

**Nutritional Supplementation and Hyperlipidemia:
A Literature Review**

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Abstract

Purpose

The purpose of this paper is to review the current literature with regard to the efficacy of various nutritional supplements utilized for hyperlipidemia. Advising on nutritional supplementation is within the scope of chiropractic. This review will investigate the studies done in order to determine the scientific validity of advising patients towards using particular supplements to reduce their cholesterol.

Methods

The PubMed database was utilized in searching for journal articles. 41 articles were selected, consisting mostly of reviews and clinical trials of various nutritional supplements.

Results

Articles were reviewed regarding soy-isoflavones, soy milk, niacin, omega-3 fatty acids, and garlic.

Conclusions

The most reliable and consistent studies done over time that had positive results regarding serum cholesterol concentration utilized plant sterols and niacin. Soy milk and omega-3 fatty acid studies demonstrated moderate reliability. Soy-isoflavone and garlic studies were mixed in their results and reliability.

Key Words:

Dietary supplements, cholesterol, soy-isoflavones, plant sterols, niacin, omega-3

Introduction

As a form of preventative medicine, chiropractic has traditionally had strong ties to lifestyle and nutrition. The adjustment may be the centerpiece of the profession, but the philosophy behind chiropractic supports the holistic model of healing. When treating the body as one functioning unit instead of many distinct parts and pieces, the health care practitioner has to consider what stresses that body is undergoing on a daily basis. Within the Medicare community alone, by 2002, 21.4 percent of aged beneficiaries and 39.3 percent of disabled beneficiaries were obese.(1) Also, obesity and Type II Diabetes are rapidly increasing among pre-teens in the United States. As these obesity numbers grow at extremely fast rates in this country, two of the critical stressors on the human body to be considered are diet and hyperlipoproteinemia.

Hyperlipoproteinemia is defined as elevated concentrations of any or all of the lipids in the plasma. As food is consumed and passes through the stomach to the small intestine, the fat is digested and resynthesized as triacylglycerols. Bile enters the intestine from the gallbladder and emulsifies the triglycerides, which are then hydrolyzed into individual fatty acids and glycerol molecules by pancreatic lipase. The molecules are then packaged, in the epithelial cells, into chylomicrons which enter the lymphatic system. Once the chylomicrons reach the lymphatic system they can bind with proteins and travel back into the blood stream, where their levels are measured as triacylglycerols.(2)

The lipids in the bloodstream, particularly low density lipoprotein (LDL) cholesterol, lead to a chronic inflammatory response in the arteries, or atherosclerosis. Atherosclerosis plays an integral role in heart disease, which affects 10.9% of the population and is the number one killer in the United States.(3) As hundreds of billions of dollars of the health care budget goes

toward heart disease, chiropractors cannot ignore their role as nutritional counselors.

There is a wide variety of supplements that have been studied in the literature. Niacin has a long history reducing hyperlipoproteinemia, but some studies show that it does not decrease mortality rates.(4) Omega-3 Fatty Acids and have gained popularity in the last decade, but they appear to be dependent on dosage, and some studies have shown that fish oils are more effective as a supplement than Omega-3 capsules.(5) There have also been debates regarding Coenzyme Q10, raw garlic, Vitamin D plus Calcium, and many others. (6,7,8)

Medical doctors have combated rising levels of hyperlipoproteinemia worldwide using several treatment protocols. The more aggressive treatments are utilized in cases of genetic hyperlipidemia. In these cases the mutant alleles usually produce a deficient amount of LDL receptor protein, so there are limited numbers of LDL receptors available to pick up and clear the LDL cholesterol. In other cases there may be problems with the binding region of the LDL receptor or the transport mechanism which brings the LDL to the proper receptor site. (2) Treating this type of hyperlipidemia caused by a genetic precursor is outside the scope of chiropractic care, so this literature review will focus on hyperlipoproteinemia and high cholesterol.

The most common treatment medical doctors utilize today in treating hyperlipidemia is prescribing statins. Statins, are a group of drugs which lower cholesterol by inhibiting the synthesis of hydroxy-methylglutaryl-coenzyme A reductase (HMG-CoA reductase). HMG-CoA reductase is an enzyme involved in the rate-limiting step of the mevalonate pathway when cholesterol is synthesized. Therefore, intracellular LDL cholesterol is decreased. When this occurs, the LDL receptors in the liver are stimulated, and more LDL is picked up

by the receptors to be cleared by the body. (9) Some common statins are Lipitor, Torvast, Mevacor, Crestor, and Zocor. These differ from cholestyramines, which form insoluble complexes with bile acids so that levels of the cholesterol passed through and out of the gut are elevated.

Over 100 million people were taking statins in 2002 (10), making them the most highly sold drugs in the United States. A considerable number of the people taking statins are experiencing side effects. Some of the most common side effects of statins are headache, nausea, vomiting, constipation, diarrhea, headache, rash, weakness, and muscle pain (11). In the past many people began taking statins in their fifth and sixth decades of life, but now it is common for patients to begin taking them as early as their fourth decade. These patients who are taking the statins for longer portions of their lives are reporting greater incidences of side-effects, particularly muscle cramping. (12) As stated previously, statins lower cholesterol by inhibiting the synthesis of HMG-CoA reductase, which limits the mevalonate pathway. Mevalonate is a precursor for cholesterol and the side chains of CoQ10. These side chains play a large role in the electron transport chain. As food is catabolized, NADH is produced via assorted pathways such as β -oxidation and the TCA cycle. Oxygen is used to oxidize NADH by the electron transport system, which employs Coenzyme Q as a component. Without CoQ10, the muscles of the body have to shift from utilizing the aerobic electron transfer chain for energy to utilizing anaerobic sources of energy.(2)

Chiropractors do not prescribe drugs, but they consider their scope of practice to include nutritional counseling. This literature review will explore the various nutritional and dietary supplements that are recognized to have lipid-fighting qualities. Advantages include that the chiropractor can provide a valuable service to patients who cannot take statins due to side effects,

nutritional counseling provides a multidisciplinary approach between chiropractors and medical doctors to lower lipid levels, and overall health can be increased as quickly as possible.

Materials and Methods

The initial literature search took place on 2 November 2007 at Logan University. It consisted of a PubMed database search using the terms nutritional AND supplements AND hyperlipidemia. The search yielded 261 articles. Initially, 24 articles were selected based on the criteria that they were printed in the last ten years, whether or not they were from refereed journals, and if they were relevant to the topic of this review.

The next search took place on 12 February 2008 at Logan University and it consisted of a search of the PubMed database using the terms nutrition AND hyperlipoproteinemia. It yielded 7 articles, which mostly focused on genetics and molecular biology. One article was selected from this search which involved testing fish oil as an effective supplement.

The third search, on 17 June 2008, also utilized PubMed and the search terms were hypercholesterolemia AND diet therapy. It yielded 254 articles, 54 of which were selected for further review, based on the criteria that they were printed in the last ten years, whether or not they were from refereed journals that were obtainable at Logan University, and that the articles were available in English. The articles were then further selected to 27 on the basis of being review articles or clinical trials. Clinical trials were favored in the selection process because most of them involve administration of a supplement followed by measurement of triacylglycerols. This review will look at how these studies differ, and how their validity is used to determine the efficacy of the various supplements described.

Discussion

Soy-Associated Isoflavones

There were several articles regarding the effects of soy-associated isoflavones found through the literature search, including meta-analyses and clinical trials. The first meta-analysis was published in 2003 and reviewed 10 controlled studies. Their initial search found a total of 148 articles, and upon reviewing the abstracts, the authors utilized criteria to eliminate the articles. Some of these criteria were that the study had to last for a duration of at least two weeks. Also, the studies had to be double-blind, the subjects needed to be weight-stable, and the independent variable could only consist of an increase in soy-isoflavone intake without other changes in the subject diets. The soy-isoflavone intake ranged from 10 mg to 60 mg per day among the ten studies, but there was no indication in the review of variation in caloric intake. The statistical analysis included calculation of absolute change in LDL and HDL cholesterol among the 959 total subjects. The correlation coefficient was only $R=0.29$, which was not considered statistically significant by the authors. Their conclusion was that consumption of soy-associated isoflavones did not change LDL or HDL cholesterol. (13)

This study utilized relatively stringent quality controls with regards to the studies reviewed. The statistical analysis, which utilized linear regression and adjusted for outliers and drift variables, was considerably thorough with detailed data listed within their review. The results the authors concluded with, which were that soy-isoflavones are not linked to significant change in LDL or HDL cholesterol levels, should be seriously considered.

A more recent meta-analysis published in 2007 reviewed 11 randomized controlled trials. (14) The studies selected lasted for at least one month and utilized from 12 to 42 subjects. As in the previous study, the subjects only

changed their diets with respect to intake of soy-isoflavones. The authors calculated weighted mean differences between starting and ending total and LDL-cholesterol levels. Also, instead of using strictly linear regression alone, the authors pooled the results of the 11 studies.

A unique aspect of this meta-analysis is that the authors looked at possible differences in the results of studies which utilized subjects who began with normal LDL-cholesterol levels versus the results of studies which utilized subjects with elevated LDL-cholesterol levels. Of the five studies that utilized hypercholesterolemic subjects, only two of them resulted in significant reductions. The reductions were more significant in the studies where subjects began with normal LDL-cholesterol levels. For our purposes of looking at possible solutions for chiropractic patients who have high cholesterol levels, this finding should be considered.

The overall results for this study were that soy protein ingested for 1-3 months would lower total cholesterol by 0.10 mmol/L and would lower LDL cholesterol by a mean of 0.13 mmol/L. These results are statistically significant, but there is another factor to be considered. The authors had published a previous review in 2004 with results that were consistent with these, so there may have been some bias in the article selection process. Researchers generally do not like to disprove themselves between research studies, so they may have known there were particular researchers or types of studies that would be consistent with their previous research.

The next meta-analysis reviewed was published in February 2005 and utilized PubMed in identifying 23 eligible randomized controlled trials that fit their review criteria. (15) The criteria required that the studies provided the amount of soy isoflavones administered, were controlled and randomized, and that they provided initial lipid profiles of the subjects. The authors found that

soy-protein containing isoflavones was indeed associated with decreased total serum cholesterol, decreased LDL cholesterol, and increased HDL cholesterol, but the more interesting aspects of the review were in *when* the changes were most significant. First of all, tablets containing extracted soy-isoflavones did not have a significant effect on cholesterol changes. Secondly, decreases in total serum cholesterol and LDL cholesterol were greatest during the initial period of administration, whereas increases in HDL cholesterol were only significant in studies that lasted for 12 weeks or more. Furthermore, the decreases in total serum cholesterol and LDL cholesterol were larger in men than women. This review is a good demonstration of how there can be multiple variables that should be considered when reviewing several studies. The fact that the authors identified these variables, and went a step further than the above mentioned studies to correlate various outcomes with these variables, shows that the review was in depth and should be considered significant.

The first specific study this review will consider is a randomized controlled trial done at the University of Massachusetts. (16) 159 subjects were split into a control group and an intervention group. For five-weeks, both groups received two sealed packets per day, containing a mixture of protein, carbohydrate, and calcium in powder form to be mixed with water. The packets were similar in flavor and calories, but the intervention group had 120 mg of soy isoflavones added to their daily packets. There were significant changes in total cholesterol and LDL cholesterol in both groups, but there was no significant difference between the two groups. The statistical analysis consisted of measured cholesterol levels in a linear regression. These results showed that protein shakes with added soy-isoflavones are effective, but no more effective than standard calcium-based protein shakes.

The results from the soy-isoflavone articles were mixed. The review that used the most stringent quality controls showed that soy-associated isoflavones did not change HDL or LDL cholesterol. Overall, the studies showed that the effect of soy-associated isoflavones is largely dependent on the population characteristics, so their reliability is not certain.

Soy Milk

In 2007 a study was published from the Stanford University comparing the effect of adding 1% dairy milk, “milk” made from whole soy beans, or “milk” from a soy-protein isolate on plasma lipids. (17) 28 subjects who were not taking cholesterol lowering drugs and had a total serum cholesterol of 160-220 mg/dL, were selected to participate. Each dosage of milk per day was calculated so that there was an additional 25 grams of protein from each milk supplement per subject. The soy bean milk and the soy-protein isolate milk led to a minor decrease in LDL cholesterol of five percent, and there was no measurable change in serum lipid levels in the group drinking dairy milk. Even though the study was randomized, there was no control group. Also, the study used products available at grocery stores instead of standardized products. Grocery store products are regulated by the manufacturer and the particular products used in the study were not tested for proteins at the source of the study. The subjects may have not been receiving exactly the same amounts of protein daily due to variance in manufacturer testing. Therefore, the results of this study should not be considered very reliable when comparing to a large population.

Another study which was published in 2007 took place at Tufts University. (18) Unlike the previous study, this study was highly regulated in that all of the food and drink for six weeks were provided by the researchers. There were four different diets given to four randomized groups amongst the subjects which differed in the source of protein. The protein in the first diet was

from animal sources and was consistent with the current dietary recommendations for cardiovascular disease prevention. The protein in the remaining three diets was soy-based. The different soy sources were soybean, soyflour, and soymilk. The only diet that resulted in decreased serum lipid LDL concentration was the diet where protein was derived from soymilk, but HDL concentrations only increased in the animal protein diet.

There was a consistency amongst the ages of the subjects in this study, in that they were all over the age of 50 and they all had LDL-cholesterol concentrations greater than or equal to 3.36 mmol/L, which is considered high by the National Cholesterol Education Program. (19) There was no control group in this study, but the study was so highly regulated and monitored that some credence should be given to the results. Also, there is consistency with the previous study in that soymilk lowered LDL-cholesterol concentrations, even if it was only by a small amount.

In comparing one study that was not strictly regulated to one that was very strictly regulated, it is interesting to see that they had similar results. In both studies, soymilk was shown to decrease LDL-cholesterol levels, but only by minor amounts.

Plant Sterols and Stanols

Outside of soy, there has been a significant amount of research in the use of plant sterol and stanol supplementation for high serum cholesterol. Plant sterols are close in structure to mammal cholesterol, most of them only differing in that there is an ethyl group attached to carbon-24. Stanols are saturated sterols (sterols without double bonds in the ring structure. (20) The functional difference between sterols and cholesterol is that about 50 percent of cholesterol is reabsorbed in the intestinal tract, whereas reabsorption of sterols and stanols ranges from 4% to 15%. (21) It has been found that food enriched with stanol

and sterol esters lower serum cholesterol levels through this reduction of intestinal absorption of cholesterol.

The first article this review will cover regarding plant stanols and sterols is a review of the "Efficacy and safety of plant stanols and sterols in the management of blood cholesterol levels." (22) The results of the meta-analysis of 41 clinical trials showed that increasing the subject's intake of daily plant stanols or sterols decreased their LDL-cholesterol levels by ten percent. Also, the reviewers found that adding plant stanols or sterols to statin medication was more effective than doubling the dose of the statin medication. The 41 trials that the reviewers studied were all randomized, double-blind studies that had a placebo, or control group, in place. The most valuable asset of this review and the trials that were studied was that there was no statistically significant heterogeneity between trial results. Considering the large number of trials studied and the relatively large average decrease in LDL-cholesterol of ten percent, this review of efficacy of plant sterols and stanols should be considered very clinically important.

In 2003 a study was published from the Centre of Clinical and Basic Research in Denmark in which 71 mildly hypercholesterolemic subjects were given a 500 mL milk blend supplement every day. (23) The patients were randomly divided into three groups where the daily consumption of sterols added to the milk blend was 0.0 in the control group, 1.2 grams per day in the Lo group, and 1.6 grams per day in the Hi group. There was no statistical difference between the Lo and the Hi groups, but they both decreased LDL-cholesterol levels by between 7.13 and 9.59 mg/dL.

An interesting point about this article is that it is one of the first studies that introduced nonesterified, nonhydrogenated sterols that can be infused into a low-fat medium. Plant sterols are usually studied in oily mediums, such as

margarines or dressings. It is important in treating patients with high cholesterol, who possibly have heart problems, to utilize supplements that are heart healthy.

The European Journal of Clinical Nutrition published a study in 2006 where 67 mildly hypercholesterolemic subjects were given 50 grams of cheese to ingest every day for five weeks. (24) One randomly assigned group received cheese enriched with 2 grams of plant stanols and the other randomly assigned group received cheese with no stanols. The 67 subjects were selected carefully so that no one in the group had pre-existing conditions and there was a mixture of men and women included in the study. Compared to the control group, total cholesterol in the treatment group decreased by 5.8% and LDL-cholesterol decreased by 10.3%. The treatment groups also lost an average of one pound during the study. It is remarkable that even though the added product was cheese, the treatment group had a significant decrease in LDL-cholesterol, which speaks strongly for plant stanols.

Each of these studies showed that adding plant sterols or stanols to the diet leads to a decrease in LDL-cholesterol levels. The reviews and the clinical trials were thorough in their methods, and the results were consistent across the board.

Nicotinic Acid

A prominent supplement that has been utilized since a landmark study came out in 1955 is nicotinic acid, otherwise known as vitamin B3, or niacin. It is an inhibitor of lipolysis in adipose tissue which results in a decrease in free fatty acids. Although it has been used widely to lower serum cholesterol levels, niacin comes with some unwelcome side effects, such as flushing, redness, and itching. (25)

In 2005, L.A. Carlson did a 50th anniversary review of niacin at the Karolinska Institute in Stockholm, Sweden. (26) The review covers over forty

important studies that have been done on niacin throughout the past fifty years, which demonstrate the efficacy of niacin in many areas of cardiovascular medicine. One interesting facet of the article was the presentation of an article allowing that niacin inhibits the rise of free fatty acids when humans were put under emotional stress. Subjects were exposed to emotional stress testing, and compared to the control groups, there was less urinary excretion of free fatty acids and plasma triglycerides. (27) In a society where stress is strongly related to cardiovascular problems, this is a very beneficial aspect of niacin to be considered.

Nicotinic acid not only consistently decreased the levels of LDL-cholesterol in the studies reviewed, but it also decreased levels of chylomicrons and VLDL-cholesterol and increased the levels of HDL-cholesterol. This is a significant finding in that HDL-cholesterol is important in lowering the risk for cardiovascular disease. Also, this review covered several studies that showed that treatment with nicotinic acid over time has led to diminished numbers of atherosclerotic lesions in patients who had had coronary bypass surgery. Even though the side effects are undesirable with nicotinic acid treatment, this review demonstrated that over the past fifty years the research has been consistent regarding the positive outcomes in overall cardiovascular health.

An article published in 2007 in Berlin, Germany, reviewed the effects of prolonged-release nicotinic acid. (28) The benefit of the time-release supplement is that the side effects which accompany niacin are diminished. 76 subjects were given 1500 milligrams of the prolonged-released nicotinic acid (Niaspan®), 74 subjects were given 1500 milligrams of immediate-release nicotinic acid, and 73 subjects were given a placebo. Niaspan® and immediate-release nicotinic acid both resulted in 18% increases in HDL-cholesterol and 12% decreases in LDL-cholesterol. The placebo group had negligible changes. This study demonstrated

that Niaspan® is as effective as immediate-release nicotinic acid, but the drawback is that Niaspan® is only available by prescription. This makes it unavailable to chiropractors as a distributable supplement, but it is an option that chiropractors can discuss with their patients' medical doctors as an alternative to other cholesterol-lowering drugs, such as statins.

Over the test of time, nicotinic acid has proven itself to be a safe supplement with consistent results. It aids in improving overall cardiovascular health as well as lowering LDL-cholesterol levels.

Omega-3 Fatty Acids

A supplement that has been under much discussion is the introduction of linolenic acids, or omega-3 fatty acids, to the diet. Initially omega-3 fatty acids gained attention when Bang and Dyerberg studied the diets and serum lipid concentrations of Greenland Inuits in the 1970s. (29) The Inuit serum concentrations of total cholesterol and triacylglycerols were significantly lower than those of other populations of similar age and sex. The Inuit diet consisted mostly of fish, so the idea that the oils in the fish had antiatherogenic nutrients was further explored and confirmed in several studies. (30,31, 32)

Most of the studies in the PubMed database were studies that were over ten years old, so this review will cover two of the more recent studies published. The first study was published in 2006 in the European Journal of Clinical Nutrition and it focused on 37 mildly hyper-cholesterolemic elderly subjects. (33) The subjects were provided with specific amounts of products that were rich in either oleic acids, alpha-linolenic acids (ALA), or a combination of docosahexaenoic acid (DHA) and eicosapentaenoic acids (EPA).

Alpha-linolenic acids are plant derived omega-3 fatty acids, and there has been much debate as to whether or not they may be as effective as EPA and DHA in lowering cardiovascular risk factors, which are derived from oily fish and

seafood. (34) Subjects were not permitted to consume fish or seafood throughout the six-week study so that the amount of acids consumed by the subjects was standardized to a large extent. This study yielded a large amount of useful information because the researchers measured changes in weight, cholesterol, triacylglycerols, fibrinogen. Weight loss was only 0.6-1.2 kilograms amongst the three groups. LDL-cholesterol actually increased in the group taking EPA/DHA and it decreased in the ALA group. HDL only increased in the EPA/DHA group, though, and the positive change in concentration of 0.04 mmol/L was a relatively significant amount. Triacylglycerols decreased six times more in the EPA/DHA group than in the ALA group. There was no significant change in fibrinogen among the groups. When weighing the cardiologic risk factors, it is clear that EPA/DHA are more effective in increasing cardiovascular health than ADA.

The next study of Omega-3 acid intake involved exclusively women and it was published by the Journal of the American Medical Association. (35) This study consisted of dietary questionnaires taken every four years from 1980 to 1994. 84,688 nurses were surveyed and incidents nonfatal myocardial infarction and coronary heart disease were obtained throughout the subjects' lives. After adjustments were made for age and smoking, it was found that women who ate fish one to three times per month were 13% more likely to die due to coronary heart disease than women who ate fish five or more times per week. Even though this study was long-term and extremely large-scale, there is the question of how accurately the questionnaires were answered. Surveys are generally not as accurate as objective information obtained through laboratory testing, which has been the consistent method of testing in the other articles reviewed in this paper. In the materials and methods section of this article, there was no mention of specific instructions given to the patients regarding the surveys. There is also the factor at hand that many times people do not keep track of their daily food

intake stringently, so there was probably some error in how the subjects reported portion sizes and number of times they ate particular food products.

Omega-3 fatty acids have been shown to positively impact cardiovascular disease risks in the above studies, but the studies were each focused on specific population groups (the elderly and women). If more recent studies had been available that looked at wider ranges in populations, this review could conclude that omega-3 fatty acids were likely to have a positive cardiovascular effect on most people, but that is not the case. The Journal of the American Heart Association has called for further widespread research to be done in this area in order to confirm what has been found in smaller group studies. (36)

Garlic

There have been several recent studies regarding the efficacy of garlic in treating patients with high serum concentrations of cholesterol. One of them which was available on PubMed was published from Monash University in Australia in 2001. (37) Allicin has been identified as the probable agent in garlic which has hypocholesteremic benefits, but the exact mechanism by which it works has not been identified since it does not circulate for very long in the blood stream, and the active metabolites which it forms have not been identified. (38,39) Furthermore, enteric-coated supplements were utilized in the study, and there has been some debate as to whether allicin is viable outside of fresh garlic. This is because allicin is dependent on the alliinase enzyme, which is inhibited in acidic conditions that can occur in the production of nutrition supplements. (40)

22 subjects received a garlic supplement or a placebo for twelve weeks. The results were that the treatment group had a significant reduction in total cholesterol, LDL-cholesterol, and HDL-cholesterol, in comparison to the placebo group. Some may say that the reduction in HDL-cholesterol speaks poorly for garlic as a supplement, but upon further inspection, the HDL-cholesterol only

decreased by 0.03 mmol/L, whereas the LDL-cholesterol had a much larger decrease of 0.4 mmol/L.

Even though this was a small study, it was double-blind and placebo controlled, and the subjects were screened for age, gender, diabetes, and renal disease, and they had to have hyperlipidemia of 6.5-9.0 mmol/dL in order to participate. The implementation of enteric coating did not seem to take away from the fact that the treatment group had significant decreases in total cholesterol and LDL-cholesterol.

The next study, which was published from Stanford in 2007, took the above mentioned trial a step further in that it was a comparison of raw garlic, powdered garlic tablets (Garlicin), a popular brand-name garlic supplement derived from aged garlic powder (Kyolic), and a placebo. (41) 192 subjects took the supplement six days per week for six weeks. They were screened for age, sex, and pre-existing diseases that may effect the study. They all began the study with LDL-cholesterol concentrations of 130-190 mg/dL and triglyceride levels less than 250 mg/dL.

The study found that there were absolutely no statistically significant changes in triglyceride, LDL-cholesterol, or HDL-cholesterol in any of the treatment groups. This is a profound finding, especially because there was such a wide variety of garlic supplementation utilized, so some variance in the amount of change per group would be expected. In reviewing the data charts for this study, the baseline numbers and the numbers from month to month remain almost exactly the same within each group. This was a much larger and more long-term study than the study done in Australia, but the patients were not mildly hypercholesterolemic when compared to the other study. It may be possible that the subjects in the previous study responded better to the garlic

supplementation because garlic is more effective in those who have higher baseline LDL-cholesterol concentrations.

There are many inconsistencies between these two studies, in their results as well as their methods. It is not clear whether or not garlic is a useful supplement in patients with high cholesterol levels. This is an area that merits more efforts from the research community.

Conclusion

This review covered a number of studies which explored the dietary supplementation of soy isoflavones, soy milk, plant sterols and stanols, niacin, omega-3 fatty acids, and garlic. The most reliable and consistent studies done over time that had positive results regarding serum cholesterol concentration utilized plant sterols, plant stanols and niacin. Plant sterols and stanols are a good option for chiropractors because they are infused into many readily available products at the grocery store. It is very simple to educate patients on how to replace certain butter, oil, or milk products in their homes with those that contain plant sterols or stanols. Niacin is also a good option for chiropractors because it is readily available for sale inside or outside the office. It may be a hard-sell for patients who cannot handle the flushing side-effect, though. There is an opening here for chiropractors to open up a dialog with medical doctors about how Niaspan® is a good alternative to other cholesterol-lowering drugs.

Soy milk and omega-3 fatty acid studies demonstrated moderate reliability. The soy milk studies did not have control groups, but both demonstrated that soymilk was a product which helped lower LDL-cholesterol. The omega-3 studies showed efficacy in overall cardiovascular health, but they only covered dietary fish omega-3 supplementation and not tablet-form supplementation. When recommending tablet-form supplementation,

chiropractors need to keep in mind the quality of the product and how closely it resembles the make-up of the whole-food fish oils and their bio-availability.

The soy-isoflavone and garlic studies were mixed in their results and reliability. Soy isoflavones showed more significant changes in those with normal to moderately high cholesterol levels, and they were more effective in men than women. Also, one of the more reliable studies showed that soy-isoflavones may not be more effective than simply adding protein to the diet. The garlic studies contradicted one another, and neither one of them discussed the possible social side effect of raw garlic leading to body odor. More studies need to be explored to come to a distinct conclusion regarding garlic.

Overall, chiropractors have a wide variety of nutritional supplementation readily available for their hyperlipidemic patients. Considering the facts that many of these supplements have been well-researched and that today cholesterol-lowering drugs that have possible side-effects are commonplace, these supplements should be more highly utilized in the health care setting.

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