 468 controls.	Participants who consumed >5 eggs per week had a higher risk (threefold) of type 2 diabetes than those who consumed <1 egg per week.	Authors suggest some limitations to the study including that egg consumption was self-reported and nutrient and energy intakes from dietary habits were not calculated.
Physician's Health Study I ¹⁴	21,327 male participants using a food frequency questionnaire to determine egg intake	<p>No association between egg intake and risk of MI or stroke.</p> <p>Among physicians with diabetes, a significant trend existed as the number of eggs consumed per week increased, the risk of all cause mortality also increased (p for trend < 0.001).</p> <p>Highest risk in those consuming 5-6 eggs per week (127% greater risk than consumption of <1 egg per week); >7 eggs per week</p>	<p>Analyses did not adjust for dietary variables such as total fat, saturated fat, energy (kilojoule) or fibre intake, or wholegrain or fruit intake.</p> <p>As there are numerous potential confounding factors, it is not possible to make any conclusions regarding egg consumption and mortality from this study.</p>

		carried a 101% greater risk.	
Health Professionals Follow-up Study and the Nurses' Health Study ¹¹	14 year follow up of 37,851 men aged 40-75 and 80,082 women aged 39-54. Dietary data was collected using a food frequency questionnaire	Risk of CHD and stroke was elevated with increasing egg intake in people with diabetes. In men with diabetes, the risks of CHD were: less than 1 egg per week (1.0), 1 per week (1.0), 2 to 4 per week (1.16), 5 to 6 per week (1.16), and 1 or more eggs per day (2.02) (p=0.04 for trend). The corresponding relative risks for women with diabetes were 1.0, 0.91, 1.05, 1.87, and 1.49 (p=0.008 for trend).	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.
Nurse's Health Study ¹⁵	5672 women with type 2 diabetes diagnosed between 1976 and 1996	CVD risk was increased with a diet characterised by higher levels of cholesterol and saturated fat. Relative risk of CVD from an increase of 200mg cholesterol / 1000kcal (equivalent to one egg per 1000kcal) was 1.37 (p=0.003).	As a higher P:S ratio was associated with a lower risk, the authors concluded that among diabetic persons, lowering dietary cholesterol and replacing saturated fat with monounsaturated fat may be effective in lowering CVD risk.
First National Health and Nutrition Examination Survey (NHANES-1) ¹⁰	Dietary data from 9734 adults aged 25 to 74 years was collected using a food frequency questionnaire, follow up of 20 years	Risk of coronary artery disease (CAD) was elevated in people with diabetes consuming greater than six eggs per week (RR 2.0 (95% CI: 1.0-3.8)	Authors noted the increased risk of coronary artery disease associated with higher egg consumption among people with diabetes warrants further investigation.

<p>European Prospective Investigation into Cancer and Nutrition (EPIC) ⁹</p>	<p>Subgroup analysis of 1013 subjects with diabetes followed up over 4.5 years. Subjects were only included if their diabetes was managed by medication and all subjects were taking medications for hypertension and/or dyslipidaemia. Category for eggs included both whole eggs and all egg dishes, such as desserts and mayonnaise</p>	<p>Egg intake was positively associated with mortality in people with diabetes (hazard ratio 1.31 for an increase of 10g egg products daily, CI: 1.07-1.60). Saturated fat also showed a positive association with mortality in people with diabetes (hazard ratio 1.82 for an increase of 10g daily) while physical activity was protective.</p>	<p>No information on quintiles of intake is presented, so it is not possible to assess whether a dose response effect exists. When measuring the effects of eggs, the authors did not adjust for saturated fat intake. The increase in risk seen with increased consumption from the egg group may be attributable to other factors such as how the eggs were cooked and the foods with which they were served.</p>
<p>Health ABC Study¹²</p>	<p>9 year follow up of 1941 70-79 year olds. Dietary data collected using a food frequency.</p>	<p>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 (a 5 fold greater risk) of cardiovascular disease.</p>	<p>These associations remained after also accounting for other dietary fats or foods high in saturated fat and cholesterol. Authors suggest non-adherence to dietary recommendations for diabetes may confound the association between dietary cholesterol and eggs and CVD.</p>

Although these studies suggest trends or associations between egg intake and CVD in people with type 2 diabetes, a clear mechanism has not been determined and therefore additional research is essential to further establish the role of eggs and/or dietary cholesterol in relation to the risk of CHD in people with diabetes.

Clinical Studies

Four clinical investigations have been carried out, one in people with type 1 diabetes, two in people with insulin resistance and one in people with type 2 diabetes, and these studies have found varying results ¹⁶⁻¹⁹.

A double-blinded crossover trial investigated the effects of dietary cholesterol from eggs on the blood lipid profile of ten male subjects with type 1 diabetes and compared the results to 11 matched controls ¹⁶. A liquid supplement containing 800mg/day dietary cholesterol from egg yolks (the amount found in four large eggs) increased total plasma cholesterol levels by 6.4% in subjects with type 1 diabetes and 9.4% in controls ($p < 0.05$) compared to those taking a placebo, while LDL levels increased 12% ($p < 0.01$) and 7% ($p < 0.05$) respectively. HDL levels remained stable in subjects with diabetes but increased in controls.

A large prospective clinical trial conducted with insulin sensitive and insulin resistant postmenopausal women randomised subjects to one of three dietary interventions for four weeks following a four week washout period. Total and LDL cholesterol concentrations did not change significantly in either insulin sensitive or insulin resistant subjects when cholesterol intake from eggs was either 113mg (washout period), 319mg, 523mg or 941mg per day for a period of four weeks ¹⁷.

The largest clinical trial investigating the effect of egg intake on insulin resistant subjects conducted to date was a double-blind randomised crossover with three one-month interventions ¹⁸. Subjects were classified as insulin resistant (IR), insulin sensitive (IS) and obese insulin resistant (OIR) cohorts. A significant increase in total cholesterol levels was observed in all three groups however was greatest in the IS group. LDL cholesterol increased significantly in the IR and IS groups, however was less in the IR group. LDL cholesterol did not change in the OIR group. HDL cholesterol significantly increased for all subjects consuming two or more eggs per day, except for the OIR subjects when this only occurred at a consumption level of four eggs per day. Obese insulin resistant subjects represent the majority of people at risk of type 2 diabetes. This study therefore suggests that egg intake may have very little impact on the plasma lipid levels of this subgroup and that the change in lipid levels is even less than that seen in healthy, insulin sensitive subjects.

An Australian study ²⁰ compared the effect of two higher protein weight loss diets on blood lipid levels, blood pressure and blood sugar control in 65 people aged 20 to 75 years with type 2 diabetes or impaired glucose tolerance. Participants were randomly assigned to consume protein at lunch time as either two eggs per day or 100 grams of lean meat, chicken or fish per day for 12 weeks. Both diets contained approximately 6,000 kilojoules per day and the same ratio of macronutrients – 40% of energy from carbohydrate, 30% each from protein and fat. The diets differed in dietary cholesterol with the egg group consuming 590mg per day and the meat group consuming 213mg per day. After 12 weeks, both groups achieved significant weight loss and showed similar improvements in blood lipid levels, blood pressure and glycaemic control, demonstrating that consumption of 2 eggs per day as part of an energy-restricted diet did not adversely affect blood lipid or glucose profiles in people with type 2 diabetes. In contrast to the meat group, the egg group appeared to improve risk factors of heart disease by improving HDL cholesterol and increasing plasma folate and lutein levels.



Gestational Diabetes

An analysis of two studies²¹ (the Omega and the Alpha studies) looked at the effect of egg consumption before or during the first trimester of pregnancy on the risk of gestational diabetes (GDM). The Omega study, a prospective cohort study, included 3158 participants. The Alpha study, a retrospective case-controlled study, included 238 women with GDM and 502 controls. After adjusting for confounding factors, researchers in both studies found a 2.4-2.5 fold increased risk of developing GDM with the consumption of 10 or more eggs per week. However both studies found little to no effect on GDM risk for those who consumed less than seven eggs per week, which is in line with current Heart Foundations recommendations of up to six eggs per week²².

Conclusions

Evidence regarding egg consumption and its effect on people with diabetes is sparse and findings are inconclusive. Furthermore, few studies have examined the effect of egg consumption on other indicators of diabetes control such as blood glucose or HbA1C levels.

Recommendations

Further research is required to fully assess the effect of egg consumption in people with diabetes. It is well established that lipid control is an important part of management for people with diabetes, which includes diet, physical activity, and, pharmacotherapy. Prudent advice is that eggs may be included in the context of a diet low in saturated fat, containing known cardio-protective foods and meeting the guidelines for diabetes management. Research supports the inclusion of up to 6 eggs a week as part of a healthy diet.

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

This statement is for healthcare professionals only.

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

Useful Links

<http://www.diabetes.com.au/>
<http://www.diabetesaustralia.com.au/home/index.htm>
<http://www.diabetes.org/home.jsp>
<http://www.joslin.org/>

References:

1. Dunstan, D., Zimmet, P. & Welborn, T. Diabetes and associated disorders in Australia, 2000: the accelerating epidemic. in *Final report of the Australian Diabetes, obesity and lifestyle study (AusDiab)* (International Diabetes Institute, Melbourne, 2001).
2. Australian Bureau of Statistics. Diabetes Mellitus. *Australian Social Trends* (2007).
3. AIHW. Australia's Health 2004: ninth biennial health report. *Australian Institute of Health and Welfare* (2004).
4. Magliano, D.J., *et al.* Projecting the burden of diabetes in Australia 2013 - what is the size of the matter? *Aust N Z J Public Health* **33**, 540-543 (2009).
5. Adult Treatment Panel III report. (National Cholesterol Education Program Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults, 2001).
6. National Heart Foundation of Australia & The Cardiac Society of Australia and New Zealand. Lipid Management Guidelines--2001. *Med J Aust* **175 Suppl**, S57-85 (2001).
7. Natoli, S., Markovic, T., Lim, D., Noakes, M. & Kostner, K. Unscrambling the research: Eggs, serum cholesterol and coronary heart disease. *Nutr Diet* **64**, 105-111 (2007).
8. Djousse, L., Gaziano, J.M., Buring, J.E. & Lee, I.M. Egg Consumption and Risk of Type 2 Diabetes in Men and Women. *Diabetes Care* **32**, 295-300 (2009).
9. 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* **259**, 583-591 (2006).
10. Qureshi, A.I., *et al.* Regular egg consumption does not increase the risk of stroke and cardiovascular diseases. *Med Sci Monit* **13**, CR1-8 (2007).
11. Hu, F.B., *et al.* A prospective study of egg consumption and risk of cardiovascular disease in men and women. *JAMA* **281**, 1387-1394 (1999).
12. Houston, D.K., *et al.* Dietary fat and cholesterol and risk of cardiovascular disease in older adults: the Health ABC Study. *Nutr Metab Cardiovasc Dis* **21**, 430-437 (2011).
13. Radzevičienė, L. & Ostrauskas, R. Egg consumption and the risk of type 2 diabetes mellitus: a case-control study. *Public Health Nutrition* [**Epub ahead of print**](2012).
14. Djousse, L. & Gaziano, J.M. Egg consumption in relation to cardiovascular disease and mortality: the Physicians' Health Study. *Am J Clin Nutr* **87**, 964-969 (2008).
15. Tanasescu, M., Cho, E., Manson, J.E. & Hu, F.B. Dietary fat and cholesterol and the risk of cardiovascular disease among women with type 2 diabetes. *Am J Clin Nutr* **79**, 999-1005 (2004).
16. Romano, G., *et al.* Effects of dietary cholesterol on plasma lipoproteins and their subclasses in IDDM patients. *Diabetologia* **41**, 193-200 (1998).
17. Reaven, G.M., *et al.* Insulin resistance, dietary cholesterol, and cholesterol concentration in postmenopausal women. *Metabolism* **50**, 594-597 (2001).
18. Knopp, R.H., *et al.* Effects of insulin resistance and obesity on lipoproteins and sensitivity to egg feeding. *Arterioscler Thromb Vasc Biol* **23**, 1437-1443 (2003).
19. Pearce, K., Noakes, M. & Clifton, P. The effects of energy restricted moderate carbohydrate dietary patterns on blood glucose and lipid profiles and cognitive and renal function in individuals with type 2 diabetes. *Asia Pac J Clin Nutr* **17(3)**(2008).
20. Pearce, K.L., Clifton, P.M. & Noakes, M. Egg consumption as part of an energy-restricted high-protein diet improves blood lipid and blood glucose profiles in individuals with type 2 diabetes. *Br J Nutr* **105**, 584-592 (2011).
21. Qiu, C., *et al.* Risk of gestational diabetes mellitus in relation to maternal egg and cholesterol intake. *Am J Epidemiol* **173**, 649-658 (2011).

22. National Heart Foundation of Australia. Position statement. Dietary fats and dietary sterols for cardiovascular health,. (2009).

