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Obesity: Not just what you eat—Research shows fat mass in cells expands with disuse

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Over 35 percent of American adults and 17 percent of American children are considered obese, according to the latest survey conducted by the Centers for Disease Control and Prevention. Associated with diabetes, heart disease, stroke, and even certain types of cancer, obesity places a major burden on the health care system and economy. It's usually treated through a combination of diet, nutrition, exercise, and other techniques.

To understand how obesity develops, Prof. Amit Gefen, Dr. Natan Shaked and Ms. Naama Shoham of Tel Aviv University's Department of Biomedical Engineering, together with Prof. Dafna Benayahu of TAU's

Department of Cell and Developmental Biology, used state-of-the-art technology to analyze the accumulation of fat in the body at the cellular level. According to their findings, nutrition is not the only factor driving obesity. The mechanics of "cellular expansion" plays a primary role in fat production, they discovered.

By exposing the mechanics of fat production at a cellular level, the researchers offer insight into the development of obesity. And with a better understanding of the process, the team is now creating a platform to develop new therapies and technologies to prevent or even reverse fat gain. The research was published this week in the *Biophysical Journal*.

Getting to the bottom of obesity

"Two years ago, Dafna and I were awarded a grant from the Israel Science Foundation to investigate how mechanical forces increase the fat content within fat cells. We wanted to find out why a sedentary lifestyle results in obesity, other than making time to eat more hamburgers," said Prof. Gefen. "We found that fat cells exposed to sustained, chronic pressure—such as what happens to the buttocks when you're sitting down—experienced accelerated growth of lipid droplets, which are molecules that carry fats.

"Contrary to muscle and bone tissue, which get mechanically weaker with disuse, fat depots in fat cells expanded when they experienced sustained loading by as much as 50%. This was a substantial discovery."

The researchers discovered that, once it accumulated lipid droplets, the structure of a cell and its mechanics changed dramatically. Using a cutting-edge atomic force microscope and other microscopy technologies, they were able to observe the material composition of the transforming fat cell, which became stiffer as it expanded. This stiffness alters the environment of surrounding cells by physically deforming

them, pushing them to change their own shape and composition.

"When they gain mass and change their composition, expanding cells deform neighboring cells, forcing them to differentiate and expand," said Prof. Gefen. "This proves that you're not just what you eat. You're also what you feel—and what you're feeling is the pressure of increased weight and the sustained loading in the tissues of the buttocks of the couch potato."

The more you know …

"If we understand the etiology of getting fatter, of how cells in fat tissues synthesize nutritional components under a given mechanical loading environment, then we can think about different practical solutions to obesity," Prof. Gefen says. "If you can learn to control the mechanical environment of cells, you can then determine how to modulate the fat cells to produce less fat."

The team hopes that its observations can serve as a point of departure for further research into the changing cellular environment and different stimulations that lead to increased fat production.

Provided by Tel Aviv University

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