

# Are your patients with risk of CVD getting the viscous soluble fiber they need?

Few patients eat the right amount of fiber known to reduce CVD risks and events

## Practice recommendations

- A diet that includes 5 to 10 g/d of viscous soluble fiber reduces cardiovascular disease (CVD) events and death independent of baseline risk (A).
- Consuming foods rich in viscous soluble fiber reduces low-density lipoprotein cholesterol (LDL-C) blood levels 10% to 15% with expected reduction in CVD events by 10% to 15% (A).
- Routinely counsel adults at risk of CVD to promote a healthy diet: assess dietary fiber consumption; recommend specific foods rich in viscous soluble fiber; monitor LDL-C levels and encourage increased dietary fiber intake at follow-up visits; motivate patients to comply with recommendations (A).

**T**he Adult Treatment Panel III and the Dietary Guidelines for Americans recommend that adults eat a healthy diet as defined in **TABLE 1**—including more than 20 to 30 g of dietary fiber per day, 5 to 10 g of which should be viscous soluble fiber.<sup>1,2,3</sup> The benefits of such a diet are supported by growing epidemiologic data:

- Risk of CVD drops by 20% to 30%
- Morbidity and mortality from cardiovascular diseases fall by more than 10%

- Foods rich in viscous soluble fiber, at a dose of 5 to 10 g/d, can reduce LDL-C levels by 10% to 15%, improve insulin sensitivity, and decrease blood pressure
- Pooled analysis of 10 prospective cohort studies showed that, for adults at low risk of heart attack (estimated with Framingham scores), every additional 10 g of fiber consumed daily may prevent 1 coronary death in 74 adults (95% confidence interval [CI], 51–154), and 1 in 19 adults at high risk (95% CI, 13–38).<sup>4</sup>

Despite these hopeful findings, the average American adult eats less than half the recommended amount of fiber: 10 to 15 g/d; just 2.4 g of viscous soluble fiber.<sup>2,5</sup> *Healthy People 2010* has set a national objective to reduce coronary heart disease (CHD) mortality from 208 deaths to 166 deaths per 100,000 people.<sup>6</sup> The US Preventive Services Task Force (USPSTF) recommends that primary care clinicians intensively counsel adults with elevated risk of CVD to improve daily intake of essential components of a healthy diet, including dietary fiber.<sup>7</sup>

In this article, we review practical approaches you can use in motivating patients to eat more fiber, types of dietary fiber and their sources, and the evidence for fiber's impact on CVD risk factors and prevention of CVD events.

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**TABLE 1**

**Recommended ATP-III dietary change  
reduces risk of CVD by 20% to 30%**

DIETARY COMPONENT	RECOMMENDED DAILY LEVELS*	EXPECTED LDL-C REDUCTION*
Total fat	25%–35%	8%–10%
Saturated fat	<7%	
Polyunsaturated fat	≤10%	
Monounsaturated fat	≤20%	
Dietary cholesterol	<200 mg	3%–5%
Carbohydrates	50%–60%	
Dietary fiber	20–30 g	
Viscous soluble fiber	5–10 g	3%–5%
Protein	15%	
Plant stanols/sterols	2 g	6%–15%
Cumulative estimate		20%–30%

\* % of total calorie intake

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**A diet rich in viscous soluble fiber drops LDL-C blood levels by 10%–15%, with expected reduction in CVD events by 10%–15%**

**■ Making sure patients get the right dietary fiber**

Dietary fiber (nondigestible non-starch polysaccharides) is classified as *insoluble* or *viscous soluble*, based on its solubility in water and other fluids in the digestive tract.<sup>8</sup>

**Insoluble fibers**, present in most fruits, vegetables, and whole grain products, constitute over 80% of the total fiber in the typical US diet. Insoluble fibers shorten bowel transit time and produce a laxative effect but have no significant impact on blood lipids.<sup>9</sup>

**Viscous soluble fiber** is present in smaller quantities in foods, but is responsible for the fiber-related physiological effects such as decreased blood cholesterol.<sup>5</sup> The US Food and Drug Administration (FDA) has also approved health claims for 2 such fibers—beta-glucan from whole oat sources and psyllium—to be used as supplements in reducing CVD risk.<sup>10,11</sup>

Viscous soluble fiber absorbs and holds

water in the gastrointestinal tract, forming a thick gel. Viscous soluble bulk reduces reabsorption of bile acids from the ileum. Consequently, the liver shifts sterol metabolism from cholesterol production to replacement of bile acids lost in the stool. Fecal excretion of total bile acids increases in conjunction with serum cholesterol reduction when diets high in viscous soluble fiber are eaten.<sup>12–14</sup>

Moreover, when viscous soluble fiber is fermented by colonic microflora, it produces short-chain fatty acids that directly inhibit intestinal fat absorption, and cholesterol transport and synthesis.<sup>15</sup> Viscous soluble fiber may delay the absorption of simple sugars from the gut, thus decreasing postprandial glucose level and the demand for insulin secretion, and increasing insulin sensitivity.<sup>16</sup>

**■ Viscous soluble fibers reduce CVD risk factors: The evidence**

The goal of the cholesterol-lowering diet is to prevent CVD events by reducing LDL-C, blood pressure, and glucose intolerance. Evidence from observational studies and randomized controlled trials confirms that foods rich in viscous soluble fiber lower blood lipids and arterial blood pressure and enhance insulin sensitivity.

**Soluble fiber reduces LDL-C and may allow lower drug doses.** In randomized controlled trials, 2 viscous soluble fiber sources at different doses resulted in a modest but clinically significant reduction in LDL-C.<sup>17,18</sup> In addition, the reduction was seen in healthy men and women and in those with hypercholesterolemia (**TABLE 2**).<sup>19–24</sup> A 1% decrease in LDL-C reduces the risk of CVD events by 1%.<sup>1</sup>

For those on lipid-lowering drug therapy, supplementation with viscous fiber may help achieve the recommended reduction in LDL-C with lower doses of drugs.<sup>25</sup> Moreyra et al<sup>25</sup> treated hypercholesterolemic adults with 20 mg of simvastatin plus placebo, 10 mg of simvastatin plus placebo, or 10 mg of simvastatin plus 15 g

**TABLE 2**

**Viscous soluble fiber reduces LDL-cholesterol (results of RCTs)**

STUDY POPULATION (N)	VISCOUS SOLUBLE FIBER SOURCE	DOSE (G/D)	LDL-C REDUCTION (%) MEAN (95% CI)	ESTIMATED CVD EVENT REDUCTION (%) MEAN (95% CI)
Hypercholesterolemic men and women (656) <sup>19</sup>	Psyllium	10	7 (5–9)	7 (5–9)
Hypercholesterolemic men (404) <sup>20</sup>	Psyllium	3–12	9 (7–10)	9 (7–10)
Hypercholesterolemic men and women (150) <sup>21</sup>	Oat*	1.2–6	16 (14–25)	16 (14–25)
Healthy men and women (236) <sup>22</sup>	Oat*	2.2	8 (2–13)	8 (2–13)
Healthy men and women (208) <sup>23</sup>	Oat*	2.4–3.3	5	5 (3–7)
Healthy men and women (245) <sup>24</sup>	Oat*	2.4	9	9 (5–12)

\*The dose of beta-glucan in oats.

of psyllium. A significant LDL-C reduction (36%) was observed in the group receiving 10 mg of simvastatin plus psyllium and 20 mg of simvastatin. The authors concluded that psyllium supplementation augmented the lipid-lowering effects of the statin.

**Blood pressure decreases, as does the need for medications.** In a prospective study of 51,529 male health professionals followed for 5 years, Ascherio et al<sup>26</sup> found an inverse association between incidence of hypertension and fruit fiber intake in young men, independent of age and other risk factors. Moderate but significant reductions in 24-hour monitored systolic blood pressure—by 5.9 mm Hg after psyllium<sup>27</sup> and by 5 mm Hg after oat administration<sup>28</sup>—were reported in randomized controlled trials. A 5 mm Hg reduction of systolic blood pressure in the population would result in a 9% reduction in fatal CHD and a 7% decrease in all-cause mortality.<sup>29</sup>

Eighty-eight patients with a history of essential moderate hypertension treated with medications were randomized to consume 5.4 g/d of beta-glucan in oats or

placebo for 12 weeks. Oat consumption reduced the need for blood pressure medications in 73% of participants in the treatment group, compared with 42% in the control group.<sup>30</sup>

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure recommends a dietary plan rich in fiber (24 g/1600 kcal/d) from fruits and vegetables among other life style modifications to treat hypertension.<sup>29</sup>

**Insulin sensitivity improves and HbA<sub>1c</sub> drops.** Foods rich in viscous soluble fiber lower glycemic index compared with reference food in healthy people and in patients with type II diabetes.<sup>31,32</sup> In a randomized trial, barley meal enriched with 1.5 to 15 g of viscous soluble fiber reduced postprandial glucose concentration by 19% to 28% compared with wheat bread, and by 15% to 30% compared with glucose solution.<sup>31</sup> Consumption of barley meal containing 3.5 g of soluble viscous fiber improved insulin sensitivity as assessed by the standard oral glucose tolerance test; it significantly reduced fasting insulin by 11.5%

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**Foods rich in viscous soluble fiber can reduce LDL cholesterol levels, improve insulin sensitivity, and decrease blood pressure**

**TABLE 3**

**Increased daily fiber consumption, regardless of source, reduces risk for cardiovascular disease**

STUDY SAMPLE (N)	INCREMENTAL INCREASE IN FIBER DOSE (G/D)	OUTCOME	RR	95% CI	NNT BASELINE RISK 5% (LOW)*	95% CI	NNT BASELINE RISK 20% (HIGH)*	95% CI
Pereira <sup>4</sup> 91,058 men 245,186 women	10 g total fiber	CHD event	14	4–22	143	91–500	36	23–125
		CHD death	27	13–39	74	51–154	19	13–38
	10 g fruit fiber	CHD event	16	1–30	125	67–2000	31	17–500
		CHD death	30	11–45	67	44–182	17	11–45
	10 g cereal fiber	CHD death	25	9–37	80	54–222	20	14–56
Women's Health Study (39,876) <sup>36</sup>	13.8 g total fiber	CVD event	35	16–49	57	41–125	14	10–31
		MI	54	28–70	37	29–71	9	7–18
	4.9 g viscous soluble fiber	CVD event	26	4–43	77	47–500	19	12–125
		MI	44	12–64	45	31–167	11	8–42
US Males (43,757) <sup>37</sup>	16.5 g total fiber	MI (nonfatal)	35	12–51	57	39–167	14	10–42
		CHD death	55	28–72	36	28–71	9	7–18
	10 g cereal fiber	MI event	27	6–43	74	47–333	19	12–83
NHANES I Follow up (9776) <sup>38</sup>	10 g total fiber	CHD event	8	2–14	250	143–1000	63	36–250
		CVD event	7	3–11	286	182–667	71	45–167
	5 g viscous soluble fiber	CHD event	8	3–13	250	154–667	63	38–167
		CHD death	9	1–17	222	118–2000	56	29–500
		CVD event	6	1–10	333	200–2000	83	50–500

RR, relative risk reduction, defined as (relative risk–1) x 100%; NNT, number needed to treat to prevent 1 event; CI, confidence interval; CVD, cardiovascular disease; CHD, coronary heart disease; MI, myocardial infarction

NNT = 1/p\*(1-RR) – p is the typical event risk without treatment (*Systematic Reviews in Health Care: Meta-Analysis in Context*, Egger M, Smith GD, Altman DG (eds). London: BMJ, 2001:333.

\*Baseline risk is obtained from the Framingham risk calculator, a probability less than 5% to have heart attack during next 10 years is defined as a low risk, a probability more than 20% is defined as a high risk

and postprandial increase in plasma glucose levels by 8.3%, and increased glucose disappearance by 7.5%.<sup>33</sup>

In patients with diabetes, postprandial glucose was significantly less by 10.6% after a meal of barley bread compared with control wheat bread.<sup>32</sup> Intake of barley bread with 5.2 g of viscous soluble fiber for 12 weeks resulted in 20% reduced postprandial glucose response and in decreased doses of oral hypoglycemic medications.<sup>34</sup>

In a meta-analysis of 12 clinical trials, diets moderate in carbohydrate intake with increased consumption of foods rich in fiber provided the best control of fasting blood glucose and a significant decrease in

glycosylated hemoglobin (HbA<sub>1c</sub>) in patients with diabetes.<sup>35</sup>

**CVD events decline with soluble-fiber diets, and diverse fiber sources yield equivalent effects**

**TABLE 3** summarizes findings from prospective observational studies of adults followed for more than 5 years to evaluate the incidence of CVD in groups consuming different kinds of dietary fiber. These studies show that risk reduction is consistent in different populations and with different sources of dietary fiber,<sup>4,36–38</sup> regardless of patient age, gender, treatment status, smoking, and other risk factors for CVD.

**FIGURE 1**

**Common foods high in fiber for a nutrition prescription\***

Recommended daily consumption: Total fiber 30 g per day, viscous soluble fiber *at least* 5 to 10 g/day†

Patient's Name \_\_\_\_\_

Date \_\_\_\_\_

FOOD SOURCE	VISCOUS SOLUBLE FIBER(G)‡	TOTAL DIETARY FIBER (G)	PRESENT DAILY SERVINGS	SERVINGS NEEDED
<b>Fruit (1 medium)</b>				
Apple	1	4		
Banana	1	3		
Blackberries (1/2 c)	1	4		
Nectarine	1	2		
Citrus fruit (orange, grapefruit)	1	2-3		
Peach	1	2		
Pears	2	4		
Plums	1	1.5		
Prunes	1.5	4		
<b>Legumes (1/2 cup cooked)</b>				
Black beans	2	5.5		
Kidney beans	3	6		
Lima beans	3.5	6.5		
Navy beans	2	6		
Northern beans	5	5.5		
Pinto beans	2	7		
Lentils	1	8		
Peas	1	6		
<b>Vegetables (1/2 cup cooked)</b>				
Broccoli	1	1.5		
Brussels sprouts	3	4.5		
Carrots	1	2.5		
Artichoke, fresh	3	4		
<b>Whole grain cereals</b>				
Cereal, all bran (1/3 cup)	0.7	8		
Oatmeal (1/2 cup cooked)	1	2		
Oat bran (1/2 cup uncooked)	1	3		
Shredded wheat (2/3 cup)	0.3	3		
Wheat germ (1/2 cup)	1	8		
Pearl barley (1/2 cup cooked)	2	5		
Hot cereal (1/2 cup cooked)	2	5		
Granola	2	4		
Brown rice (1/2 cup)	0.5	4		
<b>Seeds</b>				
Psyllium seeds, ground (1 tbs)	5	6		
Physician's Name and signature				

\*Adapted from a nutrition prescription of the American Academy of Family Physicians (<http://familydoctor.org/298.xml>).

† Individual calories intake can be calculated in the website [www.MyPyramid.org](http://www.MyPyramid.org)

‡ Total and soluble fiber content adapted from references 39-42.

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**80% of the fiber in a typical diet is insoluble; viscous soluble fiber is found in whole-grain cereals, fruits, beans, and psyllium seeds**

In a pooled analysis of 10 large cohort studies, an additional intake of 10 g/d of fruit fiber reduced the risk of CHD death by 30%.<sup>4</sup>

The Women's Health Study followed health professionals for 6 years and reported that an increase of 4.9 g/d of viscous soluble fiber was associated with a 44% reduction in myocardial infarction incidents.<sup>38</sup>

Among participants in the National Health and Nutrition Examination Survey (NHANES) I Follow-up Study, each 5 g/d increase in viscous soluble fiber intake diminished the risk of CVD by 6% and coronary heart disease by 8%.<sup>37</sup>

Estimated risk reduction is adjusted for all known risk factors of CVD; therefore it is independent of Framingham baseline CHD risk.

For another perspective on the evidence for fiber preventing CVD events, consider the number needed to treat (NNT) with increased fiber intake to prevent the particular CVD-related patient outcome for each study (TABLE 3). Based on the findings of Pereira and colleagues' pooled cohort study,<sup>4</sup> among persons at less than 5% risk for CHD according to the Framingham baseline,<sup>1</sup> 67 subjects (95% CI, 44–182) need to increase their fruit fiber intake by 10 g/d to prevent 1 CHD death. For persons at baseline CHD risk greater than 20%, the NNT is reduced to 17 (95% CI, 11–45). In the Women's Health Study, an additional 4.9 g/d of viscous soluble fiber intake among 45 women (95% CI, 31–167) was estimated to prevent 1 CHD event.<sup>36</sup>

### ■ What should patients eat to increase viscous soluble fiber?

The 2005 Dietary Guidelines for Americans recommend a daily intake of 14 g of total dietary fiber for every 1000 kcal consumed.<sup>2</sup> This would include 2.5 to 6.5 cups of fruits and vegetables and at least three 1-ounce servings of whole-grain foods daily.<sup>39–42</sup> Common foods and their dietary total and soluble fiber content per serving

are listed in **FIGURE 1**, which is a modified nutrition prescription from the American Academy of Family Physicians ([familydoctor.org/298.xml](http://familydoctor.org/298.xml)) incorporating the recommendations for viscous soluble fiber intake from guidelines discussed in this paper.<sup>1–3,6</sup>

Four servings per day of the FDA-recommended whole oats (0.75 g per serving of viscous soluble fiber) and psyllium (1.78 g per serving) are required to reduce CVD risk.<sup>10,11</sup>

An estimated 23% of Americans eat 2 to 3 servings a day of whole grains and 4 to 5 servings a day of fruits and vegetables (all sources of viscous soluble fiber). Healthy People 2010 has called for this proportion to increase to 50% to 75%.<sup>6</sup>

### Ways to approach dietary counseling

The USPSTF found good evidence that, for adult patients at increased risk for diet-related chronic disease, medium- to high-intensity counseling improves the average daily intake of core components of a healthy diet (including saturated fat, fiber, fruit, and vegetables).<sup>7</sup> It recommends that clinicians routinely provide intensive behavioral counseling to promote a healthy diet in adult patients with hyperlipidemia and other known risk factors for cardiovascular diseases. It found no evidence sufficient to recommend for or against routine counseling of unselected patients in primary care.

Both USPSTF<sup>7</sup> and Adult Treatment Panel III<sup>1</sup> offer frameworks to engage patients in therapeutic lifestyle changes.

USPSTF recommends the "5-A" framework to behavioral counseling<sup>7</sup>:

Assess dietary practices and related risk factors

Advice to change dietary practices

Agree on individual diet change goals

Assist to change dietary practices

Arrange regular follow-up and support for refer to more intensive behavioral nutritional counseling (eg, medical nutrition therapy) if needed.

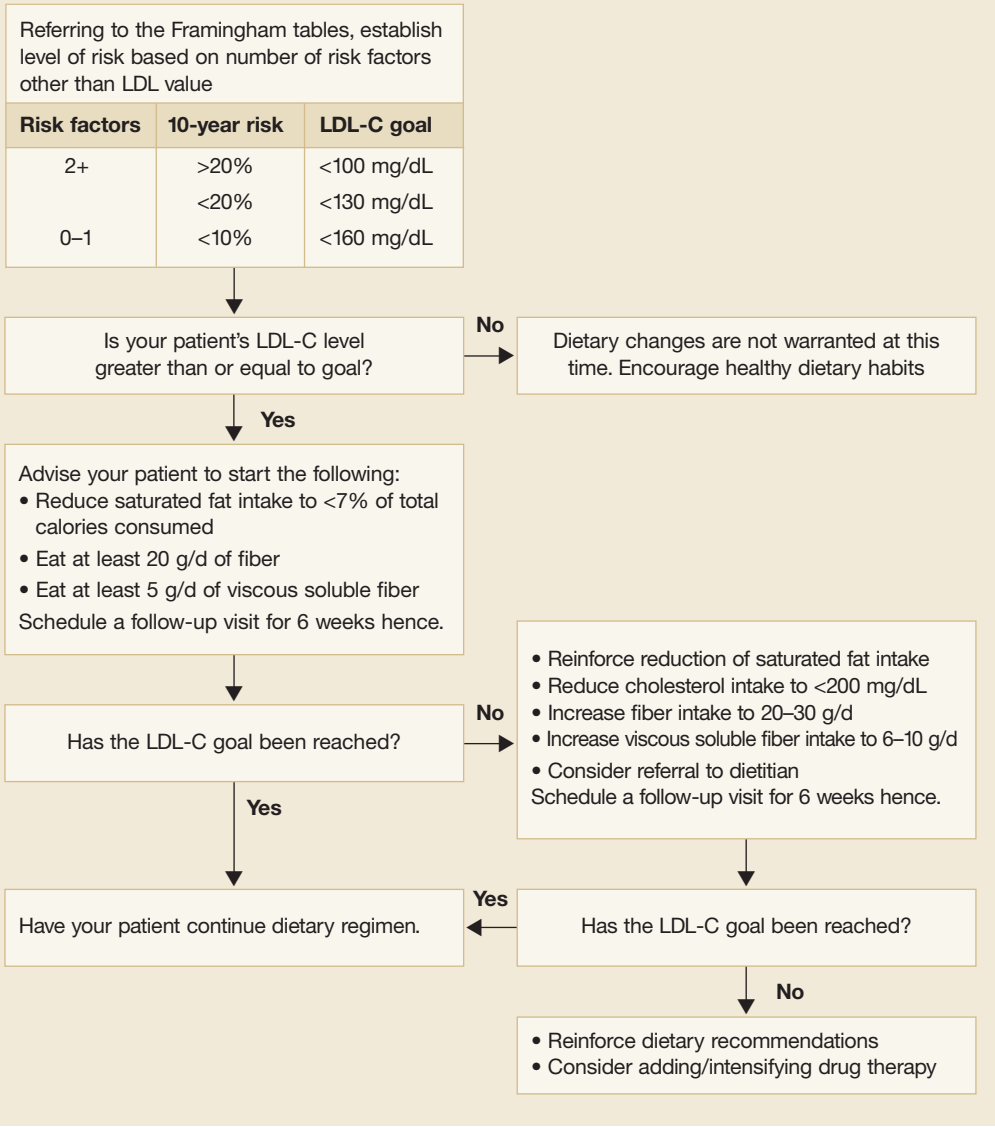
Physicians may use face-to-face and interactive health communications, staff-performed education, and nutritional pre-

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**Supplementing with viscous fiber may help those on lipid-lowering drug therapy achieve their goals with lower doses**

**FIGURE 2**

**ATP III guidance on initiating dietary changes:  
Determine your patient's 10-year risk for CVD**



**FAST TRACK**

**2-3 servings a day of whole grains, and 4-5 servings of fruits and vegetables are required to reduce CVD risk**

scriptions (FIGURE 1) to influence patients' food choices that increase dietary fiber consumption and achieve the doses recommended for adults at risk of CVD.<sup>7,43</sup>

*Low-intensity interventions* involve 5 minutes of professional counseling supplemented by patient self-help materials, telephone counseling, or other interactive health communications via Internet.<sup>44,45</sup>

*Medium-intensity interventions* involve face-to-face dietary counseling (2 to 3

group or individual sessions) delivered by a dietitian or a specially trained primary care physician.

*High-intensity interventions* yield the largest effect. These involve multiple sessions lasting 30 minutes or longer<sup>7</sup> and use office-level supports and algorithms to estimate the baseline risk of CVD, individual calorie and nutrients intake, and energy expenditure.<sup>45</sup>

The Adult Treatment Panel III outlines

a model for initiating and monitoring dietary therapy for adults with risk of CVD (**FIGURE 2**). You may start by assessing the risk of CVD with Framingham scores and current dietary patterns, then counsel patients directly or engage dietitians to help patients institute therapeutic lifestyle changes. After 6 weeks of the therapeutic diet, repeat the lipoprotein examination to determine recommendations to continue or intensify the lifestyle changes. After another 6 weeks, you may consider adding drug therapy and further reinforcing dietary recommendations.

Regardless of the approach you use to assess a patient's diet, a comprehensive individualized nutritional prescription will effectively increase daily intake of dietary fiber, with success similar to that achieved in a major randomized clinical trial.<sup>46</sup> ■

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#### REFERENCES

1. Grundy SM (ed). *Report of the National Cholesterol Education Program (NCEP) on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) Third and Final Report*. Collingdale, Pa: DIANE Publishing Company; 2002.
2. Krauss RM, Eckel RH, Howard B, et al. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. *Circulation* 2000; 102:2284-2299.
3. US Department of Health and Human Services and Department of Agriculture. *Dietary Guidelines Advisory Committee. Dietary Guidelines for Americans, 2005*. 6th ed. Washington, DC: US Government Printing Office; 2005. Available at [www.mypyramid.gov/](http://www.mypyramid.gov/).
4. Pereira MA, O'Reilly E, Augustsson K, et al. Dietary fiber and risk of coronary heart disease: a pooled analysis of cohort studies. *Arch Intern Med* 2004; 164:370-376.
5. Institute of Medicine (US). Standing Committee on the Scientific Evaluation of Dietary Reference Intakes. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington, DC: National Academy Press; 2003.
6. US Department of Health and Human Services. *Healthy People 2010: Understanding and Improving Health*. Volume 1, 2nd ed. Washington, DC: US Government Printing Office; 2000.
7. Snow V (ed). *Clinical Practice: American College of Physicians Guidelines and U.S. Preventive Services Task Force Recommendations*. Philadelphia, Pa: American College of Physicians; 2005.

8. The definition of dietary fiber. *Cereal Foods World* 2001; 46:112-127.
9. Marlett JA, McBurney MI, Slavin JL. American Dietetic Association. Position of the American Dietetic Association: health implications of dietary fiber. *J Am Diet Assoc* 2002; 102:993-1000.
10. US Food and Drug Administration, Department of Health and Human Services. Food labeling: health claims; soluble dietary fiber from certain foods and coronary heart disease. Interim final rule. *Fed Regist* 2002; 67:61773-61783.
11. US Food and Drug Administration, Department of Health and Human Services. Food labeling: health claims; soluble dietary fiber from certain foods and coronary heart disease. Final rule. *Fed Regist* 2003; 68:44207-44209.
12. Andersson M, Ellegard L, Andersson H. Oat bran stimulates bile acid synthesis within 8 h as measured by 7 $\alpha$ -hydroxy-4-cholesten-3-one. *Am J Clin Nutr* 2002; 76:1111-1116.
13. Jenkins DJA, Wolever TMS, Vidgen E, et al. Effect of psyllium in hypercholesterolemia at two monounsaturated fatty acid intakes. *Am J Clin Nutr* 1997; 65:1524-1533.
14. Marlett JA, Hosig KB, Vollendorf NW, et al. Mechanism of serum cholesterol reduction by oat bran. *Hepatology* 1994; 20:1450-1457.
15. Marcil V, Delvin E, Seidman E, et al. Modulation of lipid synthesis, apolipoprotein biogenesis, and lipoprotein assembly by butyrate. *Am J Physiol Gastrointest Liver Physiol* 2002; 283:G340-346.
16. Wolever TM, Mehling C. High-carbohydrate-low-glycaemic index dietary advice improves glucose disposition index in subjects with impaired glucose tolerance. *Br J Nutr* 2002; 87:477-487.
17. Ripsin CM, Keenan JM, Jacobs DR Jr, et al. Oat products and lipid lowering. A meta-analysis. *JAMA* 1992; 267:3317-3325.
18. Brown L, Rosner B, Willett WW, et al. Cholesterol-lowering effects of dietary fiber: a meta-analysis. *Am J Clin Nutr* 1999; 69:30-42.
19. Olson BH, Anderson SM, Becker MP, et al. Psyllium-enriched cereals lower blood total cholesterol and LDL cholesterol, but not HDL cholesterol, in hypercholesterolemic adults: results of a meta-analysis. *J Nutr* 1997; 127:1973-1980.
20. Anderson JW, Allgood LD, Lawrence A, et al. Cholesterol-lowering effects of psyllium intake adjunctive to diet therapy in men and women with hypercholesterolemia: meta-analysis of 8 controlled trials. *Am J Clin Nutr* 2000; 71:472-479.
21. Davidson MH, Dugan LD, Burns JH, et al. The hypocholesterolemic effects of beta-glucan in oatmeal and oat bran. A dose controlled study *JAMA* 1991; 265:1833-1839.
22. Van Horn L, Emidy LA, Liu KA, et al. Serum lipid response to a fat-modified, oatmeal-enhanced diet. *Prev Med* 1988; 17:377-386.
23. Van Horn LV, Liu K, Parker D, et al. Serum lipid response to oat product intake with a fat-modified diet. *J Am Diet Assoc* 1986; 86:759-764.
24. Van Horn L, Liu K, Gerber J, et al. Oats and soy in lipid-lowering diets for women with hypercholesterolemia: is there synergy? *J Am Diet Assoc* 2001; 101:1319-1325.
25. Moreyra AE, Wilson AC, Koraym A. Effect of combining psyllium fiber with simvastatin in lowering cholesterol. *Arch Intern Med* 2005; 165:1161-1166.
26. Ascherio A, Rimm EB, Giovannucci EL, et al. A prospective study of nutritional factors and hypertension among US men. *Circulation* 1992; 86:1475-1484.
27. Burke V, Hodgson JM, Beilin LJ, et al. Dietary protein and viscous soluble fiber reduce ambulatory blood pressure in treated hypertensives. *Hypertension* 2001; 38:821-826.
28. Saltzman E, Das SK, Lichtenstein AH, et al. An oat-containing hypocaloric diet reduces systolic blood pressure and

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**Intensive patient counseling improves the average daily intake of the components of a healthy diet, such as fiber, fruit, and vegetables**



- improves lipid profile beyond effects of weight loss in men and women. *J Nutr* 2001; 131:1465–1470.
29. Chobanian AV, Bakris GL, Black HR, et al. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Heart, Lung, and Blood Institute; National High Blood Pressure Education Program Coordinating Committee. Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Hypertension* 2003; 42:1206–1252.
  30. Pins JJ, Geleva D, Keenan JM, et al. Do whole-grain oat cereals reduce the need for antihypertensive medications and improve blood pressure control? *J Fam Pract* 2002; 51:353–359.
  31. Cavallero A, Empilli S, Brighenti F, et al. High (1 -> 3,1 -> 4)- $\beta$ -glucan barley fractions in bread making and their effects on human glycemic response. *J Cereal Science* 2002; 36:59–66.
  32. Urooj A, Vinutha SR, Puttaraj S, et al. Effect of barley incorporation in bread on its quality and glycemic responses in diabetics. *Int J Food Sci Nutr* 1998; 49:265–270.
  33. Thorburn A, Muir J, Proietto J. Carbohydrate fermentation decreases hepatic glucose output in healthy subjects. *Metabolism* 1993; 42:780–785.
  34. Pick ME, Hawrysh ZJ, Gee M, et al. Barley bread products improve glycemic control of type 2 subjects. *Int J Food Sci Nutr* 1998; 49:71–78.
  35. Anderson JA, Randles KM, Kendall CW, et al. Carbohydrate and fiber recommendations for individuals with diabetes: A quantitative assessment and meta-analysis of the evidence. *J Am Coll Nutr* 2004; 23:5–17.
  36. Liu S, Buring JE, Sesso HD, et al. A prospective study of dietary fiber intake and risk of cardiovascular diseases among women. *J Am Coll Cardiol* 2002; 39:49–56.
  37. Rimm EB, Ascherio A, Giovannucci E, et al. Vegetable, fruit, and cereal fiber intake and risk of coronary heart disease among men. *JAMA* 1996; 275:447–451.
  38. Bazzano LA, He J, Ogden LG, et al. Dietary fiber intake and reduced risk of coronary heart disease in US men and women: the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. *Arch Intern Med* 2003; 163:1897–1904.
  39. Li BW, Andrews KW, Pehrsson PR. Individual sugars, soluble, and insoluble dietary fiber contents of 70 high consumption foods. *J Food Composition Analysis* 2002; 15:715–723.
  40. Marlett JA. Content and composition of dietary fiber in 117 frequently consumed foods. *J Am Diet Assoc* 1992; 92:175–186.
  41. Anderson JW, Bridges SR. Dietary fiber content of selected foods. *Am J Clin Nutr* 1988; 47:440–447.
  42. National Cholesterol Education Program, National Heart, Lung, and Blood Institute, National Institutes of Health. Food sources of soluble fiber. Available at: [www.nhlbi.nih.gov/chd/Tipsheets/solfiber.htm](http://www.nhlbi.nih.gov/chd/Tipsheets/solfiber.htm). Accessed on April 28, 2006.
  43. Truswell AS, Hiddink GJ, Blom J. Nutrition guidance by family doctors in a changing world: problems, opportunities, and future possibilities. *Am J Clin Nutr* 2003; 77(Suppl):1089S–1092S.
  44. van Woerkum CM. The Internet and primary care physicians: coping with different expectations. *Am J Clin Nutr* 2003; 77(Suppl):1016S–1018S.
  45. US Department of Agriculture, Center for Nutrition Policy and Promotion. Steps to a Healthier You. Alexandria, VA: 2005. Available at: [www.mypyramid.gov/](http://www.mypyramid.gov/). Accessed on April 28, 2006.
  46. McCarron DA, Oparil S, Chait A, et al. Nutritional management of cardiovascular risk factors. A randomized clinical trial. *Arch Intern Med* 1997; 157:169–177.