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Research Digest

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Red meat is linked to poor heart health in observational studies, but recent evidence suggests that this correlation isn't causal. Part of the story may come down to saturated fat content. This trial puts that theory to the test.

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Multi-ingredient pre-workout supplements may be convenient, but they also have their downsides.

Can HMB help maintain muscle in people at risk for muscle loss?

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Different nutrients have different impacts on hunger. This study explored whether swapping carbs for avocado can impact measures of satiety.

Good meat, bad meat, red meat, white meat

Effects of red meat, white meat, and nonmeat protein sources on atherogenic lipoprotein measures in the context of low compared with high saturated fat intake: a randomized controlled trial 



Introduction

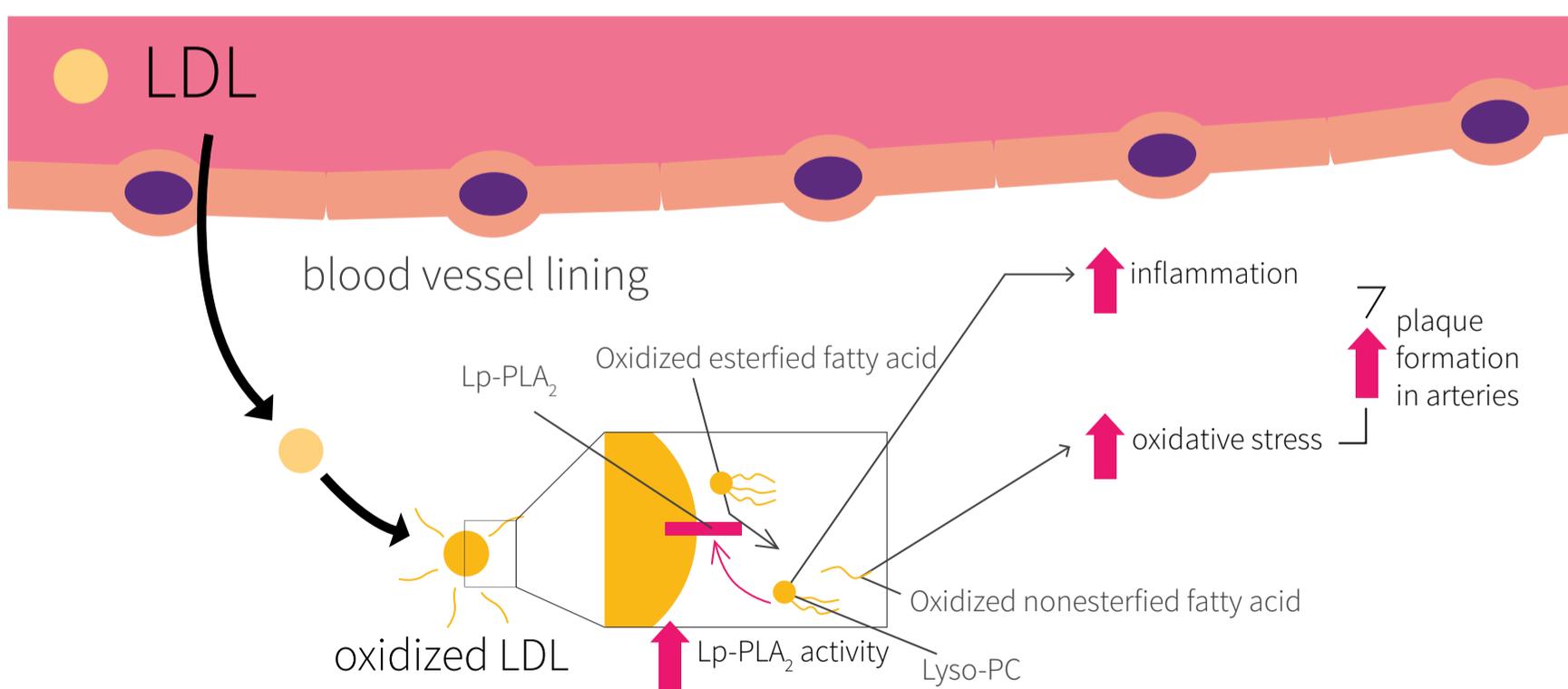
Getting sufficient [dietary protein](#) is essential to human health. However, controversies still exist regarding the health effects of consuming animal-based compared to plant-based proteins, as well as of consuming different types of animal-based proteins, such as red and white meats. According to the results from [observational research](#), the consumption of red meat is associated with a higher risk of cardiovascular disease (CVD), while the consumption of white meat is not.

While the reasons for the discrepancies between protein sources are not entirely clear, one proposed explanation is the tendency for red meats to contain more saturated fatty acids (SFAs), which are believed to contribute to the development of [atherosclerosis](#) through [increasing](#) low-density lipoprotein cholesterol (LDL-C). As you can see in Figure 1, this is a [necessary component](#) for plaque to form in the artery walls. Over time and through a complex series of [cellular events](#), plaque inside the artery walls forms and grows, eventually resulting in atherosclerosis.

Indeed, [randomized controlled trials](#) comparing red meat to white meat as part of a low SFA diet have reported a lack of significant differences in lipoproteins between diets, which suggests that SFAs, rather than red meat per se, may be the culprit. However, most of the relevant research to date is observational in nature, while the available randomized controlled trials haven't systematically evaluated the potential interaction between dietary protein source and SFA content, and their effects on atherogenic lipoprotein measures.

The study under review, called "APPROACH" (**A**nimal and **P**lant **P**rotein and **C**ardiovascular **H**ealth), aimed to evaluate the effects on atherogenic lipoprotein measures of diets in which the main source of protein was red meat compared to diets with similar total protein content delivered from white meat or plants, and to determine whether these effects were affected by the SFA content of the diets.

Figure 1: How Lp-PLA₂ may contribute to atherosclerosis



According to observational research, the consumption of red meat is associated with a higher risk of cardiovascular disease, while the consumption of white meat is not. The reason for this may be the higher content of saturated fats in red meat, which may contribute to the development of atherosclerosis by increasing low density lipoprotein cholesterol, or “bad cholesterol.” However, no studies to date have directly compared the lipoprotein effects of red meat with that of other food sources of protein in the context of both high and low saturated fat intake. The study under review compared the effects of high to low saturated fat diets with the main source of protein being either red meat, white meat, or plants on atherogenic lipoprotein measures.

Who and what was studied?

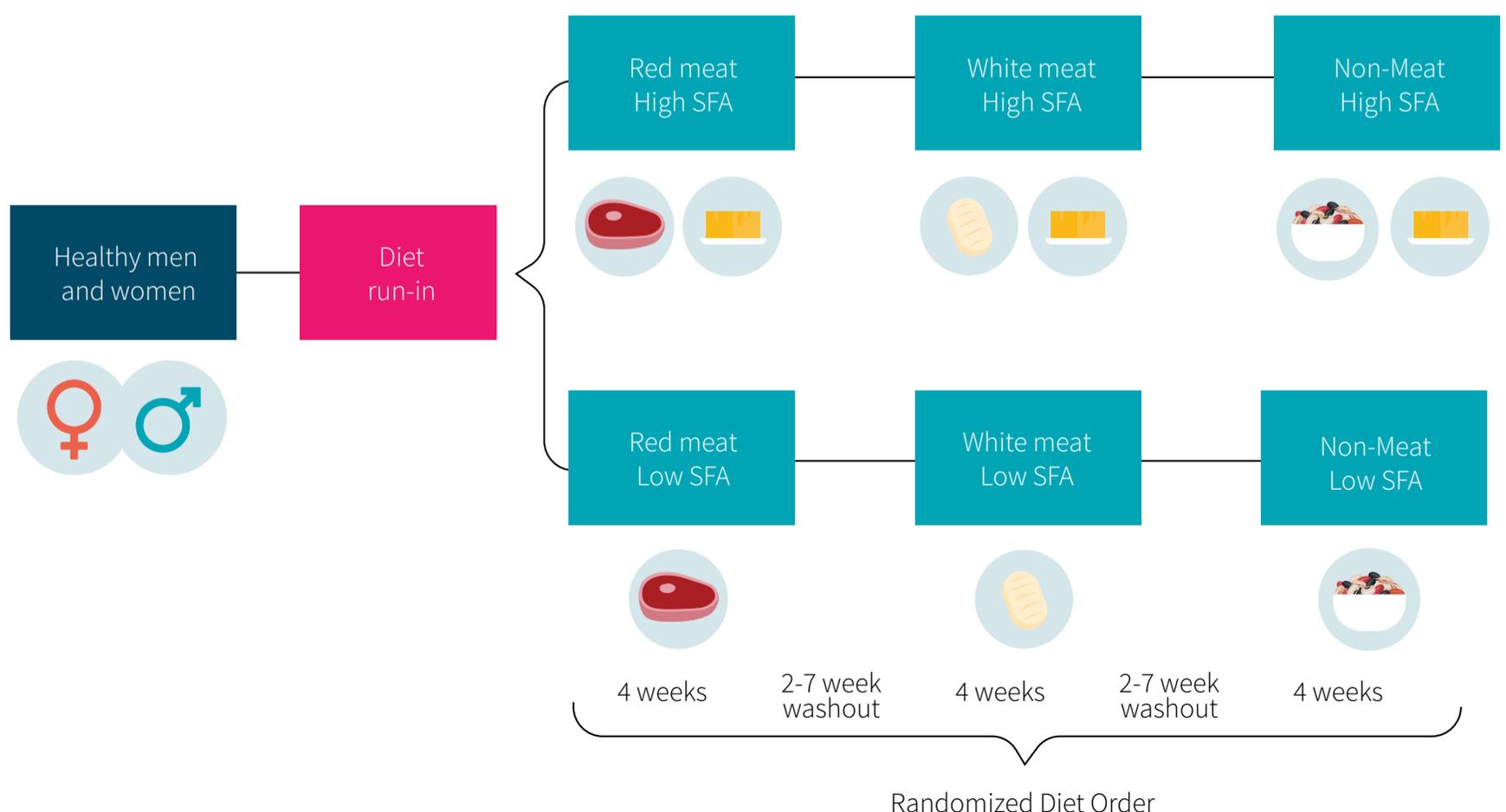
This was a [preregistered](#) randomized crossover trial involving 113 healthy men and women between 21 and 65 years of age (average age of 44 years) with an average

BMI of 26, which is at the lower end of the [overweight](#) range. Sixteen percent of the study population had obesity as defined by their BMI, while 42% were classified as overweight and 42% as normal weight. Participants were weight-stable in the three months preceding the start of the study, had no history of coronary artery disease, diabetes, or other chronic disease, and for the duration of the study, did not smoke and were not taking any medication that could affect study outcomes. They also agreed to refrain from the use of vitamin supplements and alcohol for the duration of the study.

The basic study design is depicted in Figure 2.

Following a two-week baseline diet, participants were randomized to one of two parallel arms: low saturated fatty acid (low-SFA; about 7% of total energy intake) or high saturated fatty acid (high-SFA; about 14% of total energy intake). For comparison, the current average [SFA intake](#) in North America and Europe is 10.9%. Within each SFA group, participants consumed a red meat, white meat, and non-meat diet, each for four weeks in random order, with washout periods between two and

Figure 2: Study design



seven weeks between diets. During these washout periods, the participants consumed their habitual diets.

The macronutrient composition of the experimental diets was 39-46% carbohydrates, 23-26% proteins, and 31-35% fats. For the red meat, white meat, and non-meat diets, about 12% of energy intake was derived from either lean cuts of red meat (beef and pork), lean white meat (chicken and turkey), or non-meat sources (legumes, nuts, grains, and isoflavone-free soy products), respectively, while the remaining protein (about 13% of energy intake) was derived from eggs, dairy, and vegetable sources. Differences in SFA content between the low- and high-SFA groups were achieved primarily by using high-fat dairy products and butter. Fatty cuts of meat, processed meats, and seafood were excluded from the diets to avoid potential confounding effects.

For the duration of the study, participants met with clinic staff weekly to pick up study foods (except fruits and vegetables, which participants purchased for themselves), receive dietary counselling, and to be weighed. Dietary compliance was assessed by measuring 24-hour urinary urea nitrogen and creatinine concentrations, and through menu checklists, grocery receipts, and reported deviations from dietary instructions. Activity levels were measured via a triaxial accelerometer and weekly activity logs.

The primary outcomes were LDL cholesterol, apolipoprotein B (apoB), small plus medium LDL particle concentrations, and total/high density lipoprotein (HDL) cholesterol ratio. Initially, it was planned that, with a sample size of 90 participants per group, the study would be sufficiently powered to detect a percentage change difference from a low- to a high-SFA diet with red meat relative to the other protein sources of 5.3% for LDL cholesterol, 4.6% for apoB, 14.3% for small plus medium LDL, and 4.8% for total/HDL cholesterol. However, due to an unanticipated reduction in sample size, the study ended up being underpowered

to detect changes in LDL cholesterol and apoB, but remained sufficiently powered to detect changes in small plus medium LDL and total/HDL cholesterol.

As there were no significant interactions between protein source and SFA content for any of the primary outcomes, the high- and low-SFA groups were combined (to a total of 113 participants) and analyses were performed to test for differences between protein sources in the percentage difference between a low- and high-SFA diet. Power calculations revealed sufficient power to detect changes in all primary outcomes, while pairwise comparisons were adjusted for multiple comparisons using the Bonferroni method.

In this study, 113 healthy men and women were randomized to a low or high saturated fatty acid group, with differences in SFA content achieved primarily by using high-fat dairy products and butter. Within each group, participants consumed a red meat, white meat, and non-meat diet, each for four weeks in random order, with two-seven week washout periods between diets. The primary outcomes measured were LDL cholesterol, apolipoprotein B, small plus medium LDL particle concentrations, and total/high density lipoprotein cholesterol ratio.

What were the findings?

Significant effects of both dietary protein source and SFA content were found for LDL cholesterol and apoB concentrations, with pairwise comparisons showing that both of these measures were higher with the red meat (change from baseline: LDL: -7%; apoB: -6%) and white meat (change from baseline: LDL: -7%; apoB: -5%) diets as compared to the non-meat diet (change from baseline: LDL: -12%; apoB: -10%), and with no differences between the red and white meat diets. Also, as shown in Figure 3, both of these measures were higher with high-SFA (change from baseline: LDL: -4%; apoB: -4%)

Figure 3: Main statistically significant results

	 Red meat	 White meat	 Non-meat	 High SFA	 Low SFA
LDL-C	-7%	-7%	-12%	-4%	-14%
apoB	-6%	-5%	-10%	-4%	-11%
Total cholesterol	-5%	-5%	-9%	-3%	-10%
Non-HDL cholesterol	-7%	-7%	-11%	-8%	-13%
Large LDL particles	-4%	-5%	-11%	-6%	-12%

 Statistically significant improvement

as compared to low-SFA content (change from baseline: LDL: -14%; apoB: -11%). No significant effects of either protein source or SFA content were detected for small plus medium LDL or for total/HDL cholesterol, and no significant interactions were detected between SFA content and protein source for LDL cholesterol, apoB, small + medium LDL, and total/HDL cholesterol.

It is worth noting that significant effects of both protein source and SFA content were also found for total cholesterol, non-HDL cholesterol, and large LDL particle concentration, with pairwise comparisons showing that all three of these measures were higher with the red and white meat diets as compared to the non-meat diet, as well as with high-SFA as compared to low-SFA content.

No significant differences for any outcomes were detected between the red meat and white meat diets.

LDL cholesterol and apolipoprotein B were higher with the red and white meat diets as compared to the non-meat diet, but no differences between the red and white meat diets were found. Also, LDL cholesterol and apolipoprotein B were higher with high-SFA as compared to low-SFA content. No significant effects of either protein source or SFA content were detected for small plus medium LDL or for total/HDL cholesterol, and no significant interactions were detected between SFA content and protein source for LDL cholesterol, apolipoprotein B, small plus medium LDL, and total/HDL cholesterol.

What does the study really tell us?

At first glance, it may seem like the results suggest that

high intakes of red or white meats, as well as higher compared to lower intakes of SFAs are atherogenic, and, consequently, that they may increase cardiovascular disease risk. However, a closer look at the results paints a somewhat different picture.

First, it's important to consider that although LDL cholesterol and apoB were significantly higher with the red and white meat diets as compared to the non-meat diet, and during the high- as compared to the low-SFA conditions, the blood lipids of these markers actually improved during the meat diets, and during the high-SFA condition as compared to baseline. More specifically, LDL cholesterol decreased from baseline by around 7% during the meat diets, and apoB decreased by around 6% and 5% during the red and white meat diets, respectively. Similarly, LDL and apoB decreased by around 4% in the high-SFA group, although it was not reported if these results reached statistical significance. The reason for these improvements may have been that the participants adopted controlled and healthier diets (e.g., they only ate lean and unprocessed cuts of meat) during the intervention as compared to their self-chosen unrestricted diets.

Second, although total and LDL cholesterol were higher with the red and white meat diets and with high SFA content as compared to the non-meat diet and to low SFA content, respectively, the ratio of total/HDL cholesterol was unaffected by both protein source and by SFA content. Since total/HDL cholesterol ratio is an important [predictor](#) for cardiovascular disease risk, the fact that this outcome remained unaffected by protein source and by SFA content is worth keeping in mind. This, of course, doesn't mean that LDL cholesterol levels can be completely ignored.

Finally, according to the results, small plus medium LDL particle concentrations were not affected by protein source or by the SFA content of the diets. Instead, it seems that the higher LDL cholesterol levels observed with the meat diets and with the high SFA content can be

explained by higher large LDL particle concentrations. This is important as smaller, denser LDL particles may be more [atherogenic](#) than larger, more buoyant ones. The [reason](#) for this is that smaller LDL particles appear to circulate for longer in the blood, may more effectively penetrate the cellular barrier and enter arterial walls, may be more prone to oxidation, and may, therefore, be more likely to contribute to the build-up of plaque within arteries. This idea is supported by [research](#) reporting that an atherogenic lipid profile and increased CVD risk were found to be highly associated with small LDL cholesterol particles, but not with large ones.

Overall, this was a well-conducted study with several strengths. These include the provision of almost all foods to the study participants, with the exception of fruits and vegetables, as well as the assessment of dietary compliance, both of which minimize the possibility that potential deviations from the dietary guidelines could have affected the results. Another strength worth mentioning is that a number of potential confounding variables were controlled, such as changes in bodyweight before and during the study, and changes in activity levels.

Keeping the above in mind, a few of the study's methodological limitations are worth discussing. First, the four-week treatment periods were relatively short, which means that the results can't easily and uncritically be extrapolated to the longer term. Second, the diets did not include seafood, fatty cuts of meat, or processed meat. While this helps to avoid potential confounding effects, it also makes the results less generalizable, as most people include at least one of the above in their diet. Third, while fiber intake was between 33 and 36 grams in the three high-SFA conditions and in the red and white meat low-SFA condition, it was 41 grams in the non-meat low-SFA condition. This may have affected the results, as even small (two to 10 grams) increases in dietary fiber may be able to [improve blood lipids](#) and [lower CVD risk](#). Finally, the issue of generalizability of

the results is important to consider. The study employed healthy participants who were mostly either in the normal BMI range or overweight, and who, on average, were within the normal ranges for blood pressure, glucose levels, and lipid concentrations, which means that the results can't be extrapolated to individuals with hyperlipidemia or with other metabolic conditions.

The study under review suggests that, in healthy, mostly overweight, individuals without dyslipidemia, diets high in lean and unprocessed red or white meat and/or high in saturated fatty acids may result in smaller improvements in some atherogenic lipoprotein measures as compared to non-meat diets and/or diets low in saturated fatty acids. Moreover, contrary to popular belief, the results suggest that the effects of red and white meat may be similar in the context of both high and low saturated fatty acid diets.

The big picture

The results of the study under review suggest that plant-based sources of protein may lead to larger improvements in blood lipid profiles than animal-based sources of protein. This finding is supported by other research, such as [this](#) recent meta-analysis, which found that substituting red meat with high-quality plant protein sources resulted in more favorable changes in total and LDL cholesterol. Similar results have also been reported by other [reviews](#) and [meta-analyses](#). Importantly, however, in the study under review, the non-meat diet resulted in larger improvements in atherogenic lipoproteins that were independent of the SFA content of the diet and of other confounding variables, such as the energy or macronutrient content of the diets, changes in bodyweight, or changes in activity levels. These improvements may be [related](#) to the slightly higher content of fiber, as well as the potentially higher intakes of beneficial antioxidants, polyphenols, and other [bioactive compounds](#) in the non-meat diet.

The results of the study under review also suggest that, contrary to popular belief, lean and unprocessed red meat consumption has similar effects on atherogenic lipoprotein indices as lean white meat does. This finding is in agreement with other research, such as this [2012 meta-analysis](#), which found that changes in lipid profiles were not significantly different with beef consumption when compared to those with poultry and/or fish consumption. Similarly, in a [randomized study](#) of 191 men and women with dyslipidemia, those who consumed 80% of their meat in the form of unprocessed lean red meat or unprocessed lean white meat had nearly identical mean concentrations of triglycerides, and total, LDL, and HDL cholesterol after 36 weeks.

With regard to SFA intake, the results of the study under review suggest that a higher intake of SFAs may lead to higher concentrations of LDL cholesterol and apoB concentrations, and that there are no interactions between protein source and dietary SFA intake, such that the effects of these are additive. These findings are consistent with the [majority](#) of the relevant body of research, which suggests that a high intake of SFAs tends to increase LDL cholesterol. However, similarly to the results of [other research](#), the study under review suggests that saturated fat appears to decrease small LDL particle concentrations and increase large LDL particle concentrations, the latter of which have not been strongly associated with CVD. This may explain the results of a 2010 [meta-analysis](#), which included almost 350,000 participants and which found no significant evidence for concluding that dietary saturated fat per se is associated with an increased risk of CHD or CVD.

It is worth noting that not all research has reported similar results with regard to SFA intake and lipoprotein particle size concentrations. For example, a [2011 study](#) by the same group of researchers reported significant increases in small and medium LDL particle concentrations with a diet high in beef protein and SFAs as compared to a diet low in SFAs. According to

the authors of the study under review, the discrepancies between the results may have been due to differences in the dietary macronutrient composition or in the provision of a smaller proportion of foods to the participants.

Taken together, the results from the majority of the studies suggest that, in the context of an overall healthy lifestyle and in already healthy individuals, diets high in lean red and white meats appear to have equal, non-detrimental effects on CVD risk, and that non-meat diets may improve common markers of CVD risk, potentially partly due to their high contents of antioxidants, polyphenols, and bioactive compounds. Moreover, the literature suggests that a high intake of saturated fats is likely to result in an increase in LDL cholesterol, but not necessarily in CVD risk.

Frequently asked questions

What exactly are LDL and HDL and why are they called “bad” and “good” cholesterol?

Low density lipoprotein (LDL) and high density lipoprotein (HDL) are complex [protein particles](#) that carry cholesterol, a type of lipid, throughout the body.

LDL is commonly referred to as “bad” cholesterol because it carries cholesterol from the liver to peripheral tissues in the body and, in excess, can lead to the build-up of plaque inside the artery walls, resulting in atherosclerosis and in a higher risk for cardiovascular disease.

HDL is considered as the “good” cholesterol because HDL particles play an important role in transporting free cholesterol from peripheral tissues back to the liver, a process

known as [reverse cholesterol transport](#) (RCT), which is one potential mechanism through which HDL may be anti-atherogenic. Moreover, HDL has anti-inflammatory, antithrombotic, and endothelial protective [effects](#), which add to its potential anti-atherogenic properties.

What should I know?

According to observational research, eating red meat is linked to a higher risk of cardiovascular disease, while eating white meat is not. This may be due to the higher saturated fat content of red meat, which may increase low density lipoprotein cholesterol and contribute to the development of atherosclerosis. However, no randomized trials to date have directly compared the effects of red meat to those of white meat and plant sources of protein on lipoproteins in the context of high and low saturated fat intake.

The study under review was the first study to compare the effects of high to low saturated fat diets with the main source of protein being either lean red meat, lean white meat, or plant protein on atherogenic lipoprotein measures. According to the results of this study and of the relevant literature, it appears that overall healthy diets high in lean red or white meats appear to have equal, non-detrimental effects on lipoproteins, while non-meat diets may have beneficial effects. In fact, all three led to improvements in blood lipids compared to the participants’ baseline diets. Moreover, the study provides additional evidence that diets high in saturated fats, at least from dairy products and butter, may increase LDL cholesterol and apolipoprotein B without necessarily increasing CVD risk. ◆

Let’s meet in the private [ERD Facebook forum](#) to discuss this interesting study!

Credits

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