# Influence of apple cider vinegar on blood lipids

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**Abstract:** Apple cider vinegar has been traditionally used since many years ago to treat a certain number of diseases including hyperlipidemia which is known as a risk factor for atherosclerosis. Early prevention and treatment of atherosclerosis can prevent complications of cardiovascular diseases. Hence, the present study aimed to review the influence of apple cider vinegar consumption on reducing blood lipid levels. This quasi-experiment study(time series design) was carried out on 19 patients with hyperlipidemia. The subjects had been referred to a cardiologist and agreed to consume apple cider vinegar. At baseline, blood samples were obtained to measure cholesterol, triglyceride, low density lipoprotein (LDL), and high density lipoprotein (HDL). The tests were repeated at two, four, and eight weeks of vinegar consumption. The results were analyzed using repeated measurement analysis. There were significant reduction in the serum levels of total cholesterol ($p < 0.001$), triglyceride ($p = 0.020$), and LDL ($p = 0.001$) after eight weeks of consuming apple cider vinegar and with an increased HDL levels but the trend was not statistically significant ($p = 0.200$). Consumption of apple cider vinegar over a 8 week period had a beneficial effect in significant reductions in harmful blood lipids and is recommended as a simple and cost-effective treatment for hyperlipidemia.
[Zahra Beheshti , Yiong Huak Chan**,** Hamid Sharif Nia, Fatemeh Hajihosseini, Rogheyeh Nazari, Mohammad shaabani, Mohammad Taghi Salehi Omran. **Influence of apple cider vinegar on blood lipids.** *Life Sci J* 2012;9(4):2431-2440]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 360
**Keywords**: Apple cider vinegar, Hyperlipidemia, Atherosclerosis

## Introduction

Plasma lipoprotein abnormalities and lipid metabolism disorder are known and proved risk factors for atherosclerosis.[1] Besides their impact on mortality, they have substantial, and in some cases modifiable, influences on disability rates.[2] Modifiable factors have greater impact on cardiovascular diseases (CVDs). In fact, dyslipidemia, hypertension, smoking, and diabetes increase the risk of CVDs by approximately 80-90%.[3] Increased low density lipoprotein (LDL) is a major factor in the development of coronary heart disease (CHD), i.e. every 1 mg/dL increase in LDL can increase the risk of CVD by 1%.[4]

Treatment of dyslipidemia alone will significantly reduce the prevalence of CVDs. Thus, lipid-lowering treatment is currently recommended for individuals at risk of CVDs.[5] Many studies have suggested that lowering blood lipids such as cholesterol, triglyceride, and LDL and simultaneous increase of high density lipoprotein (HDL) might reduce the risk of CVDs, particularly atherosclerosis.[2,3]

The prevalence of hyperlipidemia varies in different communities. The prevalence of hypercholesterolemia and hypertriglyceridemia in Brazil has been reported as 4.1% and 17.1%, respectively.[6] Cholesterol and triglyceride levels greater than 200 mg/dL have been found among 56.7% and 8.9-33.9% of the Portuguese population, respectively.[7] Azizi et al. evaluated 6246 individuals in Tehran, Iran, and indicated that about 31% of the subjects had cholesterol levels of 200-239 mg/dL. In addition, cholesterol levels greater than 240 mg/dL were detected among 24% of the studied population.[8] On the other hand, the prevalence of hyperlipidemia among 611 Iranian patients with acute coronary syndrome was over 80% during 2003-04.[9]

However, widespread application of chemical drugs causes complicated side effects that are sometimes even more dangerous than the disease itself. As a result, some drugs may be eliminated or prescribed with extreme caution.[10] Fear of drug side effects brings about their inappropriate use and rejection. Therefore, the disease will not be desirably controlled.[11]

Because of the above mentioned issues, a large number of studies have been performed concerning the influence of herbs such as garlic,[11] Allium ampeloprasum,[12] basil,[13] tarragon,[14] barberry,[15] fenugreek,[16] and Apium graveolens,[17] sour orange juice,[18] acetic acid,[19] and apple cider vinegar[20] on blood lipids. The influence of apple cider vinegar has been investigated for hundreds of years. It was in fact first used about 5000 years ago. In the year 400 B.C., Hippocrates, the father of modern medicine, prescribed the mixture of honey and apple cider vinegar for treatment of various diseases.[21] It has been particularly used during the American Civil War for disinfecting the wounds of soldiers.[21] More valuable properties of apple cider vinegar and its ingredients, suggesting their therapeutic effects, have been recently discovered.[19,22-24] Apple cider vinegar contains polyphenolic compounds that have beneficial health effects.[24,25] Its antioxidant flavonoid content can reduce the harmful effects of high-cholesterol diets.[23] Acetic acid is the main ingredient of apple cider vinegar. It is consumable at concentrations of 3-9%. It is used not only as a seasoning but also as a common a traditional medicine.[19] However, a study on blood lipid profile of healthy individuals following a high-fat meal failed to show the positive impacts of apple cider vinegar on serum lipids and lipoproteins.[26]

Apple products are widely used in the world.[22] Nevertheless, scientific information about the biological effects of apple cider vinegar as a traditional medicine is inadequate.[20] Apple cider vinegar is a very light vinegar that is sometimes used in Iranian foods. Very few studies, mostly animal studies, have assessed its impact on patients with hyperlipidemia. Hence, the present study aimed to review the influence of apple cider vinegar on serum lipid levels and prevention of lipid disorders.

## Methods

This quasi-exeriment study (time series design) was performed on 19 patients with hyperlipidemia, i.e. cholesterol levels greater than 200 mg/dL and/or triglyceride levels greater than 150 mg/dL.[3] A cardiologist confirmed the absence of uncontrolled diabetes, hypothyroidism, drug-induced hyperlipidemia, uremia, nephrotic syndrome, pancreatitis, pregnancy, and coronary artery diseases (CADs) in all subjects. In addition, the participants were not receiving treatments which could influence blood lipid metabolism. At the beginning of the study, blood lipids of eligible individuals were tested. All

participants were asked not to modify their diet or physical activity pattern. However, they had to consume 30 ml of apple cider vinegar 4% (made in Septico Co., Mashhad, Iran) twice a day (morning and afternoon) for eight weeks. At the end of the second, fourth, and eighth weeks, 5 ml blood samples were obtained after 14 hours of fasting. Cholesterol, triglyceride, HDL, and LDL levels were then determined using enzymatic methods in the laboratory of Shahid Beheshti Hospital affiliated with Babol University of Medical Sciences. A Pars Azmoon Kit (Hitachi Analyzer 902, Germany) was employed to perform the tests. LDL was calculated as the sum of very low density lipoprotein (VLDL) and HDL. Cholesterol levels were calculated by dividing triglyceride levels by five. The permission of conducting this study was issued within the 23rd meeting of the ethics committee of Babol University of Medical Sciences (23 August 2009).

Analyses were performed using SPSS for Windows 16.0 (SPSS Inc., Chicago, IL, USA). Trends of change over the 8-week period was assessed using repeated measurement analysis. Subgrouped analysis by gender is performed and the comparison of 2-week, 4-week and 8-week with baseline..

## Results

19 subjects, 14 (73.7%) men, with mean(sd) age of 42(8.2), range 25 to 59 years old with regular exercise were enrolled. The mean(sd), range age for the men and women were 42(9.5), 25-29 and 42(2.7), 39-46 years old respectively.

There were significant reduction in cholesterol levels ($p < 0.001$), triglyceride levels ($p = 0.020$) and LDL levels ($p = 0.001$) when all subjects were analysed. The total cholesterol trend persisted for both male ($p < 0.001$) and female ($p = 0.040$) but LDL was only significantly reduced for male ($p = 0.001$) and triglyceride for the female ($p = 0.030$), see charts 1 to 4. Table 1 shows that there is a high possibility that total cholesterol / LDL will be significantly reduced by week 2 for the men. This reduction by week 2 still holds after bonferroni adjustment of inflating the p-value by 3 for multiple comparisons. For the females, by week 2, there is a suggested reduction in triglyceride and total cholesterol

with an increase in HDL; but the significance was lost after accounting for multiple comparisons.

## Discussion

The results of the present study indicated that 8 weeks of apple cider vinegar consumption significantly reduced harmful lipids, i.e. total cholesterol, LDL, and triglyceride, in blood samples of hyperlipidemic individuals who had never used any lipid-lowering drugs. In a study on rats receiving a high-cholesterol diet, Fushimi et al. observed significant reductions in cholesterol and triglyceride after consuming acetic acid. They reported that the acetic acid of vinegar decreased fatty acid oxidation, inhibited lipogenesis in the liver, and eventually decreased triglyceride and cholesterol concentrations. They recommended the impacts of acetic acid to be investigated on hamsters that are similar to humans in terms of lipid metabolism.[19] Similarly, Mansouri et al. found that consuming apple cider vinegar 6% for four weeks improved lipid profiles of healthy and diabetic rats.[27]

Setorky et al. detected the benefits of apple cider vinegar consumption on reducing the harmful effects of a high-cholesterol diet, including atherosclerotic lesions in the aorta, among rabbits with hypercholesterolemia. They attributed the results to the influence of components, particularly flavonoids, of apple cider vinegar.[28] Various amounts of flavonoids, as subtypes of polyphenols, are found in certain foods and consumed by different communities. For instance, their daily consumption has been calculated as approximately 20 mg in the U.S., Denmark and Finland, 70 mg in the Netherlands, and 63 mg in Japan.[29]

There is an inverse correlation between flavonoids intake and concentration of serum total cholesterol. Since flavonoids have protective effects against atherosclerosis, their regular consumption will reduce CAD mortality rate among elderly men.[30] This protective effect involves several mechanisms such as prevention of LDL oxidation, platelet aggregation, and improvement of endothelial functioning. Studies have indicated that flavonoids interfere with the activity of hepatocytes in the synthesis and secretion of

lipoproteins containing triglyceride.[31] Epidemiologic studies have also shown an inverse relationship between the intake of dietary flavonoids and mortality caused by CHD. The reason is the strong antioxidant properties of flavonoids that prevent LDL oxidation.[32]

Although an increase in serum HDL of the study subjects was observed after the intake of apple cider vinegar, this difference was not statistically significant. Likewise, Panetta et al. evaluated the effectiveness of apple cider vinegar on increasing HDL levels. After eight weeks of consuming 30 ml vinegar daily, HDL levels were not increased compared to the control group and no evidence of beneficial properties of apple cider vinegar in controlling LDL, triglyceride, and total cholesterol was found.[33] In contrast, many other studies have reported increased HDL levels following apple cider vinegar consumption.[22,27] Shishehbor et al. suggested the efficacy of apple cider vinegar on modification of plasma lipoproteins, including HDL, in diabetic and healthy rats.[20] The difference between these studies and the present research can be due to both the type of the study subjects (animals vs. humans) and low number of participants (19 people). Hence, further studies on a larger group of people with hyperlipidemia are recommended.

**Conclusion**

In general, the present study indicated that consumption of apple cider vinegar can reduce the LDL, triglyceride, and cholesterol levels in patients with hyperlipidemia. Besides, given that hyperlipidemia is a known risk factor for atherosclerosis, apple cider vinegar can be used to prevent and even treat this complication and probably other heart problems.

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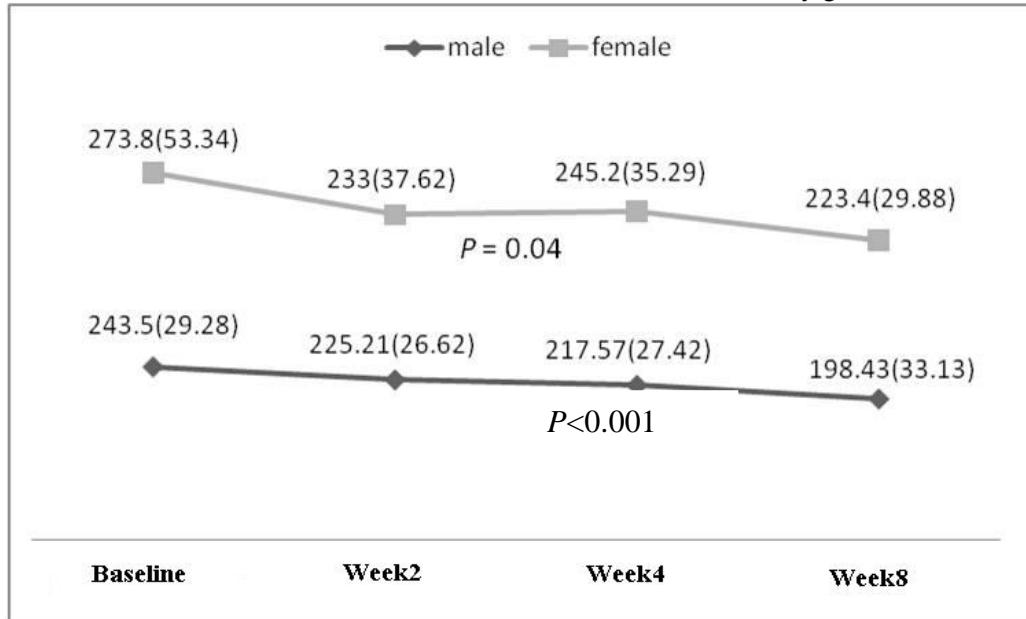
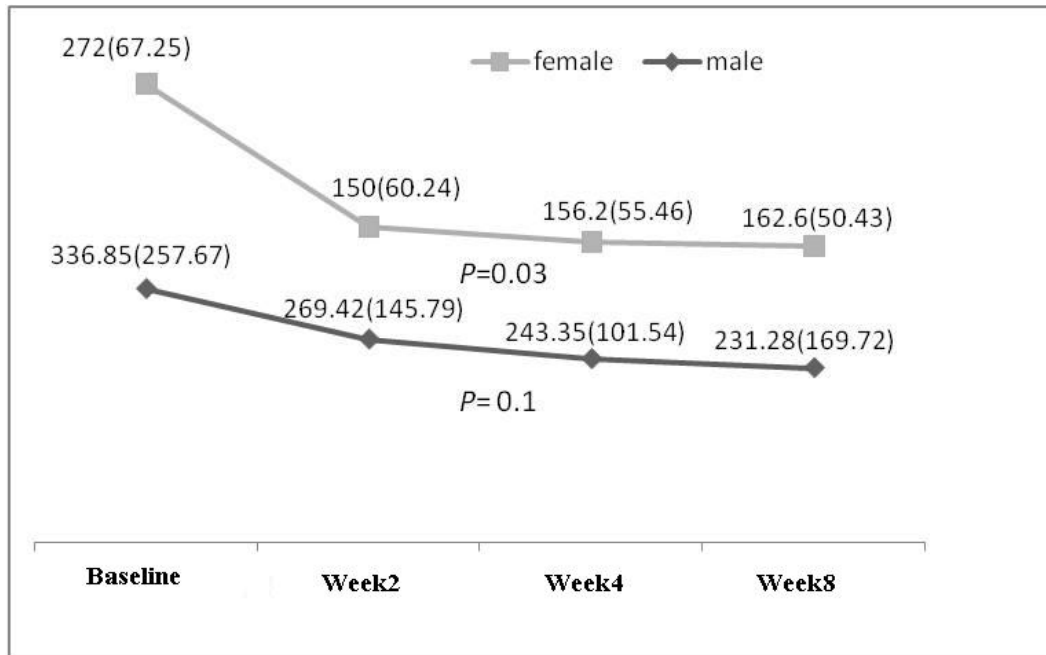**Chart 1.** Trend of Total Cholesterol levels over 8 weeks stratified by gender

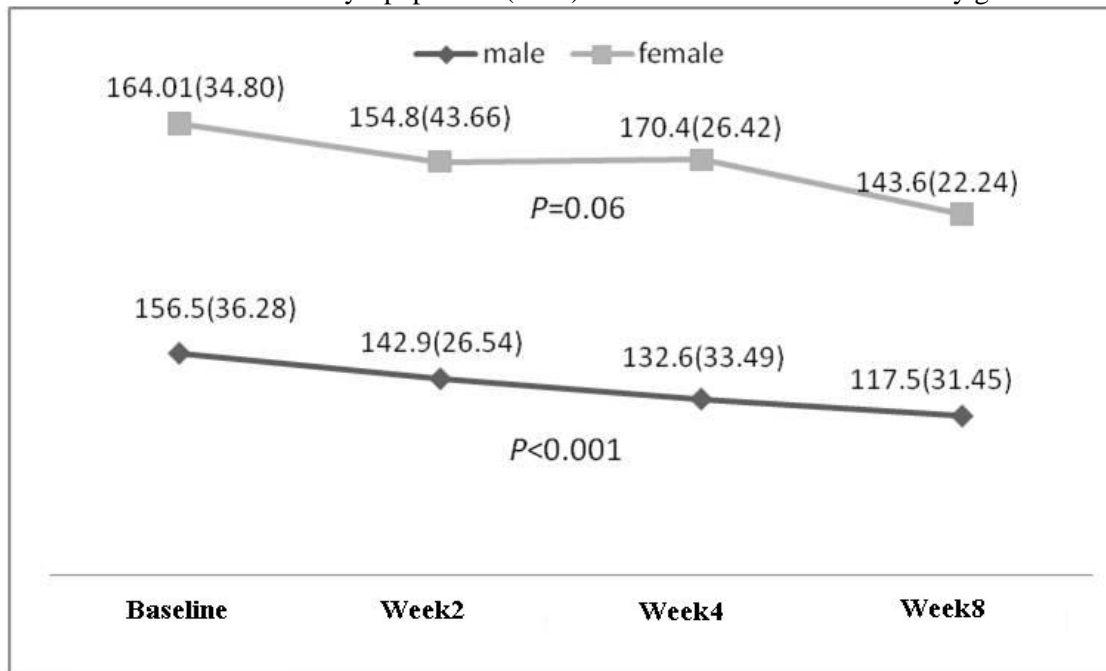**Chart 2.** Trend of triglyceride levels over 8 weeks stratified by gender
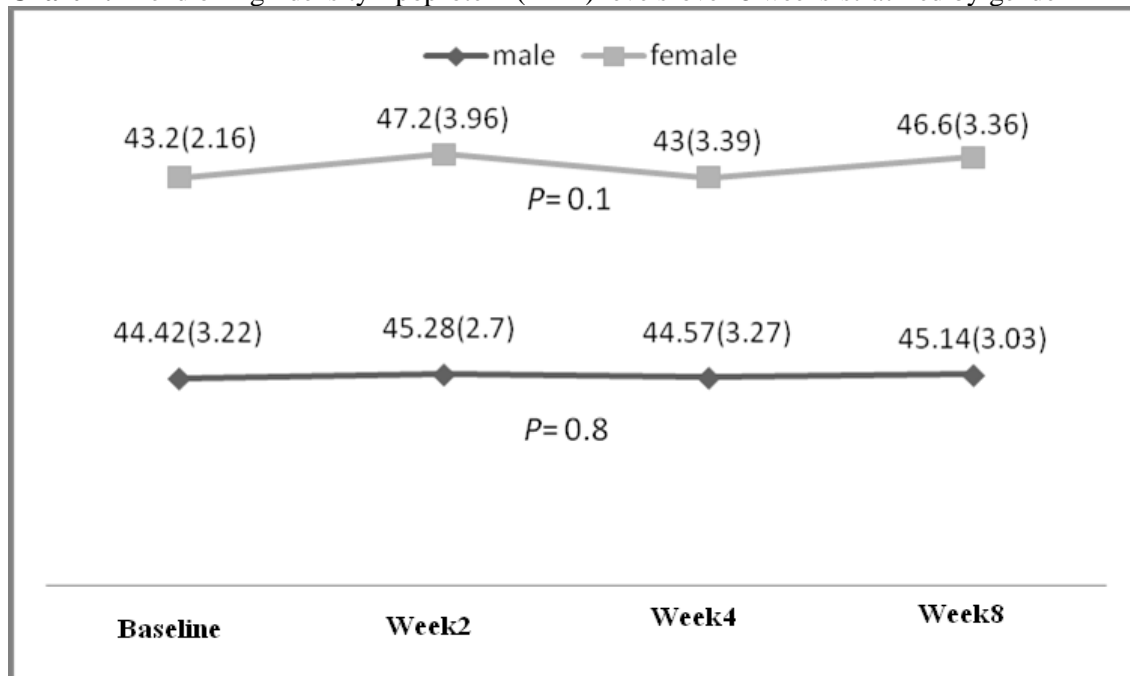
**Chart 3.** Trend of low density lipoprotein (LDL) levels over 8 weeks stratified by gender



**Chart 4.** Trend of high density lipoprotein (HDL) levels over 8 weeks stratified by gender

**Table 1.** p-value table comparing the second, fourth, and eighth weeks with baseline stratified by gender

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | 2nd week | 4th week | 8th week | 2nd week | 4th week | 8th week |
| **Total cholesterol** | 0.012 | 0.001 | < 0.001 | 0.009 | 0.182 | 0.029 |
| **Triglyceride** | 0.258 | 0.138 | 0.052 | 0.047 | 0.042 | 0.048 |
| **Low          density lipoprotein** | 0.080 | 0.007 | 0.008 | 0.324 | 0.482 | 0.086 |
| **High          density lipoprotein** | 0.441 | 0.928 | 0.560 | 0.028 | 0.895 | 0.175 |

Note : p values were LSD (not inflated)