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High Fat Diet During Pregnancy Causes Brain Inflammation in Offspring

Long Term, Irreversible Brain Inflammation in Offspring May Impact Behavior

MIAMI, FL (December 7, 2010) – A pregnant mother’s high fat diet can have profound and lasting effects on the brain of her offspring, according to evidence from an animal study. Scientists believe high fat diets activate immune cells in the brain causing inflammation in the brain, a process that may lead to neurodegenerative conditions like Multiple Sclerosis and Alzheimer’s Disease. The findings were presented today at the annual meeting of the American College of Neuropsychopharmacology (ACNP).

“Obesity is generally thought of as a condition that happens to the body, but doesn’t impact the brain,” said Staci Bilbo, Ph.D., assistant professor of psychology and neuroscience at Duke University. “But our research found changes in the brain of her offspring are linked to what a mother eats during pregnancy.”

Previous research has shown a link between obesity and inflammation in the body, but little is known about whether obesity might affect inflammation in the brain, or if obesity in a pregnant mother can affect brain functions in her offspring. Bilbo and her team investigated how immune cells in the brain of a pup respond to or are activated by high fat diet in its mother’s diet during pregnancy.

“When the brain’s immune system is out of balance it becomes inflamed,” said Dr. Bilbo. “Inflammation is good in the short term because it can aid in healing, alert us to tissue damage, but in the long run, constant inflammation can be damaging to neurons and brain function.”

This research team fed female breeding rats one of three diets: a 60 percent saturated high fat diet; a 60 percent trans high fat diet; or a 10 percent low fat control diet for four weeks prior to mating, and throughout pregnancy and lactation. After weaning (day 21), all pups were fed the low fat diet, so they were never on a high fat diet themselves.

To examine the pups’ response to the mothers’ diets, brain samples and peripheral tissue (fat, blood and liver) were collected at one day after birth, at weaning (20 days after birth) and in early adulthood (days 60-90). The investigators tested immune system functioning in the liver and in the brain, and behavioral measures of anxiety and ability to learn and remember a maze. Inflammatory response was tested in pups after weaning (day 20) and in adulthood (day 60-90) by comparing immune response four hours after injections of dead bacteria. This procedure activates the immune system, without causing an infection that would have negative impact on an animal’s health.

The researchers saw clear evidence of brain inflammation in the pups born to mothers on high fat diets. From birth through adulthood, there was evidence of low level inflammation in brain samples from high fat groups, including activation of microglia (immune cells) in the hippocampus of the brain. Inflammation was also present outside the brain as evidenced by increased C-reactive protein in the liver. Most striking was the difference in response to immune challenge. Adult animals whose mothers had been on high fat diets had a greatly exaggerated inflammatory response in these same areas compared to low fat control animals. "It was absolutely one of the largest responses we have ever seen," said Dr. Bilbo.

In response to anxiety and cognition tests, adult animals whose mothers were given the high fat diets were considerably more anxious than adult animals from the low fat group. However, no negative impact was noted on cognition as a consequence of mothers' high fat diets, "Dietary fats are critical to a healthy pregnancy, so we were unsure if the placenta would serve as a protector from the negative effects of the fats, but it seems this is not the case. The mothers' diet during pregnancy determines a lifelong neuroinflammatory condition for the fetus that cannot be reversed with low fat diet alone."

Bilbo emphasized that while these findings are exciting, this is the first look at the effects of mothers' obesity on the fetal brain. More research is needed on the composition of the diet before drawing inferences for humans.

The next step in Dr. Bilbo's important research will be to look at the success of reversing the impact of the mothers' diet of brain inflammation through interventions that target the fetal immune response.

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ACNP, founded in 1961, is a professional organization of more than 700 leading scientists, including four Nobel Laureates. The mission of ACNP is to further research and education in neuropsychopharmacology and related fields in the following ways: promoting the interaction of a broad range of scientific disciplines of brain and behavior in order to advance the understanding of prevention and treatment of disease of the nervous system including psychiatric, neurological, behavioral and addictive disorders; encouraging scientists to enter research careers in fields related to these disorders and their treatment; and ensuring the dissemination of relevant scientific advances.