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Brain Damage

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Olivia Judson on the influence of science and biology on modern life.

Tags:

Alzheimer's, diet, exercise, obesity, the brain

Being fat is bad for your brain.

That, at least, is the gloomy conclusion of several recent studies. For example, one long-term study of more than 6,500 people in northern California found that those who were fat around the middle at age 40 were more likely to succumb to dementia in their 70s. A long-term study in Sweden found that, compared to thinner people, those who were overweight in their 40s experienced a more rapid, and more pronounced, decline in brain function over the next several decades.

Consistent with this, the brains of obese people often show signs of damage. One study of 60 healthy young adults (in their 20s and 30s) found that the fatter members of the group had significantly lower gray-matter densities in several brain regions, including those involved in the perception of taste and the regulation of eating behavior. A study of 114 middle-aged people (aged between 40 and 66) found that the obese tended to have smaller, more atrophied brains than thinner people; other studies have found similar results.

Brains usually atrophy with age, but being obese appears to accelerate the process. This is bad news: pronounced brain atrophy is a feature of dementia.

Why fatness should affect the brain in this way is not clear, although a host of culprits have been suggested. A paper published this week in the early edition of Proceedings of the National Academy of Sciences has identified a gene that seems to be involved. FTO, as the gene is known, appears to play a role in both body weight and brain function. This gene comes in different versions; one version — let's call it "troublesome"— appears to predispose people to obesity. Individuals with two copies of the troublesome version tend to be fatter than those with only one copy of it, who in turn tend to be fatter than those with two copies of the "regular" version. Now, the troublesome form has been linked to atrophy in several regions of the brain, including the frontal lobes, though how and why it has this effect remains unknown.

But genes are not the only guilty parties. Obesity exacerbates problems like sleep apnea, which can result in the brain being starved of oxygen; this can lead to brain damage. Obesity often goes along with high blood pressure, heart disease and diabetes, all of which are bad for the brain in their own right. Indeed, one study has shown that if, in middle age, you are obese

and have high blood pressure, the two problems gang up on you, increasing the chances of your getting dementia in old age more than either one would do on its own.

Fat tissue itself may be a problem. Fat cells secrete hormones like leptin; leptin acts on the brain in a variety of ways, and is thought to play a role in the development of Alzheimer's. Obesity may thus disrupt the normal production of leptin, with dangerous results. Fat cells also secrete substances that cause inflammation; chronic inflammation of the brain, which is often found in the obese, impairs learning and memory and is also a feature of Alzheimer's.

Diet may play a role, too. Studies in mice have shown that eating a very-high-fat diet increases brain inflammation and disrupts brain function. And the onset of brain decay may itself play a part. Since the regions of the brain most affected by obesity appear to be those involved in self-control and the regulation of appetite, erosion of these abilities may lead to greater obesity, which may lead to more rapid brain erosion, in a downward spiral.

Whatever the causes, the implications are grave. In the United States today, around one-third of adults are obese. At the same time, dementia is already one of the most costly and devastating health problems of old age. The possibility that obesity today will lead to higher rates of dementia in the future is, therefore, deeply alarming.

The obvious question is: can obesity-associated brain damage be reversed? No one knows the answer, but I am hopeful that it can. Those two old friends, a healthful diet and plenty of exercise, have repeatedly been shown to protect the brain. Foods like oily fishes and blueberries have been shown to stimulate the growth of new neurons, for example. Moreover, one study found that dieting reversed some of the changes to brain structure found among the obese. Which suggests an interesting study. The most effective — and radical — treatment for obesity is bariatric surgery, whereby the stomach is made much smaller or bypassed altogether. Do people who have taken this option show a reversal, or at least a slowing, of brain atrophy?

But whether you are fat or thin, young or old, the best hope you have of guarding your brain is to eat well and exercise. Anyone seen my running shoes?

Notes:

For fatness increasing dementia risk in Northern California, see Whitmer, R. A. et al. 2008. "Central obesity and increased risk of dementia more than three decades later." Neurology 71: 1057-1064. For fatness and cognitive decline in Sweden, see Dahl, A. et al. 2009. "Being overweight in midlife is associated with lower cognitive ability and steeper cognitive decline in late life." Journal of Gerontology 65A: 57-62.

For obesity and the effects on gray matter in young adults, including the impact on areas involved in eating and taste, see Pannacciulli, N. et al. 2006. "Brain abnormalities in human obesity: a voxel-based morphometric study." NeuroImage 31: 1419-1425. For atrophy in the brains of fat middle-aged adults, see Ward, M. A. et al. 2005. "The effect of body mass index on global brain volume in middle-aged adults: a cross sectional study." BMC

Neurology 5:23. For "other studies with similar results", see Gunstad, J. et al. 2008. "Relationship between body mass index and brain volume in healthy adults." International Journal of Neuroscience 118: 1582-1593; and Raji, C. A. et al. 2010. "Brain structure and obesity." Human Brain Mapping 31: 353-364. (This last paper considered 94 older adults, and found that obese people had pronounced atrophy in particular brain regions rather than a general reduction in brain volume.)

For FTO and brain atrophy, see Ho, A. J. et al. 2010. "A commonly carried allele of the obesity-related FTO gene is associated with reduced brain volume in the healthy elderly." Proceedings of the National Academy of Sciences USA, published online ahead of print 19 April 2010. doi/10.1073/pnas.0910878107.

For sleep apnea and brain injury, see Lim, D. C. and Veasey, S. C. 2010. "Neural injury in sleep apnea." Current Neurology and Neuroscience Reports 10: 47-52. For high blood pressure and obesity ganging up to increase your risk of dementia, see Kivipelto, M. et al. 2005. "Obesity and vascular risk factors at midlife and the risk of dementia and Alzheimer disease." Archives of Neurology 62: 1556-1560.

For a general overview of how obesity can impact the brain, including a discussion of the possible role of leptin, see Bruce-Keller, A. J., Keller, J. N. and Morrison, C. D. 2009. "Obesity and vulnerability of the CNS." Biochimica et Biophysica Acta 1792: 395-400. For fat cells producing factors that cause inflammation, see Lumeng, C. N., Maillard, I., and Saltiel, A. R. 2009. "T-ing up inflammation in fat." Nature Medicine 15: 846-847. For inflammation, impaired cognition, and Alzheimer's, see Wilson, C. J., Finch, C. E., and Cohen, H. J. 2002. "Cytokines and cognition — the case for a head-to-toe inflammatory paradigm." Journal of the American Geriatrics Society 50: 2041-2056. For mice eating a very-high-fat diet and having brain inflammation and cognitive impairment as a result, see Pistell, P. J. et al. 2010. "Cognitive impairment following high fat diet consumption is associated with brain inflammation." Journal of Neuroimmunology 219: 25-32.

For current levels of obesity in the United States, see Flegal, K. M. et al. 2010. "Prevalence and trends in obesity among US adults, 1999-2008." Journal of the American Medical Association 303: 235-241. For the devastating impact of dementia, see Ferri, C. P. et al. 2005. "Global prevalence of dementia: a Delphi consensus study." Lancet 366: 2112-2117.

For foods that stimulate the growth of neurons (including blueberries and oily fishes) see, for example, Stangl, D. and Thuret, S. 2009. "Impact of diet on adult hippocampal neurogenesis." Genes and Nutrition 4: 271-282. See also Spencer, J. P. E. 2009. "Nutrients and brain health: an overview." Genes and Nutrition 4: 225-226. A wealth of studies have found that exercise protects the brain. See, for example, the review by van Praag, H. 2009. "Exercise and the brain: something to chew on." Trends in Neurosciences 32: 283-290. (This paper also discusses the synergistic effects of exercise and a healthful diet.)

For dieting reversing some of the changes seen in the brains of the obese, see Haltia, L. T.

et al. 2007. "Brain white matter expansion in human obesity and the recovering effect of dieting." Journal of Clinical Endocrinology and Metabolism 92: 3278-3284. As far as I know, no one has investigated bariatric surgery and its impact on brain structure.

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