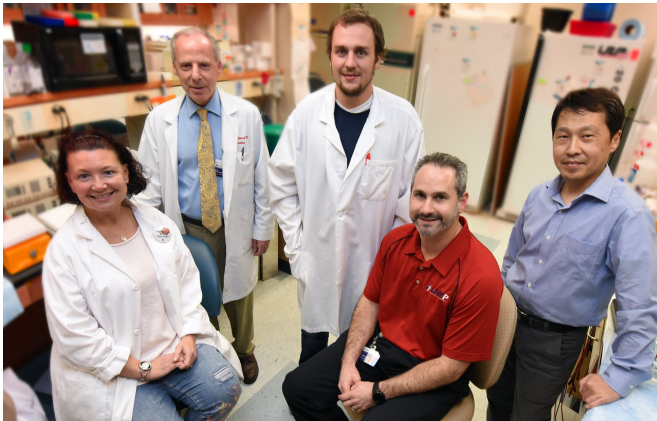


# Just one high-fat meal sets the perfect stage for heart disease

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(from left) Dr. Julia E. Brittain, Dr. Neal L. Weintraub, Tyler W. Benson, Dr. Ryan A. Harris and Dr. Ha Won Kim photo taken in the Medical College of Georgia's Vascular Biology Center Lab. Credit: Phil Jones, Senior Photographer, Augusta University

A single high-fat milkshake, with a fat and calorie content similar to some enticing restaurant fare, can quickly transform our healthy red blood cells into small, spiky cells that wreak havoc inside our blood vessels and help set the perfect stage for cardiovascular disease, scientists report.

Just four hours after consuming a milkshake made with whole milk, heavy whipping cream and ice cream, healthy young men also had [blood vessels](#) less able to relax and an immune response similar to one provoked by an infection, the team of Medical College of Georgia scientists report in the journal *Laboratory Investigation*.

While the dramatic, unhealthy shift was likely temporary in these healthy individuals, the scientists say there is a definite cumulative toll from this type of eating, and that their study could help explain isolated reports of death and/or [heart attack](#) right after eating a super-high fat meal.

"We see this hopefully as a public service to get people to think twice about eating this way," says Dr. Neal L. Weintraub, cardiologist, Georgia Research Alliance Herbert S. Kupperman Eminent Scholar in Cardiovascular Medicine and associate director of MCG's Vascular Biology Center.

"The take-home message is that your body can usually handle this if you don't do it again at the next meal and the next and the next," says Dr. Julia E. Brittain, vascular biologist at the MCG Vascular Biology Center and a corresponding author of the study.

As a practicing cardiologist, Weintraub, also a corresponding author, has patients with cardiovascular disease who continue to eat a high-fat diet and he definitely asks them to think twice: "Is this food worth your life?"

While none of the scientists recommend going overboard on calories and sugar either, the healthy males in the study who instead consumed a meal with the same number of calories but no fat - three big bowls of sugar-coated flakes with no-fat milk - did not experience the same harmful changes to their [blood](#), red blood [cells](#) and blood vessels.

"You are looking at what one, high-fat meal does to blood-vessel health," says Dr. Ryan A. Harris, clinical exercise and vascular physiologist at MCG's Georgia Prevention Institute and study co-author.

Their study in 10 young men was the first to look specifically at red blood cells, the most abundant cell in our blood. Red cells are best known for carrying oxygen and are incredibly flexible so they flow through blood vessels essentially unnoticed, Brittain says. But with a single high-fat meal, they essentially grow spikes and spew poison.

"They changed size, they changed shape, they got smaller," Harris says of the rapid changes to the form and function of red blood cells.

In both the cells and blood, there was evidence of myeloperoxidase, or MPO, an enzyme expressed by a type of white blood cell which, at high levels in the blood, has been linked to stiff blood vessels, oxidative stress and heart attack in humans.

MPO is associated with impaired ability of blood vessels to dilate, even oxidation of HDL cholesterol, which converts this usually cardioprotective cholesterol into a contributor to cardiovascular disease. When taken up by a diseased artery, it can even help destabilize plaque buildup, which can result in a stroke or heart attack.

"Myeloperoxidase levels in the blood are directly implicated in heart attack," Weintraub notes. "This is a really powerful finding."

When they used flow cytometry to examine the red blood cells, they found an increase in reactive oxygen species, a natural byproduct of oxygen use that is destructive at high levels. One effect of their elevated level is permanently changing the function of proteins, including the one that helps red blood cells maintain their normal negative charge.

MPO also impacts the cytoskeleton, the physical infrastructure of the usually plump red cells so they can't function and flex as well, says Tyler W. Benson, a doctoral student in The Graduate School at Augusta University and the paper's first author.

"Again, your red blood cells are normally nice and smooth and beautiful and the cells, after consumption of a high-fat meal, get these spikes on them," says Brittain. Much like huge ice chunks do to a river, these physical changes affect how blood flows, she says.

Bad changes occur quickly in these cells, which are "exquisitely sensitive" to their environment, Brittain says.

There were changes in [white blood cells](#), called monocytes, which got fat themselves trying to take up the excessive fat. Their earlier studies have shown these so-called foamy monocytes promote inflammation and show up in atherosclerotic plaque. Monocytes more typically travel the circulation looking for red blood cells that need

elimination, because they are old and/or diseased.

The fluid portion of the blood, called the plasma, also looked different. When they spin and separate different components of the blood to get to the red blood cells, they typically get a clear yellowish plasma on top, Benson says. But after a single, high-fat load, the fluid portion of the blood was already thick, off-color and filled with lipids.

Their blood also contained the expected high fat and cholesterol levels.

At least in mice studies and in some of Brittain's other human studies, the unhealthy changes also resolve quickly, at about eight hours, unless the high-fat feasts continue. The investigators note they only tested their participants after four hours, which is about how long it takes food to digest.

Studies to measure longer-term impact on humans would be problematic primarily because you would not want to subject healthy young individuals to the risk, Weintraub notes.

However, the MCG team also has shown that mice continuously fed a high-fat diet experience permanent changes to their red blood cells and blood similar to those experienced transiently by the [young men](#). Changes include triggering a significant immune response that can contribute to vascular disease.

More studies are needed to see if changes in the [red blood cell](#) shape impact vascular health, the scientists write. But they conjecture that the remodeled red blood cells themselves could be targeted for elimination by monocytes. In mice chronically fed a [high-fat diet](#), they have seen red blood cells actively consumed by macrophages, immune cells that eat cellular debris, and resulting inflammation.

Weintraub says primary prevention is the most prudent course for a healthy cardiovascular system including eating healthy, exercising regularly, and keeping tabs on vitals like cholesterol and blood pressure levels. Even patients with a high genetic risk of cardiovascular disease can dramatically reduce that risk with these positive changes, he

says.

Harris' research team has done studies that indicate a single aerobic exercise session by young healthy individuals like these can counteract the unhealthy slump at four hours and related reduction in the blood vessels ability to dilate.

healthy adults limit fat intake to 20-35 percent of their daily calories. The research was funded by the National Institutes of Health.

Provided by Medical College of Georgia at Augusta University

Participants in the new study included 10 physically active men with a good medical history, taking no prescription medicines and with good cholesterol and lipid levels.

The investigators did two thorough assessments of [cardiovascular disease](#) risk at least seven days apart. Participants were told to avoid caffeine and strenuous physical activity for 24 hours before each test and vitamin supplements for 72 hours. Like going to the doctor for bloodwork, they also were asked to fast overnight.

Half the men got the milkshakes containing about 80 grams of fat and 1,000 calories. The cereal meal also contained about 1,000 calories but very little fat. Meals were individually tweaked to ensure everyone got the same amount of fat relative to their body weight, Harris says.

Since estrogen is considered cardioprotective in non-obese premenopausal females, investigators opted to limit the study to males.

Red blood cells, probably best known for carrying oxygen, are the most abundant cell type circulating in our blood. "You have 25 trillion red blood cells and they affect every other cell in your body," says Brittain. They also carry and release the energy molecule ATP and nitric oxide, which helps blood vessels relax, as well as cholesterol.

A healthy red blood cell has a negative charge that keeps them away from other cells and traveling more toward the outer edge of blood vessels. In the arterial system, they travel fast, Brittain says.

The cells last about 120 days, but like many of us, they become less efficient with age as they use up their energy, or ATP stores, says Benson.

The American Heart Association recommends that

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