The Effect of Molecular Genetics on Obesity

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Abstract:

Obesity is an increasing problem in the world today. Sicknesses, disorders, diseases, and death are the adverse out comes of the excess accumulation of bodily fat. It is well known that diet and exercise play a key role in maintaining a healthy body weight, but as research is being done, more and more causes of obesity are being found, including genetics. Scientists are currently researching through tests and observations to find out how much of a role genetics has on obesity. There are so many causes of obesity that range from missing proteins and hormones, to diseases. All of the causes of obesity that do not have to do with diet or exercise are able to be inherited through genetics. Therefore, analysts have found that genetics plays a strong role in becoming obese. Despite this, the stopping of genetically caused obesity is difficult to attain because of the fact that there are numerous causes of obesity. Testing is being done continuously to help pinpoint the exact causes of this detrimental bodily state. As research continues, scientists hope that the number of obese beings in the world is depreciated greatly along with the deleterious consequences that come along with being significantly overweight.

Key Terms: obesity, genetics, hereditable, molecular genetics, adipose, Bsx molecule, genes, leptin, hypothalamic-pituitary-adrenal axis (HTPA axis), hypothyroidism, thyroid, metabolism, Cushing's syndrome, cortisol, Prader-Willi Syndrome, paternal chromosome.

Introduction:

Obesity is a condition describing excess body weight in the form of fat. Obesity commonly results in many health issues, including cardiovascular issues, and at times, death. In ancient times, obesity was looked at differently. The Egyptians believed that obesity was a disease, and the Aztecs believed obesity was given to select people through

supernatural powers (Anon, 2009). Of course today, the people of the world know these theories are not true. As obesity became more frequently studied, it was found that a main cause of obesity is poor dieting combined with a lack of exercise. However, it is seen that certain people are more susceptible to becoming obese than others. This brings up the idea that **genetics** may play a role in obesity. The goal of this paper is to study along with minimal exercise and poor dieting, does genetics play a role in obesity? The significance that genetics plays in obesity will be studied as well as certain genes or gene mutations that may cause obesity to arise. If there are certain hormones or genes that cause obesity, and are **hereditable**, than genetics does play a strong role in obesity in today's people. Because obesity affects the body on multiple levels, obesity will be studied on the cellular, molecular, tissue, and bodily levels in order to attain the goal of this paper. Being that obesity is becoming more and more prevalent in America, it would be beneficial to study the genetic causes of obesity in order to help reduce the percentage of obese people in today's world. By reducing the amount of obesity in the world, the amount of health issues caused by obesity will be attenuated. Overall, the problem of obesity will be studied in depth in order to better understand the causes of this increasing problem.

Background:

Obesity is a bodily state in which fat is accumulated in an excess amount. Due to the excess of fat, the health of the obese body may be affected negatively. On a cellular level, obesity affects the fat cells in the body and would consist of a build up of these cells. On the level of the tissue, obesity affects the **adipose** tissue. Adipose is a connective tissue which functions in storing fats as triglycerides. Triglycerides are the

form which fat is stored within the body. Adipose tissue is composed of fat cells. Therefore, a person who is obese will have an abundant amount of adipose tissue.

Cellular and Molecular Level:

On the cellular level, adipocytes make of the fat of the body. Any changes in hormonal levels in the body can cause modifications in the amount of adipocytes, along with metabolic altercations (Bjorntorp, 1991).

Scientists have been researching obesity on a molecular level, and have found that a molecule called **Bsx** could be a main cause of obesity. Bsx is a molecule that is a link between physical activity and food intake. According to study, if there is a lack of this specific molecule in the body, that person will not participate in physical activity to use up the food intake, but rather become lazy allowing for a build up of fat. Bsx is possibly the reason why certain people can eat whatever they like without any effect whereas some people will gain weight as a result of poor dieting. A person with a lack of the Bsx molecule will have more of a tendency to gain weight because their body will have less spontaneous movements, meaning that their food intake will play a larger role on their bodily fat. Bsx has been tested on mice, and it was seen that mice lacking this molecule took place in less spontaneous activity. The mice had different behavior in terms of feeding as well. By continuing the study of the Bsx molecule, scientists anticipate the creation of a drug that could help control the symptoms of a body lacking Bsx (Mansell, 2007). Although the Bsx molecule is a great start on understanding obesity, the science of subconscious movements is still being studied, and the **genes** and molecules involved remain unidentified (Anon, 2008).

There is no specific form of obesity. Obesity has many different sources, and each person has a different response to these wide varieties of causes. One scientist, Andreu Palou, says that as there is an increased understanding of genetic-molecular characteristics, foods will be changed to help combat obesity (Palou, 2002).

A theory scientists have made is genes of people in the past were used to a lack of food due to the fact that food was less abundant. This theory is called the "Thrifty Gene Theory". It states that people of the past had genes that allowed them to go long periods of time without food in order to survive times of famine. Since genes take an extensive period of time to adapt, these genes could be passed on through generations, and with all the food available to people today, the body is less prepared to handle an excess of food. However, this is just a theory because the connection between obesity and genetics is still being studied (Cramer, 2009). Through research, scientists have now found more than 200 genes that can affect body weight, but it is unknown how much of an effect these genes have (Comuzzie, 2003).

Deficiencies, Diseases, and Syndromes that Cause Obesity:

Leptin, a protein hormone which regulates energy intake and expenditure, is a cause of obesity today (Anon, 1998). A lack of this protein hormone will cause poor regulation of energy, and this could lead to obesity if the intake and expenditure of energy is not properly regulated. Obese mice were used to test the effect of leptin. When leptin was injected in the mice, in was noticed that the mice consumed a considerably lower amount of food. Leptin appears to have the effect of decreasing food consumption and increasing the amount of energy being expended (Paracchini, 2004). Leptin is

hereditable; therefore if one is obese due to a low amount or no leptin, genetics has played a role in obesity.

The hypothalamic-pituitary-adrenal axis (HTPA axis), is a feed back mechanism that controls stress, regulates digestion, the immune system, emotions, and energy storage and expenditure. A body with a poorly functioning HTPA axis could easily lead to the outcome of obesity because there would be a build-up of stress and energy stored in the form of fat. A poorly functioning HTPA axis would be caused due to a genetic disorder (Raber, 1998).

Another condition caused by genetics which can lead to obesity is **hypothyroidism**. Hypothyroidism is a condition in which the **thyroid** does not produce enough hormones (see plate 1). The thyroid hormone functions in controlling the body's metabolism. Therefore, those who are inflicted with hypothyroidism will have a slow metabolism. Having a slow metabolism can easily lead to weight gain if an excess of food is ingested. Hypothyroidism is most common in elderly women (Norman, 2009).

Cushing's syndrome is a disorder, which elevates the amount of **cortisol** produced by the body (see plates 2 and 3). Cortisol is a hormone that is secreted as a response to stress. When too much cortisol is produced, the body will get fat deposits around the body, mostly in the upper half of the body. As with many disorders, the causes of Cushing's syndrome are hereditable through genetics (Anon, 2008).

Prader-Willi syndrome is another cause of obesity (see plate 4). This syndrome is a rare chromosome disorder which is caused by the imprinting of DNA. A person who has Prader-Willi syndrome has seven missing genes on the 15th **paternal chromosome**. The effected person will have a constant feeling of hunger. Therefore if

their hunger is uncontrolled, the victim can easily become overweight or obese (Schwartz, 2008).

There are innumerable causes of obesity that are caused by genetics as well. Because there are so many causes of obesity, many of which are inherited, genetics does play a key role in many of those who are obese.

Statistics:

Obesity is clearly a problem today in America. Statistics show that almost one-third of adults in America are obese, and in 2000, 31% of Americans were considered obese (Anon, 2006). According to the Behavioral Risk Factor Surveillance System (BRFSS), 26.4% of men and 24.8% of women were obese in the year of 2007 (Anon, 2009). As research continues, scientists will hopefully be able to find cures for the genetic causes of obesity to help lower these statistics.

There are some medical restrictions in the research of obesity, but they only have to do with obesity during pregnancy. As far as scientists studying different ways in which genetics affect obesity, there are no restrictions that could be found.

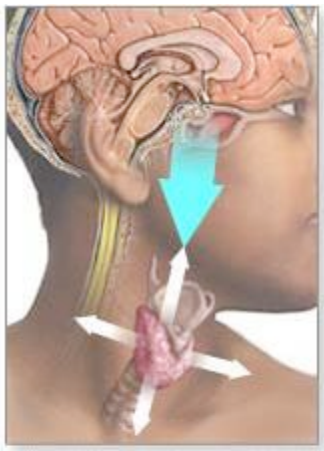
Discussion:

The genetics of obesity is a topic that scientists need to continue to research. This research is vital to the well being of millions of people through out the world. Obesity is the source of so many sicknesses and diseases including diabetes, cancer, strokes, urinary troubles, and heart disease. In many cases the detriments obesity causes can result in death. If continuing the study of the genetic causes of obesity helps reduce the amount of obese humans, ultimately many of the problems caused by obesity will be reduced as

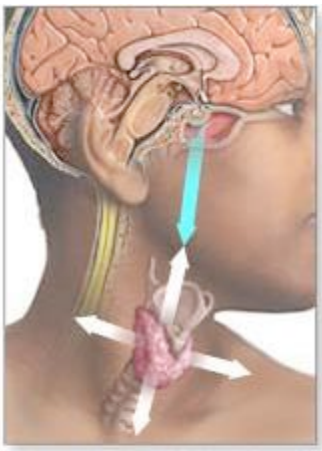
well. As I continue my research, I am finding that scientists are still experimenting with how genetics affects obesity. Because of this, some of the findings found in my research are based off of what scientists are attempting to find, rather than what they have actually found. For example, the effects that the Bsx molecule and the protein hormone leptin have on obesity have been tested only on mice, not on humans. Human genetics is a very complex subject, and there are so many causes of obesity that it makes it difficult for scientists to pinpoint precise genetic causes of obesity. As technology advances in the world, scientists need to continue to research the genetics of obesity. With more sophisticated technology, research should be able to become more conclusive. Eventually, scientists will have to take their findings form the laboratories and implement these results into the real world. Whether the research is used to create a new drug to help control obesity, or a gene is able to be added or removed to get rid of obesity altogether, scientists have to keep working on this constantly rising problem in the world. If obesity can eventually be reduced a drastic amount, people will be living longer and there will be less health issues around the world being that obesity accounts for so many sicknesses, diseases, and deaths everyday. The genetics of obesity needs to continue to be explored for the good of the people.

Plates:

Plate 1 (Anon, 2007)

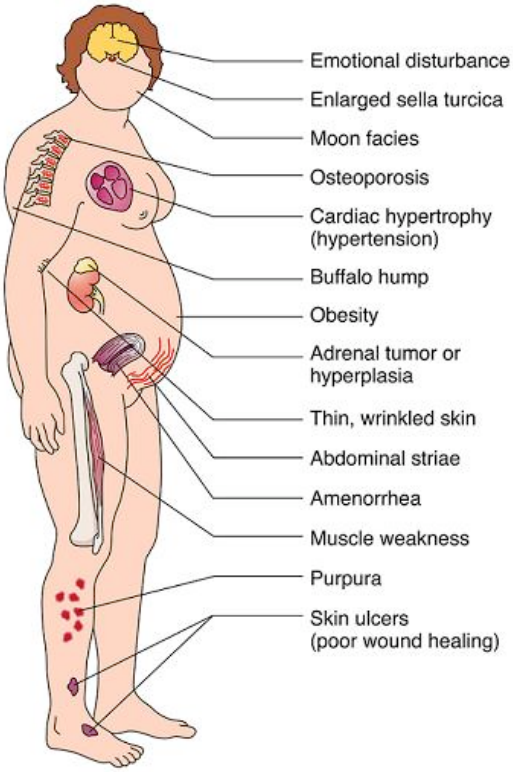


Primary hypothyroidism: thyroid can't produce amount of hormones pituitary calls for



Secondary hypothyroidism: thyroid isn't being stimulated by pituitary to produce hormones

Plate 2 (Farber, 1999)



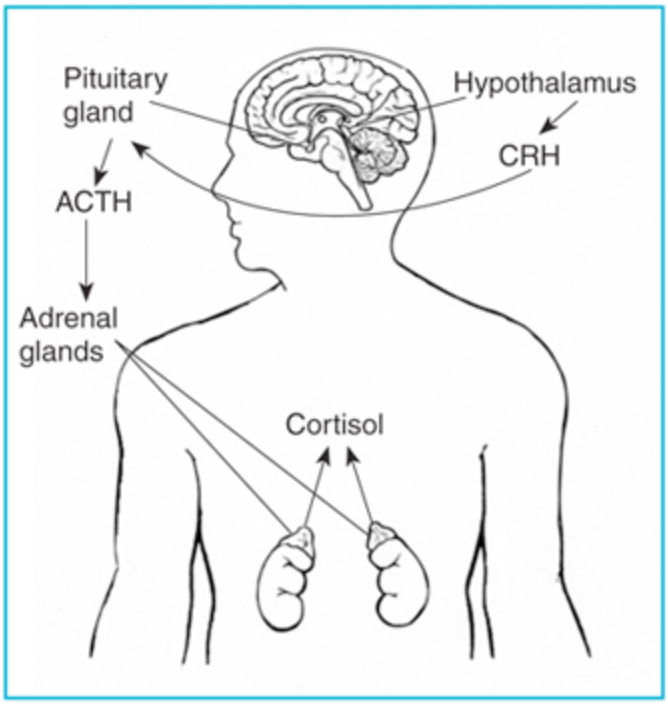


Plate 3 (Anon, 2008)

Plate 4 (Anon, 2007)

Glossary:

adipose – animal fat stored in the fatty tissue of the body.

Bsx molecule – a specific protein molecule that is the link between spontaneous physical activity and food intake.

cortisol – a hormone secreted by the adrenal gland as a response to stress.

Cushing's Syndrome – a hormonal disorder caused by too much secretion of the hormone cortisol.

genes – the basic physical units of heredity, which are composed of a sequence of nucleotides.

genetics – the science and study of heredity.

hereditable – capable of being inherited through genetics.

hypothyroidism – a condition in which the body lacks the thyroid hormone, which in turn slows down the metabolism of the body.

hypothalamic-pituitary-adrenal axis (HTPA axis) – a complex set of feedback mechanisms that controls reactions to stress and regulates many bodily processes.

leptin – a protein hormone involved with regulating food intake and storage of fat in the body.

metabolism - the sum of the physical and chemical processes in an organism by which its material substance is produced, maintained, and destroyed, and by which energy is made available.

molecular genetics – the branch of genetics concerned with the structure and activity of genetic material the molecular level.

obesity – the condition of having an excess accumulation of fat.

paternal chromosome – the chromosome of a homologous pair that is inherited from the father.

Prader-Willi Syndrome – a chromosome disorder caused by missing genes on the 15th paternal chromosome.

thyroid – an endocrine gland which helps regulate growth and metabolism in the body.

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