The Bioscientist Vol. 3(1): 68-78 , January 2015 Available online at
http://www.bioscientistjournal.com

Full Length Research Paper

HUMAN PREDISPOSITION TO OBESITY

Emeji, E. O. [1], Eze, U.S. [2]and Ubaoji, K.I. [3]
[1]Department of Integrated Science, Ebonyi State College of Education, Ikwo.
[2]Department of Biology, Ebonyi State College of Education, Ikwo.
[3]Department of Applied Biochemistry, Nnamdi Azikiwe University, Awka.
E-mail: Correspondence author**: emejiemmanuelo@yahoo.com**

ABSTRACT
The prevalence of obesity among people in our society is worrisome and many individuals are currently struggling for survival under the complications of obesity. The study examined the factors that predispose humans to obesity. Obesity is a condition characterized by the excessive accumulation of fat in adipose tissue when compared with normal quantity expected for a given weight, age and height. Epidemiologically, it occurs at any time in life, in both sexes and different social classes. The study showed that humans are predisposed to obesity by genetic, endocrine, dietary fat, sedentary life-style, psychological and antibiotic factors. Genes affect a number of weight related processes in the body and defects in them impair satiety and mechanisms of energy intake, energy expenditure and partitioning of nutrients between fat and lean tissues. Obese humans have high plasma leptin concentrations related to the size of adipose tissues without inducing the expected responses which suggests resistance to endogenous leptin. Some of the complications of obesity include mechanical disability, metabolic disorders, cardiovascular disorder, respiratory problems, and reduction in life expectancy. Our recommendations include periodic assessment of individual's nutritional status by determining the body mass index; recognizing and controlling environmental cues; and engaging in physical activities.

Key words: Obesity, Predisposition, Aetiology, Energy, Complications.

INTRODUCTION

Obesity is a condition characterized by the excessive accumulation of fat in adipose tissue when compared with normal quantity expected for a given weight, age and height. Body mass index greater than 31.1 for men and greater than 32.3 for women is considered obesity (Helen *et al*., 1995). It is generally applied to a person who is 20% to 30% or more above a so-called standard weight, usually displayed in weight-height table (Sue, 1994).

Obesity is often looked upon as a disease of middle age, but it can occur at any time in life. In a poor community it is indeed uncommon in the young and characteristically occurs in successful business men or civil servants who have prospered and in their wives. In wealthier communities it is becoming an increasingly important problem in the young.

Immediate cause of obesity is always a positive energy balance, but there are many ways in which the balance may be tilted towards the positive side. Thus, obesity is often divided into exogenous and endogenous obesity. Exogenous obesity is the type that results from overfeeding and gluttony with less physical activity. Endogenous obesity occurs due to endocrinal, metabolic or hypothalamic lesion. Pathologically, obesity is divided into hyperplastic type, a life long obesity characterized by an increase in adipose cell number and size; and hypertrophic type, adult onset obesity characterized by hypertrophy of adipose tissue cells without increase in adipose cells number (Chatterjea and Shinde, 2012).

Adolescent obesity is common in many countries and is often attributable to lack of physical activity. Obesity is now common in infants and young children as a result of change in methods of feeding. Juvenile obesity is often followed by obesity in adult life. It may occur in either sex, but is usually more common in women in whom it is liable to occur after pregnancy and at the menopause. Women gain up to 12.5kg during pregnancy (Stanley *et al*., 1975). Part of this is an increase in adipose tissue which serves as a store against the demands of lactation. Many women gain more and retain part of this weight after delivery, thereby becoming progressively obese with each succeeding child.

Any explanation of the aetiology of the obesity epidemic must account for its sudden appearance. Although a predisposition to obesity can be inherited, the fact that the incidence increased in few decades appears to discount genetics as a major cause. For instance, 6 million American adults are now morbidly obese (BMI > 40), almost twice as high as 1980 severe obesity rates, while another 9.6 million have BMI of 35-40.The percentage of overweight children 6-11 years has nearly doubled since the early 1980's (US, 2000). Developing countries like Nigeria and Asian cities are not left out. Thus, genetic causes are unlikely to be significant.

Genetic Predisposition to Obesity

Genes affect a number of weight related processes in the body such as metabolic rate, blood glucose metabolism, fat storage, hormones, etc. Recent studies from a number of research centers have shown that a considerable proportion of human obesity, accounting for perhaps as much as 50% to 79% of cases, has a genetic component meaning that genetics plays some significant roles as a cause of obesity (Hirsch-horn and Daly, 2005). Genetic factor, which involves the inheritance of genes received from our parents, may predispose a person to obesity in the sense that they make it more likely for offsprings to become obese.

These heritable factors are likely to be multiples and operate through the full range of potential mechanisms, including energy intake, energy expenditure and the partitioning of nutrient between fat and lean tissues. However, whether a genetically predisposed person actually becomes obese depends on physical, social, and psychological environment to which he or she is exposed. Thus, the development of obesity involves a complex interaction between the genetic factors within a susceptible individual and an environment that fosters obesity.

The genetic defects found to date all impair satiety, affecting the function of appetite control centers in the brain rather than being due to a 'slow metabolism' (Farooqi and O'Rahilly, 2005). This indicates that we must think of human food intake not as an entirely voluntarily controllable phenomenon but one driven by powerful biological signals from relatively primitive brain area. When these basic signaling mechanisms are severely disrupted, it is very difficult to overcome the drive to eat.

Mutations in one gene, the melanocortin-4 receptor, may be responsible for tens of thousands of cases of obesity in the UK alone (Farooqi *et al*., 2003). Knowledge of the specific molecular mechanism in this and other genetic disorders may lead to better mechanism directed pharmacotherapy.

Polymorphisms in multiple candidate genes selected by virtue of their known biological function and/or their role in the causation of monogenic obesity syndrome in human or animal models, have been examined in population and case-control studies to determine whether they influence the risk of adiposity. The Trp64Arg variant in the beta-3 adrenergic receptor gene has been the subject of more than 60 independent studies and four meta-analysis and evidence points to some effects (Zhan and Ho, 2005).

Sutton *et al* (2005) pointed out that the single nucleotide polymorphisms (SNPs) in proopio-melanocortin, a precursor peptide, have been found to associate with obesity-related variables in a Hispanic population. Thus, as is the case with common forms of type 2 diabetes, it does appear that subtle variants in gene, which when mutated result in severe early onset obesity and likely to contribute to susceptibility to obesity in the general population.

Multiple linkage studies have been undertaken on family-based dataset, with some chromosomal regions (e.g. on chromosome 2p, 3q, 10p, 20q) showing positive results in more than one study (Perusse *et al*., 2005; Bell *et al*, 2005). Some of these regions have been subjected to intensive second phase analysis. Using this approach, Froguel *et al* (2003) identified a region on chromosome 10p12 that showed significant linkage with obesity in several populations. Examining candidate genes within the region they tested GAD2, the gene encoding glutamic acid decarboxylase 65, an enzyme involved in gamma aminobutyric acid (GABA) synthesis. They found significant association of a particular GAD2 SNP in both case control and family based studies.

Meyre *et al* (2004) identified a region on chromosome 6q16.3q24.2 that was associated with significant logarithms of odd (LOD) score in relation to obesity and diabetes phenotypes. An SNP in ENPP1, a gene in this region which encodes an ecto-phosphatase, was found to associate with childhood obesity and also with insulin resistance (Meyre *et al*., 2005). Very recently, using such an approach, Herbert *et al* (2006) have identified an SNP close to the Insig2 gene which, when present in homozygous form, increases the odds ratio for obesity by 1.2-1.3.

Genetic-Metabolic Influence

There is strong evidence suggesting that many obese individuals, or those who gain weight early, do not eat more food than those who are not obese and maintain desirable weight with ease (Helen *et al*., 1995). She said that the distinction between these two types of people seems to be that food is used more efficiently in the bodies of those who are obese or who readily gain weight and that these people tend to store fat more quickly and mobilize body fat as energy source much less effectively.

Many people with a genetic predisposition to obesity have raised levels of the enzyme lipoprotein lipase (LPL). This enzyme plays key role in breaking down lipoprotein in the blood to release their fatty acids and other lipids for entry into tissue cells. Thus, raised levels of lipoprotein lipase increase the efficiency with which tissue cells take up lipids for incorporation into fat stores. Studies have also shown that possible defect in the LPL gene contributes to obesity because of the central role of LPL in breaking down fats to be either stored or used as fuel. This further reinforces that there is a genetic link to obesity as indicated by many other studies in both animal and humans (Helen *et al*, 1995).

The propensity to gain weight and become obese when consuming a high-fat diet is at least partially controlled by gene. This was demonstrated by Ji and Friedman (2007) when they determined whether preexisting difference in fat oxidation might contribute to individual susceptibility to diet-induced obesity. They used rats that differed in their genetic predisposition to gain weight and become obese when fed a high-fat diet. At the end of the study, they found that even when eating a low-fat diet and still lean, the obesity prone rats were less able to burn fat than were the obesity-resistant rats. When switched to a high-fat diet, the strain that was obesity-prone overate and became obese while the obesity-resistant strain did not.

This intrinsic deficit in fat oxidation was associated with a decrease in the capacity to make two liver enzymes. One of the enzymes is CD36 which is responsible for transferring fat fuel into liver cells, while the second enzyme, acyl-coenzyme A dehydrogenase, begins the oxidation process in mitochondria. Fat oxidation was further compromised due to a decreased ability to make CPT1A, the liver enzyme responsible for transporting fat into mitochondria (Ji and Friedman, 2007).

Dimauro (2004) reported evidence that over expression of ubiquinol–cytochrome C reductase core protein 1 (UQCRC1) might affect mitochondrial morphology and/or physiology and lead to development of obesity and related conditions. Mitochondrial dysfunction may predispose an individual to intramyocellular lipid accommodation. Statistical analysis using a general linear model (GLM) and quantitative transmission-disequilibrium test (QTDT) in a study that determined genomic organization of bovine UQCRC1, a nuclear-encoded component, and developed genetic marker in its promoter region, revealed that promoter polymorphisms are significantly associated with both subcutaneous fat depth (SFD) and skeletal muscle lipid accumulation (SMLA). The result implies that genetic polymorphisms in UQCRC1 gene might explain some cases of obesity in humans (Goodpaster and Wolf, 2004).

Endocrine Predisposition to Obesity

Obesity frequently accompanies hypothyroidism, hypogonadism, hypopitutarism and Cushing's syndrome, but it is not an essential feature of these conditions. The fact that in women obesity commonly begins at puberty, during pregnancy or at the menopause suggests an endocrine factor. Yet the overwhelming majority of obese patients show no clinical evidence of an endocrine disorder and the function of their endocrine glands is normal on routine tests (Stanly *et al*., 1975).

There are certain well-defined changes in metabolism associated with obesity that are as a result of deviations in endocrine function. According to Okaka *et al* (2006), increased adiposity may arise from or may cause endocrine disturbances.

Leptin Signaling

Leptin, a 16 kilodalton protein, may act as a sensing hormone or "lipostat" responding to the mass of adipose tissue and leptin receptors in the hypothalamus (Halaas *et al*., 1995). In obese humans, unlike obese mice, leptin deficiency and mutations in the Ob gene do not seem to have a major role. Hyperleptinaemia has been shown in animals such as *Psammomys obesus* and mice made obese by a high fat diet, as well as in obese humans. These results suggest that leptin receptors in the central nervous system are either down regulated or defective if the brain is assumed to be the location of the apparent resistance to leptin. A defect in feedback occurs in diabetic mice, and this could be the mechanism of human obesity or of some forms of it.

Feedback regulatory loop with three distinct steps has been identified: (1)

a sensor monitors the size of the adipose tissue mass; (2) hypothalamic centers receive and integrate the intensity of the leptin signal through leptin receptor b (LRb); (3) effector system, including the sympathetic nervous system, control the two main determinants of energy balance (i.e energy intake and energy expenditure). The rate of leptin production is related to adiposity, but a large portion of the inter-individual variability in plasma leptin concentration is independent of body fatness. The Ob mRNA expression is upgraded by glucocorticoids, whereas stimulation of the sympathetic nervous system results in its inhibition.

Leptin is not a satiety factor in human because changes in food intake do not induce short-term increases in plasma leptin levels. After its binding to LRb in the hypothalamus, leptin stimulates a specific signaling cascade that results in the inhibition of several orexigenic neuropeptides while stimulating several anorexigenic peptides (Figure 1). The orexigenic neuropeptides that are down regulated by leptin are NPY (neuropeptide y), MCH (melanin-concentrating hormone), orexins, and AGRP (agouti-related peptides). The anorexigenic neuropeptides that are unregulated by leptin are alpha-MSH (alpha-melanocyte-stimulating hormone), which acts on MC4R (melanocortin-4 receptor); CART (cocaine and amphetamine-regulated transcript); and CRH (corticotrophin-releasing hormone) (Halaas *et al.*, 1995).

Obese humans have high plasma leptin concentrations related to the size of adipose tissue, but this elevated leptin signal does not induce the expected responses (that is, a reduction in food intake and an increase in energy expenditure). This suggests that obese humans are resistant to the effects of endogenous leptin. This resistance is also shown by the failure of exogenous leptin administration to induce weight loss in obese patients.

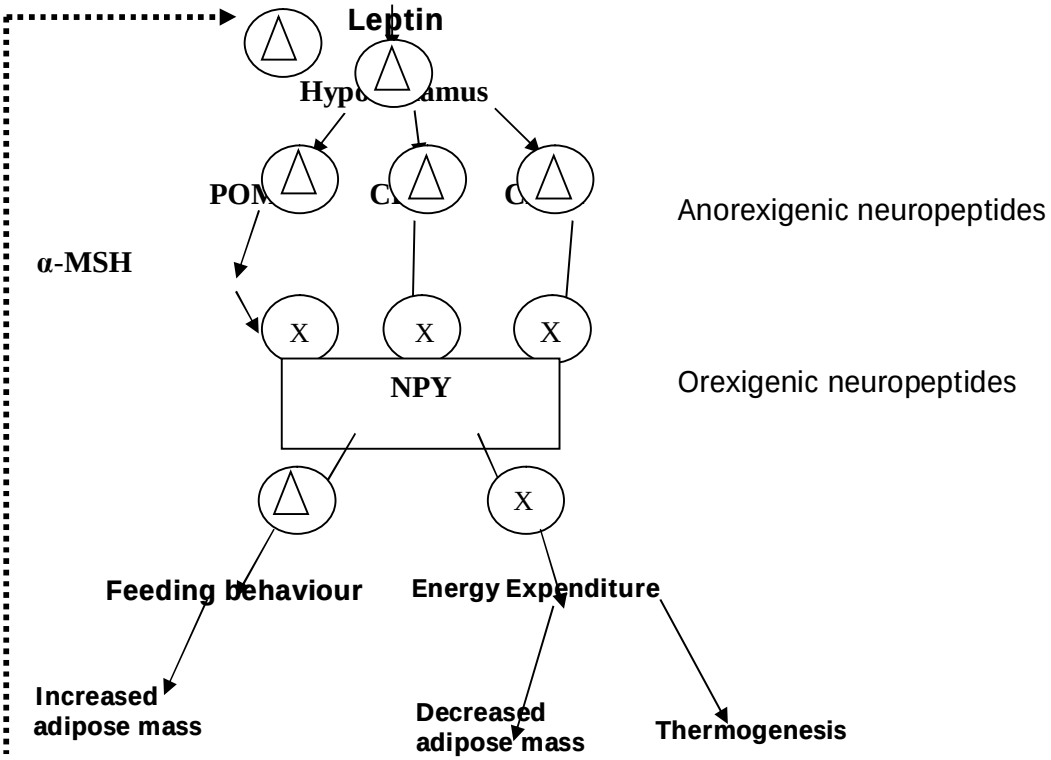

Figure 1: Leptin Cascade: Role of hypothalamus in eating behaviour and metabolic activity (David and Michael, 2000)

The mechanism that may account for leptin resistance in human obesity include a limitation of the blood-brain barrier transport system for leptin and an inhibition of the leptin signaling pathways in leptin responsive hypothalamic neurons. During periods of energy deficit, the fall in plasma leptin levels exceeds the rate at which fat stores are depleted. Reduction of the leptin signal induces several neuroendocrine responses that tend to limit weight loss, such as hunger, food-seeking behaviour, and suppression of plasma thyroid hormone levels. Elevated plasma leptin levels resulting from increased adipose tissue mass when there is plenty of palatable foods available do not prevent the development of obesity either.

In human, the leptin signaling system appears to be mainly involved in maintenance of adequate energy stores for survival during period of energy deficit. Its role in the aetiology of human obesity is only demonstrated in the very rare situations of absence of the leptin signal (due to mutations of leptin gene or of the leptin receptor gene), which produces an internal perception of starvation and results in a chronic stimulation of excessive food intake (Farooqi *et al*., 1999).

Adiponectin and its Receptors

Adiponectin, a hormone that is produced in adipose tissue, binds to adiponectin receptors in skeletal muscle and other tissues and occurs in low concentrations in obese individuals and people with type2 diabetes. Loos *et al* (2007) evaluated relations of variants of the adiponectin gene (ADIPOQ) and its receptors (ADIPOR1 and ADIPOR2) with the presence of obesity markers, which included body mass index, waist circumference, percentage body fat, and fat distribution in subcutaneous and visceral components, and with energy metabolism according to the respiratory quotient, which measures the relation between lipid and glucose metabolism. The analyses included potential effects of single gene variants and their combinations among the 3 genotypes on measure of adiposity and energy metabolism. The study found highly significant relations between a variant of ADIPOQ gene and obesity, and between gene variants of ADIPOR1 and ADIPOR2 and respiratory quotient. The effects of certain combinations of genotypes of ADIPOQ and ADIPOR1 on the prevalence of abdominal adiposity were ever more striking. They concluded that common variants in genes that regulate body fatness and the metabolism of lipid and glucose may play an important role in the incidence of obesity and type2 diabetes.

According to Philip *et al* (2003) adiponectin is a 29-KDa adipocyte protein that has been linked to the insulin resistance of obesity and lipodystrophy. They went further to state that plasma adiponectin and adiponectin mRNA levels are highly related with each other and obese subjects express significant levels of adiponectin.

Dietary Fat Predisposition to Obesity

The prevalence of obesity is increasing worldwide, which indicates that the primary cause of obesity lies in environmental and behavioural changes rather than in genetic modifications. Among the environmental influences, the percentage of fat energy of everyday diet and the lack of physical activity are two important factors, which contribute to the rising prevalence of obesity.

Obesity is induced by high-fat diets in some animals. Animal experiments have shown that the percentage of energy derived from fat in the diet is positively correlated with body fat content. However, the mechanism responsible for this correlation between body fat and dietary fat content is not clear. A high-fat diet

produces hyperphagia which is solely responsible for the increased body fat content. But many studies in rodents showed that increased body fat content still results when the hyperphagia is prevented. This suggests that some metabolic effects of high-fat diet, independent of hyperphagia may also be contributing to the obesity induced by high fat diets (David and Barbara, 1998).

There are four factors which support a link between dietary fat and obesity development (Horton *et al*, 1995). They include the thermic effect of nutrients expressed as percentage of their energy content, which are 2-3% for lipids, 6-8% for carbohydrates and 25-30% for proteins. This means that the efficiency of nutrient utilization (calculated as 100% - the thermic effect of nutrient) is higher for fat than for carbohydrate or protein; postingestive fuel selection favours the oxidation of dietary proteins and carbohydrates, whereas dietary fats are preferentially stored as triacylglycerol in adipose tissue. Alcohol, by inhibiting lipid oxidation, indirectly favours the storage of dietary fats, high-fat diet promotes excessive energy intake by passive overconsumption, and the fat-induced appetite control signals are too weak or too delayed to prevent excessive energy intake from a fatty meal.

To prove the contribution of high dietary fat to weight gain, two controlled feeding trials in dogs were undertaken. They showed that higher levels of dietary fats are associated with increased body weight and body fat content. In one study, the amounts of proteins and carbohydrates in six different diets that were fed to dogs for 8 months were varied. The highest fat diet contained 76% of energy from fat, the intermediate fat diets contained 55% and 38% of energy from fat, and the lowest fat diet contained just 13% of energy from fat. The highest fat diet was aphysiologic, however, because it contained 0% of energy from carbohydrate. The largest effects of the fat manipulation were seen in those diets with intermediate fat contents. At the end of the 32-week study, fat-free mass did not differ with fat intake, however, the dogs fed the intermediate-fat diets contained significantly greater amounts of body fats (3.1 and 3.5kg lipid) compared with the dogs in the low-fat diet group (1.9kg lipid) (Romsos *et al.*, 1976). Results of this study and others suggest that increased dietary fat content is associated with greater body fat accumulation in numerous species including humans.

Adiposity and Overeating

There are two distinct types of fat cells- the brown adipose cells and the white adipose cells. These groups of fat cells differ in size, number, distribution and metabolic activity. In human and other adult primates, brown cells are limited in number and areas of distribution and play key role in generating the increased amount of heat needed especially when exposed to cold. The white adipose tissues constitute the bulk of fat cells and of importance in obesity.

The number of adipose cells reaches a maximum during the adolescent and early life and tends to remain constant thereafter. Immature fat cells (adipocytes) do not store fat. The fat adipocytes increase in number as a result of overfeeding in infancy. This appears to play an important role in adult obesity since there are more cells available waiting to be filled with fat later in life (Okaka *et al*, 2006).

A significant physiologic factor in obesity is fat cell increase. Fat cells may increase in mass within limits, rarely exceeding about 1.5μg but not usually in number after puberty. Overfeeding after this stage when the fat cells have reached their maximal capacity triggers cells proliferation again. These increases in size to accommodate extra fuel storage are a form of obesity in this regard known as hypertrophic obesity which essentially means it is caused by an additional growth

of individual fat cells. And another more severe obesity is usually associated with an increase in fat cell number known as hyperplastic obesity (Okaka *et al*, 2006).

Sedentary Life-Styles and Psychological Factors

Obesity tends to run in families suggesting a genetic cause. Yet families also share diet and lifestyle habits that may contribute to obesity. Separating these from genetic factors is often difficult. Environment strongly influences obesity. The lifestyle behaviours of somebody such as what a person eats, physical activity and emotional state make up the environmental influences of obesity.

There is considerable evidence that sedentary life-style of many people in modern affluent societies may be a key factor in this trend towards obesity. That is weight gain that leads to obesity is caused by low energy expenditure, rather than obvious overeating. Although the energy expenditure of many activities seems small, the figure involved can mount up over longer period so that seemly minor reductions in activity can cause significant weight gain in the long term. For instance, playing tennis uses up approximately an additional 350kcal of energy per hour, whereas walking 3 miles uses about an extra 140kcal.

If a 154-pound man plays tennis for 15minutes everyday of the year, this will use up the energy within 9 pounds (4kg) of body fat. Walking just half a mile every day accounts for $2^1/2$ pounds of the body fat. These figures demonstrate that giving up such activities or similarly strenuous ones can soon lead to considerable weight gain over several years if no compensating adjustment of food intake is made (Helen *et al*, 1995).

Okaka *et al* (2006) posited that lack of physical activities is by far the most important element in the aetiology of obesity. Obesity is rarely found among active individuals. The present day man is consuming more joules while he has decreased his exercise outlets. Thus the fitness capacity of obese individuals, especially those suffering from morbid obesity is typically diminished.

Psychological factors may influence eating habits. Many people eat in response to negative emotions such as boredom, sadness, or anger. Up to 10% of people who are mildly obese and try to lose weight on their own or through commercial weight loss programme have binge eating disorder. This disorder is even more common in people who are severely obese.

Chatterjea and Shinde (2012) stated that people who suffer from anxieties, worries, constant tension or frustration, eat more to compensate. Certain neurological problems can lead to overeating and drugs such as steroid and some antidepressants may cause weight gain.

Antibiotics Factors

A US study reveals that kids who get treated with broad-spectrum antibiotics before age two face a higher risk of childhood obesity. The research in the Journal of the American Medical Association (JAMA) Pediatrics is the latest to find a link between weight problems and antibiotics, which can eliminate bacterial infections but also the beneficial intestinal microflora that colonizes the gut.

Experts at the Children's Hospital of Philadelphia looked at health records from nearly 65,000 children who were treated at primary care clinics from 2001 to 2013. Those included in the study were followed for five years. More than two thirds of the kids studied were exposed to antibiotics before age two. The increase in obesity risk ranged from two to 20 percent and was seen particularly in children who had been treated with antibiotics four or more times by age two (US, 2014).

Those given broad-spectrum antibiotics, which target a range of bacteria, were also at higher risk of weight problems in childhood. "No association

was seen between obesity and narrow-spectrum antibiotics," said the study, which described the use of broad-spectrum antibiotics in children under two as "one factor" in whether a child develops obesity.

This study offers another solid reason to more carefully consider the reasons for antibiotic use and avoid it whenever possible. The findings warrant future studies that could take into account other factors that influence intestinal flora, including the use of probiotics and breast feeding. "While, broad-spectrum antibiotic use is not the sole contributor to the rise of the obesity epidemic, the availability and use of these medications certainly coincided with the rise in obesity in the US."It is somewhat reassuring that narrow-spectrum antibiotics, which are commonly prescribed for common pediatric infections, were not associated with obesity later in childhood, making the point, that targeted selection of antibiotics is ideal (US, 2014).

Complications of Obesity

Mechanical disability is one of the complications of obesity. The structure of the human skeleton is not well adapted to carry extra load, consequently flat feet and osteoarthrosis of the knees, hips and lumbar spine are common in obese people. The abdominal muscle that supports the viscera and those in the legs which help by their contractions the venous return of blood to the heart, are infiltrated with fat. Hence their mechanical actions are impaired with consequent abdominal hernia and varicose veins. Adipose tissues around the chest and under the diaphragms interfere with respiration and predispose to bronchitis.

Metabolic disorders such as diabetes mellitus arising for the first time in middle life occur commonly in the obese although many obese people escape it. Obesity tends to be associated with a high plasma cholesterol concentration and also with stones in the gall-bladder (Stanley *et al*, 1975).

Obese people sufferfrom cardiovascular disorders. High blood pleasure is more common in them than those of normal weight. The work of the heart is increased by the extra mechanical activities needed in moving the overweight body and by the increased peripheral vascular resistance in patients with hypertension. This extra load on the heart, coupled with the tendency to atherosclerosis in the coronary arteries, no doubt contributes to angina pectoris and cardiac failure among obese people in middle life.

Respiratory disorder of increased difficulty in breathing may lead to CO2 retention and subsequent somnolence. This is known as Pickwickan syndrome.

According to Sue (1994), evidences indicate strong associations between some types of cancer with dietary fat and obesity. Data showed that obese men, regardless of smoking habits, had a higher mortality from cancer of the colon, rectum and prostrate. Obese women had a higher mortality from cancer of the breast (postmenopausal), uterus (including cervix and endometrium), and ovaries as well as the gall-bladder and biliary passages. The excessive deposits of subcutaneous fat predispose to skin infection particularly at the flexures, e.g interrigo below the breasts.

Psychologically, aesthetic considerations create emotional problems to obese patients. Obese people usually have problems of binge eating and disparagement of body image among other disorders.

In view of these manifold complications, it is not surprising that obese people are poor risks from the standpoint of life insurance. According to Taylor *et al* (1997), insurance companies have calculated that a man of 45 who is 10kg overweight reduces his life expectancy by 25%. The risks are slightly less for women.

CONCLUSION

Humans are predisposed to obesity by genetic, endocrine, dietary fat, sedentary life style, psychological factors and antibiotic treatment. However, genes do not destine people to a lifetime of obesity. Although, you cannot change your genetic makeup, you can change your eating habits and levels of activity.

Complications of obesity include mechanical, metabolic, cardiovascular, respiratory disorders, cancer, reduction in life expectancy, etc. Thus, periodic assessment of individual's nutritional status by determining the body mass index; recognizing and controlling environmental cues; and engaging in physical activities are imperative.

REFERENCES

Bell, C.G, Walley, A.J. and Froguel, P. (2005). The genetics of human obesity. *Natural revolution of gene*tics **6**:221- 234.

Froguel, P., Dina, C.,Vasseur, F., Dubosi, S. and Boutin, P. (2003). GAD2 on chromosome $^{10}p^{12}$ is a candidate gene for human obesity. Public library sci biol **1**:E68.

Chatterjea, M. N. and Shinde, R. (2012). Obesity. Textbook of Medical Biochemistry, eighth edition. Jaypee Brothers Medical Publications (P) Ltd, New Delhi, India. Pp 763-768

David, B. W. and Barbara, Y. (1998).Dietary fat, genetic predisposition and obesity: lessons from animal models. *American journal of clinical nutrition*. **67**:505S-12S.

David, L.N and Michael, M .C. (2000). Long term regulation of body mass. Lehninger Principles of Biochemistry, third edition. Worth publishers, New York, USA

Dimauro, S. (2004). The many faces of mitochondrion diseases. *Mitochondrion***4**:799-807.

Farooqi, I.S and O' Rahilly, S. (2005). New advances in the genetic of early onset obesity.

*International journal of obesity***29:**1149-1152.

Farooqi, I.S., Jebb, S.A., Langmack, G., Lawrence, E., and O'Rahilly, S. (1999). Effects of recombinant leptin therapy in a child with congenital leptin deficiency.*Northern England Journal of medicine* **341**: 879-884

Farooqi, I.S., Keogh., J.M., Yeo, G.S, Lank, E.J., Cheetham, T., and O'Rahilly, S. (2003). Clinical sepectrum of obesity and mutation in the melanocrotin for receptor gene. *Northern England Journal of medicine* **348**:1085-10 95.

Friedman, J.M. (2000). Obesity in the new millennium. *Nature* **404**:632-634.

Goodpaster, B.H and Wolf, D. (2004). Skeletal muscle lipid accumulation in obesity, insulin resistances, and type 2diabetes. *Predator***5**:219-226.

Halaas, J.L., Gajiwala K.S., Maffei, M., Cohens, S.L, Chait, B. T Rabinwitz, D. (1995). Weight-reducing effects of the plasma protein encoded by the obese gene. *Sciences* **269**:543-546.

Helen, A.G., Mary, F. P and McGraw, H. (1995). Weight Control human neutrinos. New York.

Herbert, A., Gerry. P., McQueen, M.B., Heid, I.M and Christman, M.F. (2006). A common genetic variant is associated with adult and childhood obesity. *Sciences***312**:279-383.

Hirschhorn, J.N., and Daly, M.J.(2005). Genom wide associated studies for common disease and complex trait. *Natural revolution of genetics***6:**95-108.

Horton, T.J., Drougas, H., Brachey, A., Reed, G.W., Peters, J.C and Hill,

J.O. (1995). Fat and carbohydrate overfeeding human: different effects on energy storage. *American journal of clinical nutrition***62**:19-29.

Ji, H. and Friedman, I. (2007). Reduced capacity for fatty acid oxidation in rats with inherited susceptibility to Diet induced obesity. *Metabolism***56**:1124-1130.

Loos, R.J.F., Ruchat, S., Rankinen, T., Tremblay, A., Perusses, L and Bochard, C. (2007). Adiponectin and Adiponectin receptor gene variants in relation to resting metabolic rate, respiratory quotient, and Adiposity-related phenotype in the Quebec family study. *American journal of clinical nutrition***85**:26-34.

Meyre, D., Bouatia-Naji, N., Tounian, A., Samson, C and Fraguel, P. (2005).Variants of ENPPI are associated with childhood and adult obesity and increase the risk of glucose intolerances and type 2 diabetes. *Natural genetics***37**:863-867.

Meyre, D., Lecoeur, C., Delplanque, J., Francke, S, and Fraguel, P. (2004).A Genome-wide scan for childhood obesity associated trait in French families' shows Significant linkage on chromosome 6q22.31-q23.2. *Diabetes* **53**: 803-811.

Okaka, J.C., Akobundu, E.N.T. and Okaka, A.N.C. (2006).Food and human nutrition, integrated approach. OJC Academic Publishers. Enugu. Pp 347:359.

Perusse, L, Rankinen, T., Zuberi, A., Chagons, Y.C and Bochard, C. (2005).The human obesity gene map: The 2004 update. *Obese Res***13:**381-490.

Philip, A. K, Gina, B.D.G., Tong, L., Negah, R. and Gouri, R. (2003).Adiponectin expression from human adipose tissue: Relation to obesity, insulin resistance, and tumor necrosis factor- expression. *Diabetes***52:**1779-1785.

Romsos, D.R., Belo, P.S Bennink, M.R., Bergen, W. G and Levellie, G.A., (1976). Effect of dietary carbohydrate, fat and protein on growth, body composition and blood metabolite levels in the dog. *Journal of nutrition***106**:1452-62.

Stanley, D., Passmore, R., Brock, J. F. and Truswell, A. S. (1975). Obesity, human nutrition and diabetics, sixth edition. Churchill Living Stone, Edinburgh.

Sue, R.W. (1994). Energy balance and weight management essentials for nutrition and diet therapy, sixth edition. Morshy-year book, Inc.

Sutton, B.S., Langefeld, C.D., Williams, A.H., Norris, J.M and Bowden, D.W. (2005). Association of proopiomelanocortin gene polymorphism with obesity in the IRAS family study. *Obese Research***13**:1491-1498.

Taylor, D. J., Green, N.P.O. and Stout, G.W. (1997). Nutrition in humans. Biological Science, third edition. New York, UK. Cambridge, University Press. Pp 251-263.

United States (2000).Census: NHANES iii data estimates.

United States (2014).Obesity risk rises if antibiotics given before age two. Retrieved on 01/10/2014 from http://www.msn.com/en-za/health

Zhan, S. and Ho, S.C. (2005).Meta-analysis of the association of Trp64 Arg polymorphism in the beta adrenergic receptor with insulin resistance. *Obese Research***13**:1709-1719.