Are Oat Products Effective Cholesterol-Lowering Agents?

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***Abstract*: Oat products have become popular as a treatment for hypercholesterolemia. This article was designed to address the following question: Do existing data support the conclusion that oat products are effective cholesterol-lowering agents? A comprehensive search found 11 eligible reports. Each report was analyzed for baseline data, research methodology, and study results. A quality score was assigned to each report. Nine of the 11 eligible reports scored 4 points or less (maximum possible score was 10). Specific design concerns included lack of comparison control groups, failure to randomize and blind subjects to treatment assignment, failure to control for important confounding variables, such as impact of dietary changes known to affect serum cholesterol levels, and inadequate time allotment for cholesterol level stabilization. In most reports, a wide response to oat products was noted. Ninety-five percent confidence levels for cholesterol change ranged from −47.0 percent to +23.8 percent. Despite widespread approval, available reports do not provide evidence to support or reject the purported beneficial effect of oat products in the treatment of hypercholesterolemia. (J Am Board Fam Pract 1991; 4:229-36.)**

The traditional methods for treatment of hypercholesterolemia have been a low-fat, low-cholesterol diet and, if necessary, a cholesterol-lowering drug.[1] Recently, an adjunct to these treatments has been proposed: water-soluble dietary fiber has received considerable attention as a means to lower serum cholesterol.[2-4] Of the many types of water-soluble fiber available, oat products (oat bran and oatmeal) are currently popular. Major food companies have made changes in the type of cereal products offered to consumers, and advertising is focused on highlighting the oat bran content of certain breakfast products. This emphasis is reflected in the increase in demand for oat products by consumers. The leading producer of hot cereals and oat products in this country had a sales growth of 20 percent in its 1988 fiscal year, the first substantial growth in the hot cereals market in 6 years.[5]

Recommendations to the public to increase consumption of dietary fiber have come from the medical community. The American Medical Association has published a council report on the potential benefits of dietary fiber, including its use for lowering serum cholesterol.[6] There have been reports suggesting that oat bran may be comparable to traditional drug therapy. Kinosian and Eisenberg[7] recently performed a cost analysis comparing oat bran with two cholesterol-lowering drugs (cholestyramine and colestipol). When they calculated the cost to society per year of life saved for each type of treatment, they found that the costs were: cholestyramine = $117,400, colestipol = $70,900, and oat bran = $17,800. Their conclusion was that a broad public health approach to lower cholesterol by specific dietary recommendations to increase consumption of water-soluble fiber may be preferred over a medically oriented campaign focused on drug treatment.

Given this amount of support, an important question to ask is how effective are oat products in lowering cholesterol? Do published data support the conclusion that oat bran is an effective agent? The purpose of this article is to review published research on oat products in the treatment of hypercholesterolemia and to present information to assess the quality of the literature on this subject.

Methods

A MEDLINE search of studies published in English from 1960 through September 1990 was conducted using the following key words: hyperlipidemia, cholesterol, and dietary fiber. Articles were

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selected in which an oat product (oat bran or oatmeal) was studied for the problem of hypercholesterolemia. The reference list of each retrieved report was scanned for potential additional reports. A manual search of the *Index Medicus* was performed as well. Using this search strategy, 11 articles were found. The following baseline data were obtained from each eligible report: title, authors, year and source of publication, number of patients, average age, type of patient studied (including whether they had hypercholesterolemia), oat product studied, oat product dose, site of study, research methodology, and study results.

A quality-assessment instrument was prepared to review each of the 11 reports. The quality-assessment criteria, adapted from prior works on assessment of research quality by Chalmers, et al.[8] and Sackett,[9,10] consisted of the following questions: (1) Were the subjects assigned randomly to treatment groups? (2) Was there an adequate description of the randomization process? (3) Was there adequate protection against bias? (4) Were the investigators blinded to the treatment group? (5) Were the subjects blinded to treatment groups? (6) Was there a comparison control group? (7) Was the comparison group part of a crossover design? (8) Were dropouts reported? (9) Was the diet regimen fully described for each group? (10) Was statistical analysis appropriate? One point was given for a yes answer, no points for a no or unknown. Each report was reproduced with all identifying material (title, authors, journal) removed. Four coders (three were physicians and one held a doctor of philosophy degree with a background in clinical epidemiology) reviewed each article independently and assigned a score based on maximum score of 10. The final quality score was assigned by consensus.

Results

Baseline data from the 11 individual reports are summarized in Table 1. Seven of the published studies had fewer than 25 subjects. Six studies were done on subjects who had hypercholesterolemia. Seven studies were done exclusively with oat bran. Three studies were done exclusively with oatmeal. One study compared oat bran with oatmeal. The dose of oat bran ranged from 8.3 to 100 g/d. The dose of oatmeal ranged from 30 to 125 g/d. In comparing the differences between oat bran and oatmeal studies, it is important to remember that oat bran contains approximately twice as much water-soluble fiber as does oatmeal per unit of weight.[22]

The method and results of the studies are summarized in Table 2. Four of the reports were done in a controlled setting (metabolic ward or all food prepared in a research kitchen). Of these reports, the first was done in 1963 by DeGroot, et al.[11] Twenty-one subjects were fed a control diet for 3 weeks. Afterward, they were all placed on an experimental diet that was similar to the control diet except for the daily addition of bread containing 140 g of oatmeal. In this brief report, there is no information to assess the impact of potential dietary changes from the prestudy period to the experimental time. During the ini-

Table 1. Summary of Baseline Data on Patients Included in Oat Product Studies.*

Study	Year	No.	Mean Age (Years)	Mean Cholesterol mmol/L (mg/dL)	Patient Population
DeGroot, et al.[11]	1963	21	NR	6.49 (251)	Healthy male volunteers
Kirby, et al.[12]	1981	8	50	7.24 (280)	7/8 patients with ASHD or ASPVD
Anderson, et al.[13]	1984	10	57	7.91 (309)	8/10 patients with symptomatic ASHD
Anderson, et al.[14]	1984	10	54	7.37 (285)	14/20 patients with ASHD or ASCVD
Judd and Truswell[15]	1981	10	NR	5.25 (203)	Postgraduate students and staff
Anderson, et al.[16]	1990	12	58	6.96 (269)	Male patients with hypercholesterolemia
VanHorn, et al.[17]	1986	208	44	5.39 (208)	Merchant volunteers
VanHorn, et al.[18]	1988	236	42	5.28 (204)	Bank volunteers
Gold and Davidson[19]	1988	72	26	4.63 (179)	Healthy medical students
Swain, et al.[20]	1990	20	30	4.81 (186)	Dietitians and other hospital employees
Demark-Wahnefried, et al.[21]	1990	68	NR	7.14 (276)	Patients with hypercholesterolemia from a private practice

*NR, not recorded; ASHD, atherosclerotic heart disease; ASPVD, atherosclerotic peripheral vascular disease; ASCVD, atherosclerotic cerebrovascular disease.

Table 2. Summary of Eligible Study Methodologies and Results.

Study	Oat Product	Dose g/d	Study Site	Duration	Design	Percent Change in Total Cholesterol (mean)	Quality Score*
DeGroot, et al.[11]	Oatmeal	140	Free-living	3 weeks, control 3 weeks, experimental	Two-period crossover, nonrandomized, unblinded trial	−11.2	0
Kirby, et al.[12]	Oat bran	100	Metabolic unit	10 days, control 10 days, experimental	Two-period crossover, unblinded, randomized trial	−13.0	3
Anderson, et al.[13]	Oat bran	100	Metabolic unit	1 week, control 3 weeks, experimental	Baseline control period followed by a single period, unblinded control trial	−23.1	3
Anderson, et al.[14]	Oat bran	100	Metabolic unit	1 week, control 3 weeks, experimental	Baseline control period followed by a single-period, unblinded, randomized control trial	−19.3	4
Judd and Truswell[15]	Oatmeal	125	Free-living	2 weeks, control 3 weeks, experimental 2 weeks, control	Two-period, crossover trial	−8.0	3
Anderson, et al.[16]	Oat bran	25	Metabolic unit	2 weeks, control 2 weeks, experimental	Two-period crossover, unblinded, randomized trial	−5.4	5
VanHorn, et al.[17]	Oatmeal	56	Free-living	6 weeks, control 6 weeks, experimental	Unblinded, randomized control trial	−3.3	3
	Oat bran	56				−2.7	
VanHorn, et al.[18]	Oatmeal	56	Free-living	4 weeks, control 4 weeks, experimental	Unblinded, randomized control trial	−3.1	3
Gold and Davidson[19]	Oat bran	17	Free-living	28 days	Single-period, blinded, randomized control trial	−5.3	3
Swain, et al.[20]	Oat bran	100	Free-living	1 week, base-line 6 weeks, experimental 2 weeks, washout 6 weeks, experimental	Two-period, randomized double-blind, crossover trial	†	9
Denmark-Wahnefried, et al.[21]	Oat bran	50	Free-living	12 weeks, experimental	Single-period, unblinded, uncontrolled trial	‡	3

*Maximum quality score = 10.
†Mean serum cholesterol levels were not significantly different during the high-fiber and low-fiber periods.
‡Mean serum cholesterol changes in the four groups were not significantly different.

tial control period, subjects began to show a reduction of their serum cholesterol. Because there was no comparison control group, it is impossible to determine whether this reduction would have persisted without the addition of oatmeal to the diets.

In the study by Kirby, et al.,[12] 8 subjects were randomized to receive either a control or experimental diet. The diets were identical (isocaloric with similar fat and cholesterol content) except for 100 g of oat bran added to the experimental diet each day. The subjects consumed the initial diet for 10 days and then were crossed over to the alternative diet for the next 10 days. Cholesterol levels were assessed by observing the total cholesterol values for the 2 days preceding the initial diet and comparing them with the total cholesterol values for the last 2 days of the alternative

diet. There are two significant problems with this study. First, it is difficult to determine whether the control diet had a lipid-lowering effect in itself and whether this lipid-lowering effect would have been sustained without addition of oat bran. Two of the 4 subjects who began the study with the control diet had a total cholesterol level change from 7.89 mmol/L (305 mg/dL) to 7.11 mmol/L (275 mg/dL) and 9.15 mmol/L (354 mg/dL) to 6.83 mmol/L (264 mg/dL), respectively. Second, a 10-day experimental time is clearly inadequate to assess meaningful changes in cholesterol levels. Given this short experimental time, a potential carryover effect may influence and thus confound the study conclusions.

A report from Anderson, et al.[13] described a study of 10 patients on a metabolic ward. All subjects consumed the same control diet for 7 days. They were then randomized to one of two groups: those consuming an experimental diet supplemented with 100 g of beans (6 of 10 subjects), and those consuming the same experimental diet supplemented with 100 g of oat bran (4 of 10 subjects). Subjects in both experimental groups were observed for 21 days. Although there are no data to suggest that 100 g of oat bran is equivalent to 100 g of beans, the data from the two studies were pooled and analyzed. In the second phase of the study all patients were placed on a high-fiber maintenance diet (50 g of either oat bran or beans) and followed for 24 weeks. The high-fiber maintenance diet was significantly different from the initial fiber-supplemented experimental diets in that there was substantially less saturated fat and cholesterol in the high-fiber maintenance diet. The fiber-supplemented diet provided 33 g of saturated fat a day and 450 g of cholesterol a day. The high-fiber maintenance diet provided 15 g of saturated fat a day and 150 g of cholesterol a day. Predictable changes in serum cholesterol levels may be expected from changes in dietary fat. Using a regression equation developed by Hegsted, et al.,[23] researchers determined that the changes in cholesterol levels and saturated fat levels were enough to lower the total cholesterol by 1.0 mmol/L (38 mg/dL). During this period, however, there was a reduction of only 0.2 mmol/L (8 mg/dL) in the experimental group. This discrepancy could simply reflect that the subjects did not adhere to the high-fiber maintenance diet as well as they had stated in their dietary journals.

In another study by Anderson, et al.,[14] 20 men were given a control diet for 7 days then an oat bran- or bean-supplemented diet for 21 days. The oat bran and bean data were not combined. Of interest again was the potential impact of lipid lowering caused by the control diet. The mean total cholesterol level of the group was 7.73 mmol/L (298.8 mg/dL) on selection to the study. The mean total cholesterol level of this group after 7 days of the control diet was 7.23 mmol/L (279.6 mg/dL) (a decrease of 6.4 percent). It is possible that had the patients been kept on the control diet for a longer period of time, further decreases would have occurred.

The study by Judd and Truswell[15] was done on 10 healthy postgraduate students and staff. There was a longer observed baseline period (2 weeks), with a longer observed experimental time (3 weeks). An 8 percent reduction of total cholesterol (not statistically significant) was noted in the abstract. Not reported was a 4.7 percent decrease in the high-density lipoprotein-cholesterol level.

Finally, Anderson, et al.[16] studied 12 men with hypercholesterolemia. The subjects were randomly assigned to a typical American diet containing 56 g of either oat bran cereal or corn flakes. The subjects consumed either diet for the first 2 weeks and the alternative diet for the next 2 weeks. No information is available on the subjects' diet history before the onset of the study. It is possible that the typical American diet presented to the subjects was actually lower in fat than the subjects' typical diet. Further, as noted before, a 2-week experimental time is inadequate to assess meaningful changes in cholesterol levels.

Seven of the studies were done in an unmonitored (free-living) environment, two of which were reported by Van Horn, et al.[17,18] In the first study, all 208 subjects received instruction on the American Heart Association (AHA) diet. They were then observed for a change in total cholesterol levels for the next 6 weeks. The subjects were then randomized to consume either the AHA diet (n = 70), the AHA diet plus 56 g of oatmeal (n = 69), or the AHA diet plus 56 g of oat bran (n = 69). Changes in cholesterol levels were then observed for a 6-week period. The authors found the cholesterol-lowering effect of oat products to be small (−2.7 percent for the oat bran-

supplemented diet, $P = 0.078$, and −3.3 percent for the oatmeal-supplemented diet, $P = 0.038$). Curiously, oatmeal had a slightly better cholesterol-lowering effect than oat bran despite containing one-half the water-soluble fiber content. A plausible explanation for this finding is that the oat bran group had a sizable increase in their consumption of dietary cholesterol during the study period. The oat bran muffin recipe used contained egg yolk, accounting for most of the increase.

In the second study, all 236 subjects were instructed to follow the AHA diet and were observed for a change in total serum cholesterol levels for a 4-week period. They were then randomized either to continue the current AHA diet with a supplement of 56 g of oatmeal per day (n = 113) or to continue the AHA diet without adding any oatmeal (n = 123). Changes in serum cholesterol levels were then observed for an 8-week period. Assessment of patient compliance with the dietary changes was calculated from patients' self-reported diet journal data. There was a significant decrease in total cholesterol after 4 weeks of the AHA diet. After the 8-week observation period with subjects on the AHA diet plus oatmeal, however, there was only a 3.6 percent further decrease (not statistically significant) in total serum cholesterol. When the treatment group was divided into subjects with hypercholesterolemia and normal subjects, there were small differences that were not statistically significant.

In a study reported by Gold and Davidson,[19] 83 subjects (healthy medical students) were randomly assigned to one of three groups and received muffins containing one of the following dietary fiber sources: wheat bran and whole wheat flour, oat bran (8.3 g per muffin) mixed with wheat bran and whole wheat flour, or oat bran (17 g per muffin) alone. The subjects were asked to eat two muffins a day. The group (n = 19) that consumed the higher amount of oat bran (total of 34 g/d) had a 5.3 percent reduction in total serum cholesterol. The groups consuming wheat bran muffins (n = 25) and wheat and oat bran muffins (n = 28) had no change in total serum cholesterol. Of note is that 11 of the original study group dropped out before completing the study. Further, there is no way to assess the impact of accompanying dietary changes in the study. Although 3-day food records were submitted by each subject before the onset of the study, there were no food records taken during the study to assess whether the subjects' diets had changed.

The study by Swain, et al.[20] was a randomized, double-blinded, crossover trial of 20 subjects with normal serum lipid levels. After a 1-week baseline period, subjects were randomly assigned to receive either low-fiber refined wheat or high-fiber oat bran (87 g/d) dietary supplements for 6 weeks. This period was followed by a 2-week break during which no supplements were eaten. Finally, the subjects consumed the other type of supplement for another 6-week period. Mean serum cholesterol levels were not significantly different during the high-fiber and low-fiber periods. The most significant concern for the conclusions of this study is related to the study population. All subjects had normal serum lipid levels and were within the range for desirable body weight. It may not be correct to generalize the lack of a cholesterol-lowering effect to persons with hypercholesterolemia.

Demark-Wahnefried, et al.[21] presented the results of a randomized, single-period, uncontrolled trial of patients with hyperlipidemia in a free-living environment. Eighty-one persons were screened from the patients of an internist in private practice. All had two consecutive serum cholesterol readings greater than the 75th percentile. They were asked to complete a 2-week diet record before their first appointment. They met with the dietitian and were given instructions for incorporating oat bran into their diet or instructions on a low-fat, low-cholesterol diet. The fat-modified diet instructions paralleled the Step-One guidelines endorsed by the National Cholesterol Education Program. The subjects were then randomly assigned to one of the following four diet groups: low fat, low cholesterol (n = 15); low fat, low cholesterol, plus 50 g/d of oat bran (n = 18); 50 g/d of an oat bran supplement (n = 15); or 42.5 g/d of processed oat bran (n = 20). In a 12-week study period, the average decrease in total serum cholesterol varied from 10 to 17 percent, with no significant differences among the four groups. Two issues are of particular concern in this report. First, 13 of the 81 subjects failed to complete the study. Second, there was no control group.

For each study group, the mean observed change in total serum cholesterol is given in Table

2, as well as the quality score assigned for each report. The scores ranged from 0 to 9. Nine of the 11 reports received a score of 4 or less. The study by Swain, et al.[20] received the highest score (9). For each report, 95 percent confidence intervals were calculated for the percentage of change in total serum cholesterol (Figure 1). There is a wide range in the percentage of change of total serum cholesterol levels, particularly in those studies with a poor quality score. Figure 1 also helps to delineate the lack of a difference between the reduction in cholesterol from a low-fat diet and a low-fat diet plus oat bran.

Discussion

The purpose of this review is to address the following question: Do the existing data support the conclusion that oat products are effective lipid-lowering agents? Published techniques were used to assess the quality of research.[8,9] Based on an analysis of the published studies, the quality of research on the effect of oat products in hypercholesterolemia is generally poor. The main problems are methodologic errors with resulting lowered internal and external validity. Problems included lack of comparison control groups, failure to randomize and blind subjects to treatment assignment, failure to control for important confounding variables, such as the impact of dietary changes known to affect serum cholesterol levels, and the potential problem of inadequate time during control diet periods for cholesterol level stabilization. As a result, all of the studies, except that done by Swain, et al.[20] had low-quality scores. Studies of suboptimal quality are not uncommon in the medical literature.[24,25] Generalized conclusions from these studies resulting in significant changes in medical practice are also not uncommon.[9] Swain, et al.[20] incorporated most of the important criteria to detect whether a cholesterol-lowering effect for oat bran does indeed exist. Unfortunately, the study was done only on persons with normal serum cholesterol. It may not be valid to generalize these results to patients with hypercholesterolemia.

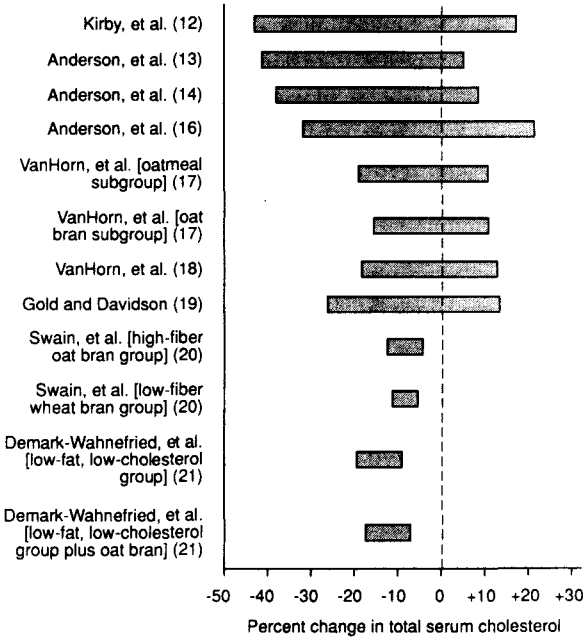

Figure 1. Ninety-five percent confidence intervals for the percentage of change in total serum cholesterol for each eligible study.

The published reports also show that the degree to which dietary fiber affects serum cholesterol levels is not yet clearly defined, as the amount of cholesterol lowering varies depending upon the site of the study. The reports from metabolic wards tend to show a much greater percentage of lowering of serum cholesterol levels than do the reports from unmonitored settings. Ideally, a meta-analysis could be used to help assess the precise treatment effect to be expected from an oat product. Because of concerns for the quality of the data, a meta-analysis was not done.[26]

Previous work on the role of dietary fats (saturated, polyunsaturated, and cholesterol) had resulted in fairly precise estimates on the effect of changes in these dietary components on serum cholesterol levels.[23] Similar work needs to be done with dietary fiber. Studies need to be devised to optimize the chance of detecting the exact amount of lipid lowering to be expected by a given amount of fiber. Well-designed studies must incorporate all of the following criteria:

Subject population. The analysis must compare normal persons separately from patients with hypercholesterolemia. For patients with hyperlipidemia, it will be important to consider whether to include those with disorders of cholesterol or triglycerides or both. Stratification by initial cholesterol measurement must occur because the greatest percentages in cholesterol reductions are often seen in those with the highest cholesterol levels.

Diet. The diet before and during the experimental intervention remains the single most im-

portant factor in evaluation study design. Diet needs to be assessed continually in all trials involving free-living populations as opposed to those occurring in metabolic wards or kitchens. If diet is not continually assessed through food records or dieticians' guidance, then a small change in saturated fat consumption can offset important clinical effects, as reported in the study by Swain, et al.[20]

Defining percentage of cholesterol reduction. In studies in which there is an adequate placebo or control group, subtracting the change in cholesterol readings between the two groups is appropriate. For studies with suboptimal methodologies, however, such as in "control-run-in" studies, in which subjects who consume a control diet are compared with the same subjects on a control diet plus the fiber supplement, this comparison does not hold true. In this study one might consider comparing the final cholesterol measurement of those on the control diet with the final cholesterol measurement of those on the experimental diet.

Compliance data. Few of the reported studies mentioned give any data on compliance with regimen, percentage of oat dose actually consumed, and whether dropouts were included in the final analysis.

Treatment duration. The treatment duration of each study is different, and short-term studies (i.e., 6 weeks or less) always yield greater effects than long-term studies. Thus, a decision about a minimum period in which to assess treatment effects is needed.

Conclusion

Does oat bran have an inherent cholesterol-lowering effect? Has the observed effect been noted simply because persons who consume oat bran selectively lower their fat consumption, which in turn lowers serum cholesterol? From the results of this review, the question cannot be answered. The greatest concern is not that patients will consume large amounts of oat products of questionable value in lowering their serum cholesterol, but that they will continue to consume diets high in fat and cholesterol assuming that inclusion of oat products will balance out any dietary indiscretions.

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