

# New biomarker discovered for oxidative stress when exercising

May 23 2014, by David Nieman, Jennifer Woodford

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New research led by David Nieman, DrPH, FACSM, director of the Appalachian State University Human Performance Laboratory at the NC Research Campus, identified a new biomarker for oxidative stress generated during exercise.

In the field of [exercise](#) science, measuring [oxidative stress](#) can be difficult, time consuming and expensive because previously used standards like the compound F2-isoprostanes are found in small amounts in the body. Nieman's discovery of 13-HODE + 9-HODE as an oxidative

stress biomarker for studies involving intense exercise provides, for the first time, an abundant and stable biomarker to measure.

The findings were published in the April 2014 edition of the *American Journal of Physiology* in the article entitled "Metabolomics approach to assessing plasma 13- and 9-hydroxy-octadecadienoic acid and linoleic acid metabolite responses to 75-km cycling." The study was conducted in partnership with the David H. Murdock Research Institute (DHMRI), a contract research organization located on the NC Research Campus, and Metabolon, a company specializing in metabolomics and biochemical profiling located in Durham, NC. Metabolon also provides metabolomic services for DHMRI.

"We are the first group to show that 13-HODE + 9-HODE reflects exercise-induced, oxidative stress in parallel to F2-isoprostanes, a well-established biomarker," Nieman said. "The good news is that HODE is 20 times more abundant than the gold standard F2, is stable and can be altered in response to lifestyle related interventions like exercise. I think the future is going to be that others will use it as a marker for oxidative stress in exercise studies."

## Practical Research Tool

Oxidative stress is important to measure because it is linked to aging and is thought to be an underlying cause of some cancers, Parkinson's Disease, Alzheimer's disease, heart disease and other illnesses. Oxidative stress occurs naturally when reactive oxygen species or free radicals that have unpaired electrons seek a more stable state by stealing an electron from another molecule. The resulting uncontrolled electron transfer cascade can ultimately harm cells at a molecular level by damaging lipids, proteins and DNA. Oxidative stress can be triggered by any number of factors such as diet, smoking, pollutants and intense exercise.

"It is generally supposed that oxidative stress, or at least too much of it, has negative consequences," said Kirk Pappan, senior study director for Metabolon and co-author of the paper. "So now, scientists can think about coupling that concept to a therapeutic or dietary approach to diminish oxidative stress that people experience or help them to recover faster. Scientists can ask more questions now because they have a good marker to follow."

For Nieman, 13-HODE + 9-HODE is a practical tool for measuring the effects of natural compounds on oxidative stress. "Highly active individuals have more enzymes in their bodies to counter oxidative stress," he said. "We're trying to figure out if this effect can be enhanced through the use of certain fruit or vegetable compounds like polyphenols or flavonoids that will help the body better cope with or recover from exercise-induced oxidative stress. When we do an intervention, we think that this new marker will be highly responsive."

By applying metabolomics, Pappan explained that Nieman was able to gather "real-time measurements" of what was happening with the cyclists' metabolism and the level of stress.

"David is a pioneer in using metabolomics and trying to introduce it as a useful research tool in the field of exercise science," Pappan commented. "At the end of the day, what is interesting and exciting about this discovery is that it provides a simple-to-measure, stable marker of oxidative stress. The compounds that Dave measured emerged from the data as significantly elevated chemicals after the cyclists had gone through [intense exercise](#)."

## About the study

In studying the scientific literature, Nieman found papers that claimed 13-HODE + 9-HODE, which comes from the fatty acid linoleic

acid, functioned as an indicator of oxidative stress. The compound had never been studied in an exercise context.

During Nieman's study, male cyclists pedaled for 75 kilometers on their own bicycles in a laboratory setting using electromagnetically-braked cycling ergometers. Blood samples were taken before exercise, immediately after and at 1.5 and 21 hours after. The results showed that "prolonged and intensive exercise caused a transient, 3.1-fold increase in the stable linoleic acid oxidation product 13-HODE + 9-HODE, and was related to increases in F2-isoprostanes."

"I would not have been able to make this discovery without the type of collaboration that ASU, DHMRI and Metabolon shared," Nieman added. "This type of collaboration is what defines the NC Research Campus and makes so many scientific advances possible."

Provided by NC Research Campus

Citation: New biomarker discovered for oxidative stress when exercising (2014, May 23)  
retrieved 10 April 2024 from  
<https://medicalxpress.com/news/2014-05-biomarker-oxidative-stress.html>

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