

# UNSCRAMBLING DIETARY CHOLESTEROL

## RESEARCH AND RECOMMENDATIONS

### ANSWERS TO KEY QUESTIONS ON DIETARY CHOLESTEROL

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*Analysis of both clinical and epidemiological studies conducted in recent years indicates that for the general population, dietary cholesterol has little effect on coronary heart disease (CHD) risk.<sup>1</sup>*

#### What is the Basis for Dietary Cholesterol Recommendations Introduced in the Last 20 Years?

Recommendations to reduce dietary cholesterol to 300 mg/day are based largely on population studies, such as the Seven Countries Study and prediction equations derived from controlled metabolic studies that date back to the 1960's.<sup>2,3</sup> However, recent meta-analyses, carefully controlled metabolic studies and epidemiological data indicate that earlier predictions overestimated the effect of dietary cholesterol on serum cholesterol.<sup>1</sup> Research indicates that the effect of dietary cholesterol is minimal when compared to other risk factors such as overweight, lack of physical activity and high intake of saturated and *trans* fats.

“Evidence amassed over the past decade indicates that dietary cholesterol is not a major factor affecting plasma cholesterol and lipoproteins in the general population.”<sup>1</sup> (National Institute of Nutrition, 2000)

According to the Heart and Stroke Foundation of Canada, “One long-standing myth about high blood cholesterol is that it is caused by eating foods containing cholesterol. It’s not so – research shows that it is the fat in food, particularly the saturated and *trans* fat and not the cholesterol in food that raises blood cholesterol the most. Although the majority of people are not adversely affected by food cholesterol, a small percentage of people, particularly those with a family history of high blood cholesterol, are very sensitive to it and must limit it.”

Source: Healthy Living section at [www.heartandstroke.ca](http://www.heartandstroke.ca)

## HOW OUR SCIENTIFIC UNDERSTANDING HAS EVOLVED

In the 1980's, concerns regarding the high incidence of CHD led to dietary recommendations to lower fat intake, particularly saturated fat and cholesterol. Although there was sound scientific rationale for the recommendation to reduce saturated fat intake, recommendations to reduce total fat and dietary cholesterol intake were not as well substantiated.<sup>1</sup> Since that time there has been a marked evolution in our scientific understanding of the impact of different types of fat and dietary cholesterol on serum cholesterol levels.

Despite the emphasis on total fat intake in earlier recommendations, research has clearly shown that reducing total fat intake is of little benefit for lowering CHD risk without a reduction in saturated fat.<sup>1</sup> Studies have also shown that dietary cholesterol has only a small effect on serum cholesterol levels. When confounding factors are properly controlled, there is no significant association between dietary cholesterol intake and heart disease incidence.<sup>4,5,6,7</sup>

**The estimated decrease in serum cholesterol in response to a 100 mg change in dietary cholesterol represents only about 1% of the average adult's total cholesterol level.**

Source: National Institute of Nutrition. NIN Review No. 30, 2000.

### Clinical Trials on Dietary Cholesterol

Numerous clinical trials have examined the effects of dietary cholesterol on serum cholesterol levels. Three meta-analyses of experimental data published over the past 30 years have assessed the effect of dietary fat and cholesterol on plasma lipids and lipoproteins.<sup>4,5,6</sup> Although these analyses found a positive relationship between dietary cholesterol intake and serum cholesterol levels, the estimated response was much lower than previously estimated.<sup>1</sup>

Prediction equations based on meta-analyses published during the 1990's estimate a decrease in serum cholesterol between 0.035 and 0.069 mmol/L for each 100 mg/day decrease in dietary cholesterol.<sup>4,5,6,8</sup> These estimates are significantly lower than estimates from the 1960's of a 0.175 mmol/L decrease for each 100 mg/day decrease in dietary cholesterol.<sup>2</sup> Research also indicates that serum cholesterol response to a given amount of dietary cholesterol appears to diminish as baseline cholesterol intakes increase.<sup>8</sup>

### Higher Cholesterol Intakes Decrease Absorption

<b>Cholesterol intake</b>	28 mg	188 mg	421 mg
<b>Percent absorbed</b>	41 %	36 %	25 %

Source: Journal of Lipid Research, 1999; 40:1453-8

**The Dietary Reference Intake (DRI) report on macronutrients includes a summary of epidemiological studies published from 1984 to 1999. This summary clearly shows that studies have consistently found no association between dietary cholesterol intakes and CHD risk when multivariate analysis is used to control for confounding risk factors.**

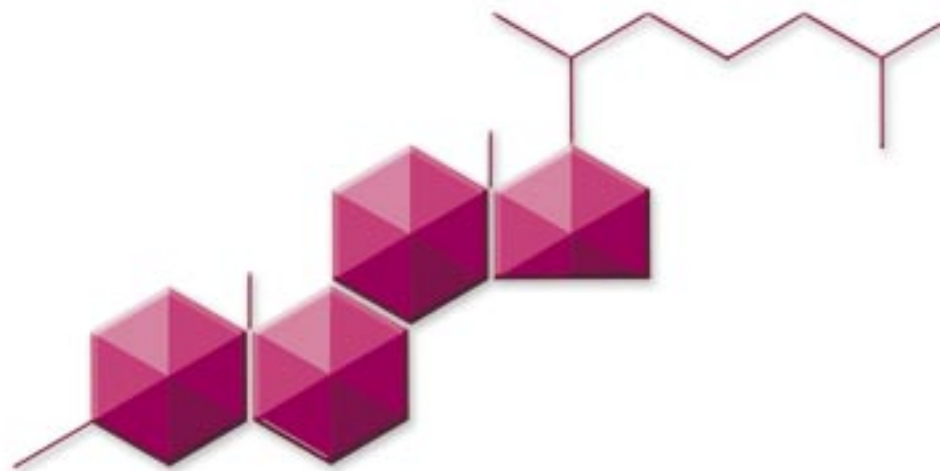
## **Epidemiological Evidence**

Epidemiological studies have become increasingly sophisticated in their examination of confounding factors. Numerous prospective epidemiological studies have investigated the relationship between dietary cholesterol and CHD.<sup>9,10</sup> Two factors of particular relevance to serum cholesterol levels and CHD risk are saturated fat and fibre intake. These and other risk factors must be accounted for with multivariate analysis to allow for an accurate evaluation of the effect of dietary cholesterol on CHD risk.

Although several studies have reported significant univariate associations between cholesterol intake and CHD risk, they failed to adjust for important confounding variables.<sup>11-14</sup> Other studies that have included multivariate analysis to control for other risk factors have found no significant independent association between cholesterol intake and CHD risk.<sup>15-22</sup>

A closer look at the data from the Health Professionals Follow-up Study and the Nurses' Health Study, demonstrates the importance of multivariate analyses. In a cohort of 43,757 male health professionals, dietary cholesterol intake was significantly related to age-adjusted risk for CHD.<sup>17</sup> However, there was no significant association after multivariate analyses to adjust for other risk factors such as body mass index, fibre intake, alcohol consumption, physical activity, smoking habits, history of hypertension or high blood cholesterol, family history of myocardial infarction and profession. A similar analysis with a cohort of 80,082 female nurses found no significant relationship between dietary cholesterol and CHD.<sup>19</sup>

*Source: The National Academy of Sciences, DRI report on Macromolecules, 2002, Table 9-4, Dietary Cholesterol and Coronary Heart Disease, Chapter 9, p. 13-15.*



## EGGS AND SERUM CHOLESTEROL

Recommendations to limit dietary cholesterol intake have often included statements about limiting egg consumption since eggs are a concentrated source of cholesterol in the diet.<sup>9</sup> However, in the largest epidemiological investigation conducted to date on the relationship between egg consumption and coronary heart disease involving over 118,000 men and women from the Health Professionals Follow-up Study and the Nurses' Health Study, consumption of up to one egg per day had no significant impact on CHD risk.<sup>21</sup> The authors did note a significant increase of CHD risk in diabetic patients with higher egg consumption.<sup>21</sup> Although this finding was corroborated in another European study, the association was no longer significant after multivariate analysis adjusting for fibre intake.<sup>22</sup>

A recent cross-sectional population-based study of 27,378 men and women showed that more frequent egg consumption was negatively associated with serum cholesterol concentration.<sup>23</sup> Those who reported eating more than four eggs per week had a significantly lower mean serum cholesterol level than those who reported eating one or fewer eggs per week.<sup>23</sup> The findings from this study also indicate that egg consumers are more likely to have adequate intakes of Vitamins B<sub>12</sub>, A, C and E.<sup>23</sup>

1 large egg has 70 calories and only 1.5 grams of saturated fat. It also contains 6 grams of the highest quality protein. Eggs contribute many additional nutrients that benefit heart health including:

- folate, vitamin B<sub>12</sub>, B<sub>6</sub>, and other B vitamins
- unsaturated fats such as omega-3 fatty acids
- antioxidants such as vitamin E, lutein and zeaxanthin

See the Nutrition Facts table on page 7 for more detailed nutrition information.

Source: Canadian Nutrient File, Health Canada, 2001

In both the Health Professionals Follow-up Study and the Nurses' Health Study cohorts, there was no relationship of egg intake to CHD risk with intakes of up to one egg a day.<sup>21</sup>

### MEN (Health Professionals Follow-up Study)

Egg Intake (eggs/week)	Mean Cholesterol Intake (mg/d)	Relative Risk of CHD
< 1	237	1.00
1	266	1.06
2-4	330	1.12
5-6	404	0.90
7 or >	536	1.08

### WOMEN (Nurses' Health Study)

Egg Intake (eggs/week)	Mean Cholesterol Intake (mg/d)	Relative Risk of CHD
< 1	228	1.00
1	258	0.82
2-4	342	0.99
5-6	436	0.95
7 or >	557	0.82

## RISK IN PERSPECTIVE

The authors of a recent meta-analysis on the effect of dietary cholesterol from eggs estimated that eating an egg a day may increase CHD risk by 2%, (but only in those with a low ratio of polyunsaturated to saturated fat intake).<sup>24,25</sup> Although this report confirms the findings from many other recent analyses that dietary cholesterol has a small effect on serum cholesterol, it is clear that this effect is minimal when put into perspective relative to other risk factors shown in Table 1.<sup>25</sup> When the risk associated with each of these factors is considered, it is evident that efforts to promote heart health should focus on achieving a healthy weight, increasing physical activity and reducing saturated fat and *trans* fat in the diet.

### Dietary Cholesterol Intakes

Although there is no recent national data on dietary cholesterol intake in Canada, Table 2 shows median cholesterol intakes of American men and women from the US Continuing Food Survey of Intake for Individuals (1994 -1996).

**Table 2 Median Cholesterol Intakes**

	<b>Cholesterol (mg/day)</b>
<b>Women</b>	<b>180 to 200</b>
<b>Men</b>	<b>250 to 325</b>

Source: The National Academy of Sciences. DRI Report on Macronutrients, 2002, Appendix Table E-15, Chapter 9, page 6.

**Table 1 Major Risk Factors for Coronary Heart Disease**

<b>Risk Factors</b>	<b>Lifestyle Change</b>	<b>Associated Risk</b>
<b>Saturated and <i>Trans</i> Fats</b>	<b>Replacing 5% of energy from saturated fat with 5% from unsaturated fat</b>	<b>42% lower risk<sup>19</sup></b>
<b>Physical Inactivity</b>	<b>Adding 1½ hours of vigorous walking one day a week</b>	<b>51% lower risk<sup>26</sup></b>
<b>Overweight</b>	<b>A BMI less than 23 kg/m<sup>2</sup> relative to being overweight with a BMI of 25-28.9 kg/m<sup>2</sup></b>	<b>72% lower risk<sup>27</sup></b>

## CURRENT GUIDELINES

### DRI Report on Macronutrients

The 2002 DRI Report on Macronutrients published by the National Academy of Sciences recommends Acceptable Macronutrient Distribution Ranges (AMDR) for fat, carbohydrates and protein (see Table 3).<sup>7</sup> The AMDR for fat and carbohydrates were established to help reduce the risk of CHD and ensure adequate intakes of essential nutrients.

The DRI Report on Macronutrients does not provide a Recommended Dietary Allowance or an Adequate Intake level for dietary cholesterol since endogenous cholesterol production is sufficient for biological functions. In addition, there is considerable evidence for variation in serum cholesterol response to dietary cholesterol between individuals, ranging from zero to greater than 100 percent.<sup>8</sup> Research indicates that genetic factors play a role in this variation in cholesterol response between individuals.<sup>1</sup> Although the report recommends limiting dietary cholesterol intakes, it cautions that dietary cholesterol should not be avoided altogether since this could result in inadequate intakes of other important nutrients.

**The WHO/FAO Report on Diet, Nutrition and the Prevention of Chronic Diseases recommends a population goal of less than 300 mg of dietary cholesterol per day. However, the report states that saturated fat increases serum cholesterol to a greater extent than dietary cholesterol. Since egg yolks are low in saturated fat, there is no need to severely restrict egg intake if saturated fat intake is controlled.**

*Source: World Health Organization, Food and Agriculture Organization. Report on Diet, Nutrition and the Prevention of Chronic Diseases, 2003.*

**Table 3**  
**Acceptable Macronutrient Distribution Ranges<sup>7</sup>**

<b>Recommendations for Adults</b>	<b>DRI AMDR (% of total energy)</b>
<b>Total Fat</b>	<b>20 to 35%</b>
<b>Carbohydrates</b>	<b>45 to 65%</b>
<b>Protein</b>	<b>10 to 35%</b>

*Source: The DRI Report on Macronutrients is available online at the National Academy of Sciences web site at [www.nap.edu/books/0309085373/html/](http://www.nap.edu/books/0309085373/html/)*

### New Canadian Medical Association Recommendations

The Canadian Medical Association (CMA) published updated “Recommendations for the Management of Dyslipidemia and the Prevention of Cardiovascular Disease” in 2003.<sup>28</sup> This update notes the increasing prevalence of obesity despite reductions in saturated fat and cholesterol intake over the past 4 decades. In view of this, the recommendations emphasize that decreasing energy consumption should be an important focus for dietary treatment. In particular, refined carbohydrates and sugar should be reduced to achieve and maintain a body mass index of less than 25 kg/m<sup>2</sup>. The CMA update recommends several key dietary interventions (see Table 4) as well as physical activity.

## PUTTING RESEARCH INTO PRACTICE

**Table 4**  
**Canadian Medical Association 2003 Updated Dietary Recommendations for CHD Treatment**

Increase	Reduce
Fruits and vegetables	Refined carbohydrates and sugar to reduce total calories
The proportion of mono and poly-unsaturated and omega-3 fatty acids	Saturated and <i>trans</i> fats to less than 7% of calories

Source: The full text of the updated CMA recommendations is available online at [www.cmaj.ca/cgi/content/full/169/9/921/DC1](http://www.cmaj.ca/cgi/content/full/169/9/921/DC1)

The % Daily Value is based on dietary recommendations for healthy populations and shows how a food fits into one's overall diet. For example, Health Canada recommends that a healthy diet should not include more than 30% of calories from fat per day. For a 2000 calorie diet, this translates to 65 g of fat per day. This amount is the basis for the % Daily Value for fat and the fat content in a serving of food is expressed as a percentage of 65 g.

In the case of cholesterol, current scientific evidence does not support setting a limit on cholesterol intake for the general population. However, some individuals under treatment for CHD may be prescribed diets which recommend a reduced cholesterol intake. The amount of cholesterol must be listed in milligrams, but including the % Daily Value for cholesterol is optional so it may or may not be listed in the Nutrition Facts table.

Nutrition Facts	
Per 1 large egg (50 g)	
Amount	% Daily Value
<b>Calories 70</b>	
<b>Fat 5 g</b>	<b>8 %</b>
Saturated 1.5 g	8 %
+ Trans 0 g	
<b>Cholesterol 190 mg</b>	
<b>Sodium 55 mg</b>	<b>2 %</b>
<b>Carbohydrate 0 g</b>	<b>0 %</b>
Fibre 0 g	0 %
Sugars 0 g	
<b>Protein 6 g</b>	
Vitamin A 8 %	Vitamin C 0 %
Calcium 0 %	Iron 2 %
Vitamin D 2 %	Vitamin E 6 %
Riboflavin 15 %	Niacin 6 %
Vitamin B <sub>12</sub> 30 %	Folate 15 %

Source: Health Canada Canadian Nutrient File, 2001

### Using the New Nutrition Facts Table

With appropriate consumer education, Health Canada's new nutrition labelling regulations will make it easier for Canadians to make informed food choices. By 2006, most prepackaged foods will carry a Nutrition Facts table that lists calories and a minimum of 13 key nutrients. The % Daily Value indicates whether there is a lot or a little of a nutrient in a serving of food.

## WHAT MATTERS MOST

Current evidence shows that the most effective strategies for reducing serum cholesterol levels include achieving a healthy weight, increasing physical activity, and lowering saturated and *trans* fat intake. Research shows that dietary cholesterol is not a major risk factor for CHD.

Use the "Unscrambling Cholesterol" fact sheet that accompanies this resource to educate your clients and patients about lifestyle changes based on current research and the updated CMA recommendations to reduce CHD risk.

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