

## **Chapter 10: Energy Balance and Obesity – Associated Conditions**

Obesity is the most common nutritional disorder in the United States. In the world at large, the number of overnourished people is now greater than the number of undernourished individuals for the first time in human history.

Obesity is defined as excess body fat, not excess body weight (See section on body composition). However, on average, body weight is a useful surrogate, and body mass index is used to follow the obesity epidemic and its association with diseases since, as a practical matter, it is difficult to measure body composition on tens of thousands of individuals.

### **CAUSES OF OBESITY**

The most common causes of obesity are overeating and underactivity. There is evidence for differences in metabolism making some individuals more efficient in hanging onto calories, but the most common reasons for differences in the tendency to gain or lose weight relate to age, height, sex and weight. Therefore, obesity results from common genetic predisposition, but is expressed only when there is excess energy available for storage.

### **Energy In = Energy Out + Energy Stored**

However, energy out is largely related to body composition in terms of lean tissue rather than fat tissue. So a man who is 74 inches tall might burn 2,200 Calories per day, while his wife at 62 inches tall burns only 1,200 Calories per day due to differences in the amount of lean body-mass they each have. Is it any wonder that the woman in this case will lose weight more slowly than her husband on the same diet of 1,000 Calories per day?

Despite these individual differences in energy needs and expenditure, it is clear that the modern diet contains too many calories per bite to enable the normal weight regulatory mechanisms in the body to operate properly. This is illustrated by a rat experiment. If you feed a rat pellets with more oil, the rat will eat fewer pellets and maintain a normal weight. If you remove fat from the pellets, the rat will eat more pellets and still maintain its weight. On the other hand, if you feed the rat what is known as a cafeteria diet (made up of peanut butter, salami and chocolate chip cookies), the rat will lose all control of its homeostatic mechanisms and become as large as genetically obese rodents.

Mankind, by analogy, adapted to low-nutrient density diets but is no longer able to maintain normal body fat on the high fat and sugar diets of modern times. There is

accumulating evidence that reward circuits and the reinforcement resulting from the intake of favorite foods are important factors in binge eating disorders associated with addictions and obesity. The food cravings observed clinically differ among individuals but include some of the most popular foods such as cakes, cookies, pastries and savory snack foods. Animals can be addicted physically to sugar and humans may not be far behind. The result of the excess calorie intake is the accumulation of body fat.

## **BODY FAT REGULATION AND FUNCTION AS AN ENDOCRINE ORGAN**

Your body fat is a vital organ in your body just like your heart, liver, kidney or skin. It has nerves, blood vessels and fat cells, and this organ secretes hormones and small proteins that affect energy balance, fat storage and your metabolism. The function of body fat organs depends on where they are located on your body. Each of the body fat organs in the lower body as female fat and in the upper body in men and women have special functions with regard to the uptake and release of fatty acids and in terms of the hormones they secrete and to which they respond.

### **Female Fat**

The fat on women's hips and thighs provide the energy mothers need to provide milk to their newborn babies. This fat responds to female hormones, and in every menstrual cycle right after ovulation there is a one thousand-fold increase in the blood levels of the female hormone, progesterone. So when women believe they are gaining small amounts of weight in addition to being bloated – they are right. The body is preparing for pregnancy by developing the fat organ in the hips and thighs and it grows much more if a woman becomes pregnant due to the large amounts of estrogen and progesterone produced by the placenta. A considerable number of calories must be stored, since breast milk production normally requires about 500 calories per day.

The main factor accounting for female obesity is weight gain after pregnancy. Women typically gain between 30 and 40 pounds during pregnancy. If they do not breast feed or diet in the six months after delivery, the weight gained during pregnancy is not lost. The next pregnancy starts at a higher weight and more weight is gained with the second pregnancy – and so forth. Understanding how this fat accumulates can help young women lose this fat after delivering their children and can lead to prevention of obesity in these women.

Just as women are born with different shaped bodies, women are born with different size hip and thigh fat organs. There is nothing wrong with that body of fat, except that our modern society has labeled it as bad. This was never the case in the history of man prior to past four decades. Women with lower body fat were always in demand, and biology reflected what was desirable. There is a disconnect between women's genetics and what is considered attractive by many people. However, there is a backlash. There needs to be more tolerance of different body shapes in our society.

Finally, this fat tends to be more resistant to diet and exercise, and there are many women who starve themselves trying to lose this fat. Some even lose too much fat in their faces and chests in an attempt to look healthy. It is important to be aware of your appropriate target weight and shape if you have more fat in the hips and thighs than in the upper body.

### **Abdominal Fat**

The fat in the middle of the body surrounds the intestines and has special properties both in terms of the substances released into the bloodstream by this fat and in the hormones to which this fat responds. Both men and women can accumulate abdominal fat. There are some women who have only upper body fat, and never accumulate much lower body fat. Then there are also women who accumulate both upper and lower body fat.

Those women with upper body fat have higher male hormone levels than women with lower body fat. They are three times more likely to get breast cancer and about nine times more likely to get diabetes than women with lower body fat.

This fat is designed to store a limited amount of fat to enable you to survive starvation. It secretes a number of substances to fight infection called cytokines. A cytokine is a small protein-signaling molecule that can promote inflammation and oxidation in cells. When malnourished, humans are more susceptible to infections. Therefore, it makes sense that abdominal fat should work to protect against such infections. This response is beneficial when it turns on and off in response to an infection, however abdominal obesity leads to ongoing low-grade inflammation with increased release of cytokines from abdominal fat due to an interaction of these fat cells with specialized white blood cells from the bone marrow that travel to the abdominal fat.

## **Fat Cells Are More Than a Bag of Fat**

While adipose tissue has been regarded classically as an inert fuel reservoir, recent studies have demonstrated that fat cells are endocrine and immune cells. This makes sense since the most common reason for death with malnutrition is infection due to immune impairment. On the other hand, when there is excess body fat, there is excess immune activity, which can be harmful. This is another example of how mankind is poorly adapted to overnutrition while being well-adapted to starvation.

In its function as an endocrine organ, adipose tissue secretes hormones, cytokines, and growth factors that help to regulate insulin sensitivity, inflammation, nutrient and energy homeostasis, and lipid metabolism.

## **REGULATION OF FOOD INTAKE**

In the last 15 years there have been major advances in our understanding of the regulation of food intake. There are three areas of the brain involved in this vital function – the hypothalamus, dorsal vagal complex and reward system along with the fat tissue discussed above. Importantly, there is also non-homeostatic eating – or eating when you are not hungry in response to emotions, environmental factors, etc. Much of this behavior is learned and its correction requires a behavioral approach. ***Often psychology trumps physiology.*** Understanding how the various hormones and factors respond to nutrients is interesting and positions individuals to make better behavioral changes. However, this adaptation to starvation is too strong to ever be overcome at any one point in the system. A combined behavior, exercise and nutrition program that truly changes daily habits is the only long-term solution to weight management.

## **Adipokines and Inflammation**

Overnutrition, as already mentioned, leads to excess inflammation. The inflammation occurs as the fat cells outgrow their blood supply and die as the result of rapid accumulation of new fat tissue to store extra calories. The dead cells send a signal out that recruits macrophages that are specialized white blood cells from the bone marrow. These travel to the abdominal fat and cross the blood vessels into the fat to surround and destroy the dead fat cells

The inflammatory state of adipose tissue in obesity leads to infiltration of the tissue by macrophages, which can further propagate and amplify the inflammation.

Weight loss is associated with a decrease in inflammation, which may explain the improvements in some obesity-associated conditions.

### **Genes and Obesity**

Obesity is the result of an interaction of genes and environment. However, the genes involved represent at present about 17 different genes that can account for obesity. Nonetheless, the total number of individuals with these genetic diseases account for only 5 percent of all cases of obesity. Some of these disorders are fascinating and involve multiple problems in mental functioning, reproduction, vision and facial appearance. However, the majority of the obese population is simply well-adapted to starvation. Research on the genes involved in familial obesity have so far shown up some 70 associations with parts of the human genome. However, it is unlikely that this search will uncover any single unique targets that account for a significant percentage of obesity cases. Rather, most experts suggest any one defect may contribute about 2 percent to the tendency to gain weight. Somehow the cumulative effects of multiple genes are what tip the balance toward gaining weight.

On the other hand, it is the sedentary lifestyle of the current age that combines with the high-fat, high-sugar, and high-starch diet to unmask the genes for obesity. It is generally believed that the very obese, those over 100 pounds overweight or with a BMI greater than 40, have the greatest genetic programming for obesity. In the last 10 years, when obesity has doubled, the number of people with severe obesity has increased fourfold, according to a recent Rand study. However, beyond obesity in general, your shape is genetic. Identical twins reared apart not only have similar body weights but photographs of their fat distribution show almost identical pockets of fat. So your body's shape is genetically determined but it can be altered with diet and lifestyle changes.

### **Heart Disease and Hypertension**

Obesity is related to the pathogenesis of heart disease through multiple pathways, including hypertension, increased ability of the blood to clot and dyslipidemia, which is an abnormality of lipid metabolism in which there is overproduction of triglycerides with a depression of "good" HDL cholesterol and normal or increased "bad" LDL cholesterol.

The hypertension that is seen in obesity is related to the hyperinsulinemia and increased secretion of catecholamines. These patients have elevated renin and angiotensin levels and the drugs of choice for hypertension in these patients are called angiotensin

converting enzyme (ACE) inhibitors. Weight loss will also reduce blood pressure, but the new guidelines for these patients suggest that lifestyle and diet be used to lower blood pressure to less than 135/85 along with medications. Only 5 percent of all hypertension is due to salt sensitivity, but this disorder does occur. Salty foods will increase blood pressure in patients where obesity is the primary problem. However, low-salt diets have relatively little effect on blood pressure in these patients.

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