"My doctor told me to stop having intimate dinners for four. Unless there are three other people."

—Orson Welles

INSIDE

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NUTRITION CLOSE-UP

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Protein Intake at Breakfast Improves Satiety for Dieters

We've all heard it before—it's certainly what grandmother taught us—but is breakfast really the most important meal of the day? Researchers from the University of Kansas and from the Ingestive Behavior Research Center at Purdue University certainly think so. According to their research, not only are the morning hours a key window for nourishment, but the kinds of foods eaten at breakfast can influence feelings of fullness and satiety, and thus help influence calorie intake throughout the day.

Several studies have indicated that breakfast-skippers tend to consume more calories throughout the day and are more likely to be overweight. In addition, existing research from Leidy and colleagues has shown that increased protein consumption at breakfast during energy restriction enhanced feelings of fullness and reduced hunger and the desire to eat among participants. The purpose of the present study was to determine whether this appetite effect is unique to breakfast or whether additional protein at lunch, dinner, or divided equally across mealtimes influences hunger and satiety as effectively.

Ten non-dieting, but overweight (BMI 25-39.9 kg/m^2) men were recruited for this five-week cross-over feeding trial. The study was comprised of five controlled 6-day feeding trials: normal protein (NP), higher protein (HP) breakfast (HP-B), lunch (HP-L), dinner (HP-D) and higher protein intake spread equally across meals (HP-E). During the first 3 days of each trial, participants were provided with energy-balanced diets, after which they followed the prescribed energy-restricted diet for the remaining 3 days. Measures of appetite were assessed for a period of 15 hours on days 3 and 6 of each feeding trial. Both NP diets contained 0.8 g protein/kg per day, which was divided equally among breakfast, lunch, and dinner. The NP diets did not allow any eggs or meat such as pork. Both HP diets provided 1.4 g protein/kg per day, with the additional 0.6 g/kg protein being consumed at breakfast, lunch, dinner, or divided equally among meals. The additional protein came from egg and pork products.

"...the present data lend further support for the need to incorporate increased dietary protein at breakfast when designing effective energy-restricted diets."

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The diets:

Energy-balanced NP—11% protein
64% carbohydrate
25% fat

Energy-restricted NP—14% protein
61% carbohydrate
25% fat

Energy-balanced HP—18% protein
57% carbohydrate
25% fat

Energy-restricted HP—25% protein
50% carbohydrate
25% fat

Participants consumed all meals for 5 consecutive weeks under the supervision of research staff in the metabolic kitchen and were instructed to consume nothing but water between meals. Fullness, hunger, and desire to eat were assessed by questionnaire on days 3 and 6 at thirty minutes before meals and at 30, 60, 90, 120, and 180 minutes after breakfast, lunch, and dinner.

No differences in meal-related fullness were reported between HP treatments during the energy-balanced period of any of the feeding trials. However, compared to HP-D, the HP-B resulted in greater meal-related fullness (P=0.003). Reported fullness rankings with the HP-B did not differ significantly from the HP-L (P=0.188) or HP-E (P=0.587). With regard to overall fullness ratings, compared to HP-L (P=0.009) and HP-D (P=0.05), the HP-B treatment resulted in greater fullness ratings over the 15 hour assessment period during energy restriction. Overall fullness ratings were similar among the HP treatments during energy balance. During energy restriction, the HP-B resulted in greater fullness ratings throughout the 15 hour assessment period compared to HP-L (P=0.009) and HP-D (P=0.05). Overall fullness ratings for HP-B did not differ significantly from those reported from the HP-E (P=0.188). Meal-related and overall hunger and desire to eat ratings were similar between diet treatments during energy balance. During energy-restriction, the ratings were comparable to those observed in fullness ratings, but were statistically weaker.

The fullness (satiety) ratings observed in this study indicate that during energy restriction (dieting), consuming increased protein at breakfast results in greater fullness (satiety) compared to lunch and/or dinner. The authors suggest that this effect might be due to the change in macronutrient consumption from the habitual protein-poor breakfast habits of most Americans, however, appetite responses following the higher protein meal vs. the normal protein meal appeared unaffected by habitual protein intake in this study. In conclusion, the results of this study suggest that increasing protein intake at breakfast might improve satiety for individuals on reduced-calorie diets. According to the authors, "the present data lend further support for the need to incorporate increased dietary protein at breakfast when designing effective energy-restricted diets." ■

Leidy HJ, Bossingham MJ, Mattes RD, Campbell WW. Increased dietary protein consumed at breakfast leads to an initial and sustained feeling of fullness during energy restriction compared to other meal times. *British J of Nutr* 2009;(101):798–803.

KEY MESSAGES

- Increased protein intake at breakfast appears to improve satiety for individuals following reduced-calorie diets.
- These observations support the hypothesis that the kinds of foods eaten at breakfast can influence feelings of fullness and satiety, and thus might help influence calorie intake throughout the day.

Egg Consumption During Weight Loss has no Significant Impact on Serum Lipids

Recent breakfast studies have indicated that eggs eaten in the morning (when compared with a higher-carbohydrate breakfast meal) increase feelings of satiety and can enhance weight loss for people following reduced-calorie diets. However, despite increasing evidence that egg consumption does not contribute to the development of CHD and has no negative impact on serum lipid profiles, many individuals trying to lose weight might bypass eggs in favor of other breakfast foods because of the belief that egg intake unfavorably impacts serum lipid profiles. But the results of a recent study in free-living volunteers undergoing weight-loss interventions suggest that regular egg consumption during weight loss actually has little impact on serum lipids.

Fifty-three healthy adults were randomized into one of two parallel diet treatment groups. All were instructed to follow reduced-calorie diets (500-1000 kcal deficit per day) throughout the 12-week trial. The egg group (n=27) added two medium eggs daily to their reduced-calorie diet regimen, while the control group (n=26) was instructed to eat no eggs. The two medium eggs provided an additional 400 mg dietary cholesterol over habitual intakes. Weight loss was monitored throughout the study and total plasma cholesterol and triglyceride levels were measured.

Eight participants withdrew from the study, leaving 24 in the egg group and 21 in the control group. There were no significant differences between diet groups at baseline with regard to age, weight, or plasma lipids and lipoprotein levels at baseline. Both groups significantly reduced calorie intake from baseline (25% for the egg group and 29% for the control group; $P<0.01$). Cholesterol intake more than doubled in the egg group to 582 mg/day (an increase of 109%, $P<0.01$) and decreased in the control group by 44% ($P<0.01$).

Weight loss over the course of the study was statistically significant for both groups. There were no significant differences in total body weight or percent body fat between groups by the conclusion of the study and loss of body fat was also similar between groups.

While dietary cholesterol increased markedly for egg group participants, plasma lipid and lipoprotein concentrations (including total, LDL, and HDL cholesterol, and triglycerides) tended to decrease over the course of the study (no significant change from baseline.) This finding was mirrored in the control group. Although a significant decrease in LDL cholesterol was seen at 6 weeks, there was no significant change from baseline by week 12. No significant dietary effects were observed between groups. Plasma glucose and insulin concentrations also remained similar between groups over the course of the study.

These results indicate that the consumption of additional dietary cholesterol from eggs during calorie-restriction/weight loss has virtually no effect on plasma lipid or lipoprotein concentrations. The authors conclude that "these findings support the view that cholesterol-rich foods should not be excluded from an energy-restricted diet on account of producing an unfavourable effect on blood cholesterol." ■

Vander Wal JS, Gupta A, Khosla P, Dhurandhar NV. Egg breakfast enhances weigh loss. *Int J Obes* 2008;32(10):1545-51. Epub 2008 Aug 5.

Vander Wal JS, Marth JM, Khosla P, Jen KL, and Dhurandhar NV. Short-term effect of eggs on satiety in overweigh and obese subjects. *J Am Coll Nutr* 24:510-515.

Harman HL, Leeds AR, Griffin BA. Increased dietary cholesterol does not increase plasma low density lipoprotein when accompanied by an energy-restricted diet and weight loss. *Eur J Nutr* 2008;47:287-293.

Eggs and Dietary Cholesterol—an International Perspective

"Dietary cholesterol in foods such as eggs has only a small and clinically insignificant effect on blood cholesterol, especially when compared with the much greater effects of dietary saturated fatty acids on blood cholesterol. These facts are now well established and, as a consequence, recommendations from major food and health bodies concerning dietary cholesterol have been relaxed in the UK and elsewhere in recent years. However, in the minds of the public, cholesterol in the diet, specifically from eggs, continues to be viewed with suspicion and that view is still reflected in the advice of some professionals." So wrote Dr Bruce Griffin, Professor of nutritional metabolism of the University of Surrey, Guildford, UK and Dr Juliet Gray, registered public health nutritionist (also of Guildford, Surrey, UK). Their recent article, "Eggs and Dietary Cholesterol—Dispelling the Myth" was published in the British Nutrition Foundation's Nutrition Bulletin and reviewed the evidence that has led the UK Food Standards Agency, the British Heart Foundation and other bodies to dispense with previous recommendations to limit egg intake to 3-4 per week … and to remind health professionals that the guidance has changed.

In recognition of the evolving international perspectives on dietary cholesterol and the role of eggs in a heart-healthy diet, the Egg Nutrition Center is pleased to provide a summary of their review in this edition of *Nutrition Close-Up*.

Early research leads to misconceptions about dietary cholesterol…

"The misunderstanding of the relationship between dietary and blood cholesterol originated in part from the erroneous belief that the cholesterol we eat converts directly into blood cholesterol, but also from the strong dietary messages about egg restriction that emanated primarily from the United States (US) in the 1970s."

In this article, Gray and Griffin describe early research in the field of diet and serum lipids, adding that the misconceptions surrounding dietary cholesterol probably originated with poorly-chosen animal models and dietary interventions for research. Cholesterol research began in the early 1900s with scientists feeding cholesterol-rich foods (which were also commonly high in saturated fat) to rats and rabbits. According to the authors, these animals, "adapted to low fat, high carbohydrate diets" and having cholesterol metabolism that differs somewhat from that of humans, were not reliable models for the human response to dietary cholesterol feeding. It was assumed that since atherosclerotic plaque was made up primarily of cholesterol, that dietary cholesterol must play a central role in the disease process and that the cholesterol we eat converts directly into serum cholesterol. Such beliefs led public health entities to caution the public about dietary cholesterol and to incorporate egg and cholesterol-limiting language into their dietary guidance.

Research advances shed light on the issue…

Many studies published during the latter half of the 20th century "were subject to confounding by the presence of large amounts of SFA [saturated fatty acids] in the experimental diets and used extreme contrasts of cholesterol (>1000 mg per day)… Although cross-population and longitudinal studies showed associations between dietary cholesterol and CHD, the results most likely reflected the close association between dietary cholesterol and SFA, which tend to exist together in the same foods."

Many of the early cholesterol feeding trials utilized intervention diets that were not only high in cholesterol, but also rich in saturated fat, which is now known to have an independent influence on serum cholesterol concentrations. This made it difficult, if not impossible to determine the independent influence of dietary cholesterol on serum lipids, and eggs (low in saturated fat) became "guilty" by association. As research methods have improved in recent decades, researchers have been able to differentiate the effects of dietary cholesterol vs. dietary saturated fat on serum lipids. We now know that while cholesterol feeding can increase serum lipids in individuals classified as dietary cholesterol "responders," this increase is minimal; and the few, more recent studies that have successfully isolated cholesterol in the treatment diet have shown that when dietary cholesterol raises serum total cholesterol concentrations, both LDL and HDL cholesterol increase, leaving the LDL:HDL ratio essentially unchanged, thus, "the potential adverse impact of raised LDL-cholesterol on CHD risk is countered by the potential beneficial effects of increases in HDL-cholesterol."

The authors note that "despite observations that dietary cholesterol can increase serum cholesterol, it is important to note that there is no consistent evidence from the 30 or more years of prospective studies that dietary cholesterol or specifically egg consumption has an independent association with risk of heart disease."

Changing recommendations in response to a growing body of research…

At one time, the British Heart Foundation did recommend limiting egg intake to 3-4 per week for healthy people, but has since removed this language from its guidance, emphasizing, instead, the need to limit dietary saturated fat. The UK Food Standards Agency (an independent government department commissioned to protect the public's health and consumer interests in relation to food) also counsels that for most people, there is no need to limit eggs as long as they are part of a

balanced diet. The Irish Heart Foundation focuses on limiting saturated fat intake and encourages the use of eggs in a balanced, heart-healthy diet. But the weight of the evidence has reached far beyond the UK. In fact, most countries do not have a dietary cholesterol restriction as part of their dietary guidelines for healthy individuals:

•The European Heart Network emphasizes limiting saturated and trans fats and does not make recommendations regarding eggs or dietary cholesterol with regard to controlling serum lipids.

•Historically, the Heart Foundation of Australia recommended limiting dietary cholesterol and egg intake, however, it no longer makes any specific recommendation about dietary cholesterol. In fact, the Heart Foundation now allows egg cartons to carry the Tick™ symbol, indicating that they meet strict Heart Foundation nutritional standards (See www.heartfoundation.org.au/Tick.)

•Although not specifically mentioned in this article, Canada's Food Guide emphasizes limiting saturated fat and trans fat intake and does not specifically mention dietary cholesterol. In Canada, eggs carry the Health Check™ symbol of the Heart & Stroke Foundation of Canada (See www.heartandstroke.com and www.healthcheck.org).

•Although the American Heart Association (AHA) still recommends a daily intake of <300 mg dietary cholesterol for healthy people and <200 mg dietary cholesterol for those with elevated LDL cholesterol levels, the AHA has removed specific references to eggs in their dietary guidance.

In conclusion…

Gray and Griffin conclude that the guidance surrounding dietary cholesterol and egg intake has evolved in recognition of the following facts:

1)The results of many early cholesterol feeding studies were confounded by the presence of high levels of saturated fats in the intervention diets.

2)The effect of dietary cholesterol on serum cholesterol concentrations is minimal and clinically insignificant in comparison with the known lipid-raising influence of dietary saturated fat.

3)Research shows that when egg intake results in a small increase in LDL cholesterol levels, HDL levels also increase, leaving the LDL:HDL cholesterol ratio virtually unchanged.

4)Prospective cohort studies indicate that this small increase in serum cholesterol levels is not associated with an increase in CHD risk. ■

Gray J and Griffin B. Eggs and dietary cholesterol—dispelling the myth. British Nutrition Foundation *Nutrition Bulletin* 2009;34:66-70.

Prioritizing Modifiable Lifestyle Factors to Reduce the Risk of CHD: A Relative Risk Analysis

Heart disease remains the leading cause of death for men and women in the U.S. and Canada. Decades of research have allowed scientists to identify multiple risk factors for coronary heart disease (CHD). Some—such as race, ethnicity, family history, genetic predisposition, male gender, advanced age—are not modifiable. Others—like smoking, physical inactivity, overweight and obesity, high blood pressure, elevated blood cholesterol, diet, alcohol consumption—are modifiable and behavioral in nature. Because modifiable lifestyle factors are, by definition, the only factors within an individual's control, authoritative health organizations generally emphasize guidelines surrounding these factors. Of the identified modifiable risk factors, the focus almost invariably falls on diet—and more specifically, on dietary saturated fat and cholesterol. With a host of other recognized modifiable lifestyle factors, researchers have questioned whether the emphasis on reducing dietary cholesterol is appropriate or proportional to the potential benefit of doing so.

The American Heart Association recommends limiting dietary cholesterol to 300 mg/day. Since one large egg contains about 195 mg of cholesterol (~65% of the daily recommended intake), eggs are often restricted in the diets of healthy individuals as a way to reduce the risk of heart disease. The push to reduce egg consumption to decrease heart disease risk has been, perhaps, one of the most recognizable and impactful social marketing efforts in recent decades. Indeed, eggs have been seen as an icon for dietary cholesterol and heart disease, despite numerous studies showing no association between egg intake and CHD or stroke. The inherent danger in emphasizing relatively simple, but proportionally less effective prevention methods, is that it removes the focus from more relevant health behaviors that if changed, could have much greater impact on risk reduction.

Researchers from the Rollins School of Public Health at Emory University recently conducted a relative risk analysis to determine the impact of egg consumption on coronary heart disease (CHD) risk relative to known modifiable and potentially treatable risk factors. They used a risk apportionment model to assess the independent and interrelated impact of these factors—egg consumption, overall diet, smoking status, BMI, physical activity, alcohol consumption, family history, age, blood pressure, diabetes, and serum lipid profiles—on CHD risk. To minimize confounding factors that might otherwise be present when comparing data across populations from various geographical locations, data for this analysis was collected mainly from the populations studied in the Nurses' Health Study (NHS) for women and from the Health Professionals Follow-up Study (HPFS) for men.

To assess overall diet, information from the HPFS was used to classify men's diets based on the Alternate Healthy Eating Index (AHEI), which scores diet based on food components such as multivitamin use, percent energy from trans fat, ratio of polyunsaturated to saturated fat intake, ratio of chicken and fish to red meat intake, daily servings of alcohol, fruits, vegetables, and vegetable proteins, and cereal fiber intakes. Overall diet scores for women were derived by combining scores for trans fat, glycemic load, cereal fiber intake, marine omega-3 fatty acids, folate, and ratio of polyunsaturated to saturated fat in terms of quintiles of intake.

The estimated risk ratios (RRs) for various levels of egg consumption were less than 1.0 and would, according to the authors, have "implied a protective effect of eggs for females and, hence, could not be used in the apportionment model to estimate the relative contribution of egg consumption to the increased risk of CHD." Thus, the researchers chose to focus on the additional cholesterol consumed at various levels of egg consumption and to predict the impact on serum lipid levels. According to previous research, consumption of one large egg per day might be expected to produce a 0.12 mmol/L (4.7 mg/dL) increase in serum total cholesterol. CHD risk ratios associated with egg intake were thus estimated based on associations between serum lipid levels and CHD risk. In the final analysis, the researchers estimated an increase of 0.0067 (for men) and of 0.0049 (for women) in the RR for CHD per .025 mmol/L (1 mg/dL) increase in serum total cholesterol, resulting in RRs for CHD of 1.03 for males and 1.02 for females consuming one egg per day.

The models used for this analysis specifically included smoking, alcohol consumption, physical activity, BMI, overall diet score, and egg consumption (lifestyle risk factors); and blood pressure, serum LDL, and serum HDL (potentially treatable risk factors). The results of this analysis indicate that these modifiable lifestyle factors are responsible for 30-40% of the population CHD mortality and that other risk factors (potentially treatable factors in combination with non-modifiable risk factors such as age and genetics) are responsible for the remaining 60-70%. In addition, across all risk groups representing >85% of U.S. males and 86% of U.S. females 25 years and older, the consumption of one egg per day was responsible for less than 1% of CHD mortality risk.

When smoking (which has a disproportionately large RR compared to other modifiable lifestyle factors) was removed from the analysis, the estimated impact of eating one egg per day remained the same, at less than 1%.

This analysis did not account for the beneficial impact of egg intake including the presence of lutein (associated with lower CHD risk) and choline (associated with lower homocysteine levels) in the yolk or the documented increase in HDL cholesterol with egg consumption. The authors note that "given the epidemiological and clinical evidence it is unclear whether an intervention strategy of limiting egg consumption in healthy adults would lead to a significant reduction in LDL levels or CHD risk" and that "wide-sweeping recommendations to restrict egg consumption to avoid CHD risk may not have the desired result, especially when the nutritional benefits of eggs are considered."

Barraj L, Tran N, Mink P. A comparison of egg consumption with other modifiable coronary heart disease lifestyle risk factors: A relative risk apportionment study. *Risk Analysis* 2008; 29(3):401-415.

EDITORIAL

Eggs and Cholesterol: Erasing the Mythology—a UK Perspective

Eggs are bad for your cholesterol aren't they? Eggs are bad for the heart aren't they? These are a couple of myths that still prevail in the minds of many people in the UK and indeed are still reflected in the advice of some health professionals. A consumer survey carried out among 1000 adults in the UK at the end of 2008 showed that just under a half (45%) of those surveyed believed that they should be eating only three eggs or less each week (1). These egg-dietary cholesterol myths persist even though it has been established for more than a decade that dietary cholesterol in foods such as eggs has only a small and clinically insignificant effect on plasma cholesterol when compared to the cholesterol-raising effects of saturated fatty acids and despite the fact that in the UK, the US and elsewhere, previous restrictions on egg intake set by food and health bodies have been lifted for most people.

In this issue of *Nutrition Close-Up* there is a summary of a paper that was recently published in a UK nutrition journal, the *Nutrition Bulletin* (2), a paper that created remarkably extensive media interest in the UK and on the web. In order to ensure that the issues discussed in this paper would be disseminated to the wider public, health journalists from the national media were invited to a press briefing to listen to presentations from an academic scientist, a medical practitioner, a registered nutritionist and a dietitian, each addressing the different issues raised in the paper. However, these journalists were initially less than enthusiastic—'Don't people know this already?' was their response. Indeed, there were no new research findings proffered in the article—my co-author Professor Bruce Griffin and I were criticised by some for trying to make a story out of nothing—but what was new was the context. Critically, the article sought to juxtapose an overview of research on dietary cholesterol, eggs and cardiovascular disease with an overview of recommendations on egg and dietary cholesterol intake. The paper firstly emphasised the lack of scientific evidence for an independent effect of dietary cholesterol on plasma cholesterol, highlighting the misconceptions in this field that have arisen from the erroneous and simplistic conclusions drawn from early research. Secondly, it pointed out that the UK Food Standards Agency (an independent Government body tasked with 'protecting the public's health and consumer interests in relation to food') does not recommend egg restriction, but emphasises the nutritional benefits of eggs as part of a balanced diet and, importantly, that the British Heart Foundation had dispensed with its previous recommendation to limit egg intake to 3-4 per week, although individuals who have familial hypercholesterolaemia (1 in 500 in the UK) are still advised to restrict egg consumption.

Although the story may not have been news to the health correspondents, on the day, interestingly, it was the news journalists who picked up the story and ran with it, so that it made the front page in several newspapers and was the focus of longer articles in many others. It featured in radio and TV news bulletins and in more detailed interviews and in the ensuing days it was followed up in commentaries and egg recipe feature articles. Evidently, it was news to the public at large and generally very welcome news! No doubt it helped that this was a positive nutrition news story on a day otherwise dominated by doom and gloom stories about British banking, but the overall tenor of the reporting was one of relief—eggs are back on the menu!

In the course of this media coverage, a spokesperson for the British Heart Foundation confirmed that they no longer advised restricting eggs and that they could be consumed by most people as part of a healthy balanced diet. The size and nature of the response to the news story concurs with the results of the survey mentioned earlier and appears to confirm the fact that until now this message has not reached the public. It also suggests that egg-cholesterol mythology—the result of thirty years of negative publicity in which eggs were 'demonised'—is still deeply ingrained in the public psyche. What's more, isn't it much easier to eliminate an individual food, such as the egg, than to confront the fact that cutting down on saturates usually requires a significant overhaul of the total diet and entails a reduction in the consumption of the foods that predominate in our diets on both sides of the Atlantic—among others, the saturate-laden cakes, cookies, pastries and full fat cappuccinos?

It goes without saying that as health professionals we need to ensure that our advice is underpinned by the current evidence base. The evidence indicates that dietary cholesterol is not a significant contributor to elevated plasma cholesterol levels for most people and therefore we can be confident in reassuring the public that the egg is a valuable, nutrient-dense food that is not high in saturates or calories and which can make a useful contribution to a healthy balanced diet, without increasing their blood cholesterol levels and cardiovascular risk. ■

1) Gfk NOP Consumer Survey of 1000 adults (16+) conducted between 31 October and 2 November 2008.

2) Gray J, Griffin B. Eggs and dietary cholesterol—dispelling the myth. British Nutrition Foundation Nutrition Bulletin 2009; 34: 66-70.

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