

Three brain responses linked to successful weight loss surgery

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Three types of brain responses which help to prevent weight regain following bariatric surgery have been identified for the first time in a new study.

In a small study, researchers looked at the [brain activity](#) of sixteen people with type 2 diabetes or pre-diabetes who underwent weight loss [surgery](#). The brain activity was measured using magnetic resonance imaging (MRI) scans that detected the blood flow through different areas of the brain. They found that there were three distinct types of responses in areas of the brain that control hunger, appetite and [food intake](#) which were different from a separate group of people who had used a very low calorie diet to lose weight. The researchers believe that these changes in brain activity after weight loss surgery can help explain why people who undergo this type of treatment have successful and long term weight loss, in comparison with those who have followed a very low calorie diet, where very often there is a regain of weight.

Sustainable weight loss programs

The study, published in *Diabetes Care*, is led by researchers at Imperial College London and Imperial College Healthcare NHS Trust. The researchers suggest that any weight loss program aimed at helping people with Type 2 diabetes could be assessed using similar scans to understand whether any weight loss is sustainable in the long-term.

Professor Tricia Tan, principal investigator of the research and Professor of Practice (Metabolic Medicine & Endocrinology) at Imperial College London, said:

"Tackling obesity and diabetes is a priority for many healthcare systems around the world. There are many different weight loss programs and methods, with varying results on long term weight loss. Although very low calorie diets can help people to lose a great deal of weight in the short term, in the long term they often find it difficult to keep the weight off.

Weight loss surgery has been shown to be very successful in producing a

sustained reduction in weight and it also helps to put diabetes in remission. However, we still don't know why the surgery works so well.

"Our study is the first to show how three types of brain response are activated in people who have had weight loss surgery. These responses are related to how the mind takes pleasure in food and eating; limiting the impulse to eat; and how the brain and body control body weight. We found that these brain responses were not activated in our participants who undertook the very low calorie diet. This may help to explain why those who have weight loss surgery experience continued weight loss benefits and those who embark on low calorie diets find continued weight loss difficult to sustain.

"These findings can be used to further develop weight loss programs and treatments which are not surgical. By using magnetic brain scans to examine how the brain responds to a treatment, we might be able to improve the performance of these programs. This was a small study so we need to do more work to see if this result is replicated in a larger group of people who undergo weight loss surgery."

Interconnecting theories

Lead study author, Dr. Victoria Salem, Clinical Senior Lecturer in Endocrinology (Department of Bioengineering, Imperial College London), added: "This study is unique because we pulled together three interconnecting theories about the brain changes that explain why patients who have had weight loss surgery find it so much easier to maintain their weight loss compared with those who have been on a strict calorie-controlled diet."

Brain activation patterns and weight loss

Weight loss achieved with very low calorie diets can produce remission of type 2 diabetes lasting up to two years in some people. However, severe calorie restriction induces hormonal and metabolic responses that encourage high rates of weight regain. Only weight loss or bariatric surgery has been shown to produce the enduring weight loss that translates into long-lasting remission of diabetes and a reduced risk of other diseases such as cardiovascular disease and cancer. However, the mechanisms by which this surgery produces its benefits are not fully understood.

A number of studies have reported changes in brain activation patterns before and after weight loss surgery but few have focused on participants with diabetes and pre-diabetes. None have investigated the evolution of these patterns in participants with obesity and diabetes that lose weight through diet versus surgery.

The researchers wanted to investigate changes in brain activity and weight responses following surgery or a very [low calorie diet](#) (VLCD) in people with obesity and type 2 diabetes or pre-diabetes. Sixteen participants were recruited to the study at Hammersmith Hospital, part of Imperial College Healthcare NHS Trust, between 2016-2018. The team also recruited 19 matched participants who undertook a very low calorie (meal replacement) diet for four weeks.

The participants in the surgery group underwent an MRI scan where they were shown images of low and high calorie food, as well as other non-food objects to measure the brain's response to these images. They then underwent gastric bypass surgery, followed by a further MRI scan four weeks after the procedure.

Participants in the VLCD group underwent the same MRI scans before and after starting their 800-calorie daily diet for four weeks. They were then followed up a year after the trial to monitor their progress and

compare results between the groups.

Following the trial, the team found that participants in the surgery group lost 12.3 kg on average whereas participants in the VLCD group lost 8.4 kg on average at four weeks. At 12 months, the VLCD group regained all the weight they had previously lost, while those in the surgery group continued to lose weight.

Three brain responses

After analyzing the MRI scans before and after the interventions, the team found that people in the surgery group experienced three different types of brain responses that are linked to long-term weight loss.

Firstly, when surgical participants looked at images of food compared to non-food objects after surgery, there was a significant reduction in areas of the brain associated with the 'reward' response to food. In contrast, in those who had had the VLCD, there was an increase in activation of these same areas in response to the food pictures.

Secondly, in the VLCD group, after viewing pictures of food, there was an increased activation of brain areas associated with restraint against over eating. This was not found in the surgical group. The researchers believe that following VLCD participants may need to engage a greater cognitive effort to suppress food craving, compared with those who had [bariatric surgery](#).

Lastly, the team found that the hypothalamus—an area of the brain which subconsciously controls appetite and weight—is more strongly linked to higher brain centers, which are involved in conscious thought, after surgery in comparison to the VLCD group. The researchers suggest that this stronger link, by providing subconscious feedback from the hypothalamus to the conscious mind, may help to dampen hunger

cravings and any compulsions to eat high calorie foods.

The team believe that the three types of brain responses interlink with each other and may explain why, after [weight loss surgery](#), people have a long lasting loss of weight, but, after VLCD, people tend to have a regain of weight.

Obesity and Type 2 diabetes are amongst the greatest global health challenges. The UK ranks as the country with the highest level of obesity in Europe, with more than one in four adults obese. Obesity is believed to account for 80-85 percent risk of developing Type 2 diabetes. Many people also have pre-diabetes, which is where blood sugar levels are higher than expected, although not at the level to diagnose diabetes. People with pre-diabetes are at high risk of developing diabetes.

Population-based weight loss strategies are being heavily invested in by health systems around the world to reduce these health problems, but there is ongoing debate about the most effective way to achieve long-term improvements in health. With the discovery of these [brain](#) responses, it may be possible to assess the durability of weight loss after different types of [weight](#) loss treatments such as new dietary regimens and medications using MRI scanning.

More information: Victoria Salem et al, Weight Loss by Low-Calorie Diet Versus Gastric Bypass Surgery in People With Diabetes Results in Divergent Brain Activation Patterns: A Functional MRI Study, *Diabetes Care* (2021). [DOI: 10.2337/dc20-2641](https://doi.org/10.2337/dc20-2641)

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