OBESITY & WEIGHTLOSS MANAGEMENT

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A. DEFINITION & EXPLANATION

Obesity is not simply the accumulation of excess body fat. Obesity is a chronic (long-term) disease that is difficult and time consuming to treat. As such, it requires daily treatment to lose weight and keep it off. There is no overnight solution – effective, permanent weight loss takes some time.

Obesity is a multifactorial problem, which has no single distinct cause. Only some 5% of obesity occurs secondary to a specific disease, such as a tumor of the hypothalamus, Cushing's syndrome, or Prader-Willis syndrome. Most obese conditions are due to an undetermined combination of individual, genetic, familial, environmental, physiological, and psychological factors.

Despite a better perception regarding the causes of obesity, the numbers of obese and overweight people are rising at an alarming rate. According to statistics presented at the recent European Congress on Obesity, more than 300 million people worldwide are affected by obesity. Studies evaluate that obesity rates in Europe have risen 15 percent in the past ten years, while in Japan it has doubled since 1982.

The big concern among specialists is the astounding number of obese and overweight children. In the US for instance, the percentage of obese young population has tripled in the past 25 years.

Obesity is no more an aesthetic problem. In some West Europe countries, up to 8 percent of the total healthcare budget is related to obesity and its complications. The obese condition is tightly connected to a number of severe diseases such as diabetes, atherosclerosis and other significant health problems that are causes of death.

Being very fat, or obese, is linked to many health problems including heart disease, stroke, diabetes and arthritis. And as the world population is becoming fatter, some people believe that we are in the grip of an obesity epidemic.

The finding that excess weight is becoming an epidemic, leads to the conclusion that obesity must be recognized and treated as a disease with fatal complications. Most of the prevention efforts must target the young population because obesity in children is closely associated to a high risk of developing heart disease, stroke and diabetes in later life.

"Obesity can damage the body by its mechanically and metabolically adverse effects on normal bodily function; not to mention the psychological anguish it can also bring."

Weight reduction is usually recommended for obese individuals, and for overweight persons with other health risk factors (such as, hypertension, hyperlipidemia, noninsulin-dependent diabetes, family history of diabetes, women with a history of gestational diabetes etc). Weight reduction is also recommended for overweight individuals with heart disease, gout, gallbladder disease, and in situations where excessive weight imposes a functional burden (that is, chronic obstructive pulmonary disease, congestive heart failure, osteoarthritis of the spine, hips, or knees).

Obese children and teens in order to reduce weight should avoid restrictive diets and in favour of increased activity and moderation in food intakes, allowing them to "grow into" their body weights, excessive television viewing in view of its sedentary nature can contribute to undesirable weight gains in young people. Although an overweight child or adolescent does not necessarily guarantee obesity later on in life, about 30% of obese adults developed the condition during childhood (before age 18), and 80% to 85% of obese teens eventually become obese adults. Obesity beginning early in life tends to involve a significant amount of fat cell hyperplasia, making it more difficult to control than excess weight gained later in life.

Obesity and overweight are not synonymous terms, individuals who are 20% or more overweight are obese, and body weight at this level constitutes an established health risk. Individuals who weigh 10% to 20% above the recommended range are not necessarily obese or over fat, since the body's weight may be largely composed of muscle tissues and /or bone. Some normal weight individuals are actually over fat that is the percent of body fat is undesirably high although the body weight is not above the recommended range.

Obesity is a state in which there is a generalized accumulation of excess adipose tissue in the body leading to more than 20% of the desirable weight. Obesity invites disability, disease and premature death. Excess body weight is an hindrance, leading to breathlessness on moderate exertion and predisposes a person to diseases like atherosclerosis, high blood pressure, stroke, diabetes, gall bladder diseases and osteoarthritis of weight bearing joints, varicose veins etc.

A certain amount of "adipose," that is, fat tissue, is important for insulation of the body from heat, cold and mechanical shock; to serve as a energy supply when glycogen reserves are depleted and food intake is delayed; and for protection against environmental stresses. The obese are more prone to hypertension, hyperlipidemia, noninsulin- dependent diabetes, arthritis and other chronic diseases. Obese men have a higher mortality rate from cancers of the colon, rectum and prostate; obese women from cancers of the gallbladder, biliary passages, breast (postmenopausal), uterus and ovaries, obese individuals may have shorter than normal life spans.

Mostly obesity is due to positive energy balance. That is the intake of calories is more than the expenditure of calories.

B. CAUSES OF OBESITY

Obesity is caused by ingesting more energy than is expended over a long period of time. Our bodies need calories to sustain life and be physically active, but to maintain weight we need

to balance the energy we eat with the energy we use. When a person eats more calories than he or she burns, the energy balance is tipped toward weight gain and obesity. This imbalance between calories-in and calories-out may differ from one person to another. Genetic, environmental and other factors may all play a part.

The excess calories that are consumed lead to an accumulation of body fat either by being stored as fat or preventing the mobilization and oxidation of endogenous fat. In general, ingesting 3500 kcal more (or less) than expended will lead to a gain (or loss) of approximately 1 lb of fat. Genetic factors may influence the amount of weight gained with overfeeding. In one study, weight gain varied greatly among 12 monozygotic twin pairs who were chronically overfed 1000 kcal/d. However, weight gains were very similar within each member of a twin pair. In another study, body fat gain after 8 weeks of overfeeding also varied among study subjects but was inversely related to changes in non- volitional energy expenditure, which may be determined genetically.

People come up with many reasons for being overweight, but the truth is that obesity is usually down to one of the following factors or a combination of factors such as:

- Genetics
- Eating Habits
- Physical Activity
- Environmental and Social Factors

Genetics

Obesity tends to run in families. Children with two obese parents have about 70% risk of becoming obese compared to less than 20% in children with two lean parents. This could be explained by environmental factors since families usually share the same diet, lifestyle and cultural influences. These habits tend to persist into later life. However, studies of adopted children have revealed weight patterns similar to those of their natural rather than their adopted parents and so obesity does have some genetic basis. However, some studies of genetic transmission, including studies of mono and dizygotic twins have placed the influence of genetic factors from as low as 5% to more than 50%.

In a study involving 540 Danish adoptees, a strong correlation was observed between weight category (thin, median weight, overweight, obese) of the adoptee and the BMI of the biologic parents. This relationship was present across all weight categories. In contrast, there was no relationship between weight category of adoptee and the BMI of adoptive parents.

In animal models, it has been shown that a defect in a single gene can lead to obesity. The so-called **ob** gene was first described in 1994 and was found to control the production of a protein called leptin. Genetically obese ob/ob mouse produce insufficient leptin and are hyperphagic, eating excessive quantities of food, which leads to obesity. When leptin is injected, the mice stop eating, energy expenditure increases and weight is lost. In man, the situation appears to be more complex and no single gene has been identified as the cause of

obesity. Human obesity is more likely to be the result of a multi-gene defect, which is inevitably more difficult to trace.

Genes can only exert their effect by increasing energy intake or decreasing energy expenditure, for example through a genetically determined preference for high fat foods or a sedentary lifestyle. The rapid increase in the prevalence of obesity over the last 50 years (a very short period of evolution), suggests that obesity is more strongly determined by environmental influences since the gene pool has remained essentially constant.

Eating Habits

Certain eating habits as enumerated below may lead to obesity.

- Nibbling between meals is common among housewives and is a potential cause for obesity, especially if the snacking is in addition to existing meals.
- Some may eat faster taking less time for chewing; therefore they tend to consume more food at each meal.
- Obese persons respond to external cues to eat rather than internal hunger they eat when it is mealtime or when they are surrounded by tasty foods instead of when they are hungry.
- Housewives who are fond of cooking a variety of foods or persons who are working in the kitchen may become obese due to the constant ingesting of foods.
- Business executives who frequently attend business lunches have more chances of becoming obese due to the high fat, high calorie, and commercial food preparations.
- Housewives who do not want leftover foods to be thrown out may consume these and put on weight.
- Some persons eat more food when they are unhappy as a compensation mechanism. In summary, excess food eaten beyond the body's actual needs will result in fat storage increasing in the body.

Physical Activity

People who lead an active life are much less likely to gain weight than those who spend most of their day sitting in front of a computer or the TV, or in the car. Regular exercise can help to control weight by utilizing calories and also by burning body fat reserves to meet energy and exercise needs. In addition, exercise does improve fitness too, reducing the risk of problems such as heart disease and diabetes.

Obesity doesn't develop overnight. It takes around 3,500 excess calories to gain just 1 lb (0.5kg). Few people gain more than 2 to 5lb each year. Weight fluctuates from day to day, but one should aim to stay about the same weight from week to week. If one notices a consistent increase in the weight, the person should try to stabilize weight before it develops into a serious problem. Begin by reducing the amount of calories in your diet and incorporate 20 to 30 minutes of activity into your day. A moderate 30 minutes exercise program will utilize about 200 calories, per session.

Environmental and Social Factors

Environment strongly influences obesity. Environment includes lifestyle behaviors such as what a person eats and his or her level of physical activity. Too often people eat out; consume large meals and high-fat foods, and put taste and convenience ahead of nutrition. Also, most people do not get enough physical activity.

Environment also includes the world around us – our access to places to walk and healthy foods, for Today, more people drive long distances to work instead of walking, tend to eat out or get 'take out' instead of cooking, or have vending machines with high-calorie, high-fat snacks at their workplace. People may eat too much just because food is always there. On top of that, because of our modern world – remote controlled television, drive-in banks, and escalator, it easy to be physically inactive. Our environment often does not support health habits.

Other Causes of Obesity

Ethnicity: Analysis of the prevalence of obesity in USA has indicated marked ethnic differences in the likely development of obesity, with Black and Hispanic groups at much greater risk than White Americans. Important differences also exist in fat distribution. Asian immigrants to the UK have more central fat than native Caucasians and across Europe; Mediterranean women have more central fat than Northern European women. These differences may be the consequence of genetic, cultural or socioeconomic factors or more likely, some combination of all three.

Emotions: Some people overeat because of depression, hopelessness, anger, boredom, and many other reasons that have nothing to do with hunger. This doesn't mean that overweight and obese people have more emotional problems than other people. It just means that their feelings influence their eating habits, causing them to overeat.

Gender: Men have more muscle than women, on average. Because muscle burns more calories than other types of tissue, men use more calories than women, even at rest. Thus, women are more likely than men to gain weight with the same calorie intake.

Age: People tend to lose muscle and gain fat as they age. Their metabolism also slows somewhat. Both of these lower their calorie requirements.

Pregnancy: Women tend to weigh an average of 5 kgs more after a pregnancy than they did before the pregnancy. This can compound with each pregnancy. This weight gain may contribute to obesity in women.

Medical conditions: Certain medical conditions and medications can cause or promote obesity, although these are much less common causes of obesity than overeating and inactivity. Some examples of these are as follows:

- Hypothyroidism
- Cushing syndrome

- Depression
- Certain medications
- Prader-Willi syndrome
- Polycystic ovarian syndrome

Certain drugs such as steroids, some antidepressants and some medications for psychiatric conditions or seizure disorders may cause weight gain. These drugs may slow the rate at which the body burns calories, stimulate appetite, or cause the body to hold on to extra water. Be sure your doctor knows all the medications you are taking (including over- the-counter medications and dietary supplements). He or she may recommend a different medication that has less effect on weight gain.

Obesity can be associated with other **eating disorders** such as binge eating or bulimia.

The **distribution of your body fat** also plays a role in determining your risk of obesity-related health problems. There are at least 2 different kinds of body fat. Studies conducted in Scandinavia have shown that excess body fat distributed around the waist ("apple" shaped figure, intra-abdominal fat) carries more risk than fat distributed on the hips and thighs ("pear' shaped figure, fat under the skin).

Increasing affluence itself (including many of the above factors as accompaniments of affluence) may be a cause or contributing factor since obesity tends to flourish as a disease of affluence in countries, which are developing, and becoming westernized.

Prosperity: Obesity is common in prosperous countries like UK, USSR and USA and people from higher socio-economic status of developing countries. They have the purchasing power and availability of surplus food. Obesity is rare in primitive societies and wild animals. Civilization has brought plentiful supply of appetizing foods, concentrated foods and variety of foods in the market.

Evolutionary aspects: Although there is no definitive explanation for the recent increase of obesity, the thrifty-gene hypothesis provides some understanding of this phenomenon. In times when food was scarce, the ability to take advantage of rare periods of abundance and use such abundance by storing energy efficiently was undoubtedly an advantage. Individuals with greater adipose reserves were more likely to survive famine. This tendency to store fat is likely maladaptive in a society with adequate and stable food supplies. Although many people likely have a genetic propensity towards obesity, in most cases this propensity requires the modern environment with increased caloric availability and decreased requirements for physical labor in order to be expressed fully.

Crash diets: Gimmicky fads and schemes may cause temporary weight loss due to an increase in eating awareness and a forced change in habits, yet any results are impermanent. As soon as the diet is forsaken, any lost weight is regained – usually with additional poundage. Long-term weight control requires a permanent sense of awareness and lifelong habit change. Only temporary weight loss and certain undesirable side effects-will be accomplished with erratic bursts of drastic caloric restriction.

Conclusions: Obese people should be willing to devote much time and long-term effort in order to change lifestyle habits that have contributed to the weight problem. Those who are not ready to examine and discuss these issues should be encouraged to wait until the time is right before beginning to make changes.

Focus should be on nonweight goals such as improved health and fitness, and increased self-esteem. Success is more likely when goals are reasonable and allow for a gradual adjustment in lifestyle.

Learning the approximate caloric values of common foods is one part of the education process, but food choices should not be based solely on caloric contents. Compulsive calorie counting is counterproductive. Preplanned menus should only be used to illustrate meal planning possibilities within certain caloric ranges. A predetermine diet will only serve to shift the responsibility away from the dieter onto the diet itself. Dieters need to learn how to be in control of their own eating practices and to rely on themselves to choose foods wisely.

Many individuals use food for reasons unrelated to physical needs (for example, to relieve boredom, reduce anxiety or alleviate stress). People too should explore their emotional connection to food and to determine psychological reasons for eating and overeating. To be in control of eating behaviors, People need to be able to listen to and trust body signals and to understand the difference between physical and emotional hunger.

C. ENERGY METABOLISM & OBESITY

Energy Balance

Obesity develops gradually over a period of time as weight is gained. Weight gain occurs when the amount of energy (calories) consumed as food and drink exceeds the energy, which is used for exercise and other metabolic processes of the body. This is known as **positive energy balance**. The excess energy is stored principally as fat. Each kilogram of fat stores approximately 7000 kcal. This fat can only be lost when the body utilizes more energy than is available from food and thus draws upon its energy stores. This is known as **negative energy balance**.

Energy balance is tightly regulated in most people and does not usually require conscious control. A change in life circumstances that alters either the diet (and thus energy intake) or activity (and thus energy expenditure) can lead to weight gain or loss. It is often difficult to pinpoint these changes; however, a small imbalance can lead gradually, but perceptibly, to changes in body weight and fatness.

Obesity is a condition of excess fat. In the short term small fluctuations in body weight can result from fluid retention or loss. Changes in body weight of 1 – 2 kg can be explained by short term changes in the body's water and glycogen (carbohydrate) stores. During the early days of weight loss the body burns its glycogen stores. Since each gram of glycogen binds with 3 g of water, there is a proportionally large decrease in weight relative to the energy imbalance. Conversely, following a period of energy restriction, a large meal will refill these glycogen stores plus the water associated with them. This apparent rebound in weight after a

period of weight loss can be very disheartening but is necessary part of establishing the body's physiological equilibrium.

Energy Intake

Many people are familiar with counting calories. The calorie is the unit used to describe the energy content of food and drinks. Recommended energy intakes change with age and lifestyle, but are approximately 2000 – 2500 kcal per day for adults.

Energy Balance and Obesity

Weight gain results from positive energy balance where more energy is consumed than expended and the excess is then stored, mainly as fat. This is sometimes called the **dynamic phase of obesity**. However, as weight increases the energy requirements of the body also increase.

Most obese people are in energy balance for most of the time. Although they are heavier and have more fat than is desirable for good health, their weight is stable and no longer increasing. This is sometimes referred to as the **static phase of obesity**. For an obese person to lose weight, they must achieve a state of negative energy balance, either by eating less or using up more energy. To maintain weight loss, a permanently lower energy intake and/ or higher level of energy expenditure must be maintained life-long since the reduced-weight body requires and uses less energy. Unfortunately, it seems that many or all of the body's physiological controls serve to defend weight and combat weight loss.

In evolutionary terms, the imperative is to store fat for times of food shortage. It appears that the drive to eat has a much stronger physiological basis than the signals, which indicate fullness. This is sometimes described as the 'asymmetry of appetite'. It helps to explain why weight loss and weight loss maintenance are so hard to achieve.

Energy is stored in the body in the form of **triglyceride and glycogen** within adipose tissue, liver and skeletal muscle. Triglyceride present within adipose tissue is the body's major fuel reserve. A lean adult has approximately 35 billion adipocytes. An extremely obese adult can have 4 times as many adipocytes, each containing up to twice as much lipid. Intramuscular glycogen and triglyceride provide an important source of fuel for working muscles during exercise.

Triglycerides are a fivefold better fuel per unit mass than glycogen, because triglycerides liberate 9.3 kcal/g when oxidized, whereas glycogen liberates 4.1 kcal/g when oxidized.

Human Body Adaptation to Overeating

The human body seems to easily adapt to changes in our lives and the reason for this is simply down to survival. The fact is our body must adapt in order to stand any chance of surviving sudden changes to the environment. Our body adapts to changes in eating, both overeating and under eating causes the body to adjust.

The reason why we adapt to changes in eating is again for survival reasons. For example, if we struggled to find food our metabolism gradually lowers so we no longer require as much energy for growth and maintenance. The result is we can still survive on low food intakes.

For most people food is in ample supply, the problem now is having too much. Some people become overweight by eating too much and one positive point to the obesity epidemic of today is that a majority of overweight people would have been a lot heavier if it wasn't for our body's adaptation to overeating.

The human body adaptation to overeating is basically the reverse to under eating. As we overeat and slowly gain weight it forces the body to change, we could say the changes are a by-product of an increasing body weight. This is because all weight gained will NOT be composed entirely of fat, some of the weight will be made up from extra protein deposited in cells and this is basically a gain in lean tissue. Extra lean weight will **increase the metabolism** and cause us to burn more calories than we did before the weight gain. Also, a heavier body requires more energy to move, thus we burn more energy during any movement that involves shifting body weight. Every time we walk around at home, work, go upstairs or perform many other general, physical duties we burn more energy than we did before the weight gain.

Another basic change is that the more food eaten, the more energy required to digest and absorb all the nutrients. It means if we eat more then more energy will be lost through this thermic effect.

Most obese people do not have an abnormal reduction in energy metabolism. Both total energy expenditure and resting energy expenditure are usually greater in obese than lean persons who are of the same height and gender because of greater body cell mass (both fat and fat-free cell masses) in obese people. Therefore, obese persons must consume more calories than lean persons to maintain their larger body size.

Fat Cell Theory

Several comparative studies of adipose cellularity in the obese and non – obese human show conclusively that fat accumulation in the obese occur either by strong large quantities of fat in existing adipose cells, new fat cell formation or by both.

The number of fat cells are determined early in life to provide space to store fat, once they have been formed, fat cells have a tendency to remain full of fat, supporting this notion, the juvenile onset obesity was caused by an increase in the number of fat cells while the adult onset is mainly caused by increase in fat cell size. In the massively obese (60% body fat, about 170% normal weight) almost all the fat cells have attained their hypertrophic limit. This limit is reached when the cell contains about 1.0µg of lipid per cell (normal is about 0.5 to 0.6µg) and then more cells may be recruited from the pre adipocyte pool to increase cell number. Thus in maturity onset severe obesity in which the already fat adult, becomes fatter, hyper cellularity (increasing fat cell recruitment) may accompany greatly increasing size of the existing fat cells.

The Normal fat cell number is 25-30 billion fat cells. In the extremely obese this may be as high as 260 billions.

When obese adults reduce body size there is a decrease in fat cell size, but no change in cell number. If normal body mass and body fatness are achieved then individual fat cells shrink and actually become smaller in size than the fat cells of non-obese individuals.

Set Point Theory

When reviewing the scientific literature on the success of weight loss through dieting, one is forced to conclude that on a long-term basis, dieting for many people just does not work. One can crash off large amounts of body mass in a relatively short time period by simply not eating, but this success, however, is short-lived and eventually the urge to eat wins out and body mass is regained. The reason for this failure, it is argued, lies on "set points" that differ from what the dieter would like to have. The proponents of a set point theory argue that the body has an internal control mechanism, a set point, probably located deep within the brain's lateral hypothalamus that drives the body to maintain a particular level of body fat. In a practical sense, this would be the body mass one would achieve when one is not counting calories. The problem is that we all have different set points, and various factors such as drugs, nicotine, as well as exercise, lower the particular setting- whereas dieting has no effect. Each time we manage to reduce our fat level below our "natural" set point, the body makes internal adjustments to resist this change and conserve or replenish body fat. In fact, even when a person attempts to gain weight above one's normal level by means of overfeeding the body resists this change through an increase in the eating metabolic rate.

How Does Human Metabolism Work?

Our metabolism is the rate at which the body uses energy to support all basic functions essential to sustain life, plus all energy requirements for additional activity and digestive processes.

Different body tissues have markedly different resting energy requirements. Organs that have large metabolic demands, such as the liver, gut, brain, kidney and heart have the highest energy requirements per gram of tissue. In a lean adult, these organs account for approximately 75% of resting energy expenditure, although they constitute only 10% of total body weight. In contrast, resting skeletal muscle consumes only 20% of resting metabolic rate, although it represents approximately 40% of total body weight. Adipose tissue consumes less than 5% of resting metabolic rate but usually accounts for approximately 20% of body weight.

Human metabolism is basically made up of three parts

Physical activity 20 – 25 %
Thermic effect of foods 10%

Resting body metabolism 70%

1. **Resting Metabolic Rate (RMR)**

This is the amount of calories needed to run all essential functions and chemical reactions while in a rested and quiet state. RMR is the largest part of total metabolism and accounts for 65 – 75% of calories burned in a day.

If lean weight is lost from the body though increased protein metabolism the RMR decreases. This often happens when people go on a strict diet; the body is forced into what's known as a "negative nitrogen balance" which means more protein is lost than what is replaced due to less protein/energy intake. This imbalance causes a gradual loss in lean weight thus lowering the RMR.

Many dieters limit the amount of lean weight loss with some type of intense exercise in order for muscles to develop a need to hold onto more protein forcing the body to take more energy from fat stores.

2. Thermic Effect of Food (TEF)

The body uses energy to digest and absorb the nutrients present in the food we eat. The rate of energy used for the TEF is about 10%; it can be increased depending on the composition of each meal.

The TEF causes much confusion when dieters calculate calories in and out. For example;

If we overeat the TEF actually increases due to more food to digest, the stomach and intestines have to work harder and longer. It means if we ate an extra 3500 calories (number of calories per pound of fat) we wouldn't actually gain 1 pound of body fat because the TEF has to be accounted for, we would gain less.

The opposite also happens if we cut 3500 calories to lose 1 pound. The TEF decreases because there would be less food/nutrients to process so energy expenditure would reduce thus we would lose less than a pound in weight.

Calories do count but our body has sophisticated mechanisms to balance energy within the body to enable us hold onto as much energy as possible for a time when starvation may occur!

3. Physical Activity

The amount of energy the body burns during daily activities such as recreation, work, housework, and etc. account for 20 – 40% of calories burned each day. This part will vary depending on the individual and how active they are each day. A sedentary person will require fewer calories to maintain weight than a busy worker in a construction site!

It is here where we can have the greatest effect on metabolism. The intensity, frequency and duration of any exercise activity all have an effect on metabolism.

Fat Metabolism

Fat functions as an energy reservoir. It is laid down when food is plentiful, and then converted back to energy when needed. Normal levels of fat are not a problem for the body. In fact, they're necessary for it to function smoothly.

On a basic level, people become obese when their calorie intake is higher than their calorie expenditure. However, a host of factors complicate this picture. An individual's genetics, metabolism, culture and lifestyle all have a role to play.

Where is Fat Stored in the Body?

Most fat is stored under the skin. But there is also some on top of your kidneys and inside your liver and muscles. Other body parts that gather fat depend on your gender:

- Adult men: chest, waist and buttocks
- Adult women: breast, waist, hips and buttocks

Fat tissue is made up of fat cells. These are like tiny plastic bags that hold droplets of fat. Fat cells are formed in our childhood. They start growing while we are in the womb. The next stage of generation is during puberty, when the sex hormones, estrogen and testosterone are triggered. These define the areas in which the fat cells grow.

After puberty, we do not grow any more fat cells. Our cells just expand or shrink to accommodate the fat inside our bodies. The amount of fat in the body varies from one person to another. In an adult it can be as little as about 3kg, but it can increase to an almost infinite amount.

Detailed analysis of the composition of the body has shown that a typical healthy 70 kg man has about 12 kg of fat and 58 kg of lean tissue. This lean tissue includes about 42 kg water, 12 kg protein, 3.5 kg bone mineral and about 0.5 kg glycogen (carbohydrate). Women have about twice as much fat as men of similar build. About half of the body protein is in the form of skeletal muscle, and most of the remainder is in connective tissue of skin, bones, fascia and tendons. A small proportion, about 1 kg is in visceral organs such as the heart, liver, gut and kidneys. Glycogen is contained in the liver and in skeletal muscle. When people gain weight, around three quarters will be fat and the remaining lean tissue. Only about one quarter of the lean tissue will be protein, the remaining is water.

Fat in the body can be considered in three distinct categories – structural fats, metabolic fats and storage fats**,** although there are overlaps between them. **Structural fats** form part of each and every cell in the body, mainly in the cell membrane, and include phosphoglycerides and cholesterol. **Metabolic fats** are a group of lipids which participate in metabolic processes, for example, oxidation to produce energy or the metabolic transformation into the hormone-like substances known as eicosanoids. **Storage fats** represent the bulk of the fat in the body and provide a long term energy reserve. Most storage fat is in the form of triglycerides. This fat is

derived from the diet and the precise fatty acid composition will reflect the fatty acid composition of the diet. Obesity represents a condition of excess storage fat. Approximately two-thirds of the storage fat is deposited subcutaneously (under the skin) and about one third around the visceral organs (liver, heart, kidneys etc), where it provides a protective cushion for these vulnerable tissues. Fat may also accumulate in the muscles, visible as 'marbling' in animal carcasses and also in the liver, where small globules are sometimes visible. Excessive accumulation of fat in the liver is unhealthy and may reflect an underlying disease or illness.

Quantity versus Size of Fat Cells

Fat cell numbers are different between two people yet it's possible for both to have a similar fat percentage. For example if someone had 500 million fat cells and a second person only had 300 million fat cells, these two people could both have a similar fat percentage if the second person has a sedentary lifestyle causing more fat to be stored in his/her cells. That is, the fat cells have become fuller and contain a greater volume within each cell. In this case it would result in a fat percentage higher than normal for this person but around the same as the first person with a higher number of fat cells.

Fat cells tend to increase in number most readily when excessive weight is gained due to overeating and or inactivity during the following periods;

- During late childhood and early puberty
- During pregnancy
- Most commonly, during adulthood when extreme amount of weight are gained

Body Fat Composition

Body composition is the difference between the amounts of lean body weight compared to fat weight. Body fat composition is usually expressed as a percentage of fat. The recommendation for men is 12–18% and women 20-25% body fat. Lean body weight includes all muscles, bones, skin, hair, and blood, basically everything except fat weight.

How is fat stored?

The sole purpose of a fat cell is to store small droplets of fat molecules. These fat molecules are formed as the concentrations of fatty acids in the blood rises, such as after a big meal. An increase in concentration within the blood triggers lipase enzymes located in fat tissue, to grab the fatty acids and convert them into a fat molecule (triacylglycerols) for storage.

In fact as we gain weight and become fatter, the fat cells do not multiply, rather they just store more fat molecules thus they expand to become larger. Fat cells in the human can multiply but only if fat storage cells "run out".

How fat is used?

When the body uses stored fat for energy it breaks down the contents of the fat cell via enzymes to release glycerol and fatty acids into the blood. As the circulating fatty acids reach muscle cells that require extra energy they are transported across the membrane and

into the muscle cell where the fatty acid enters the mitochondria of the cell. Mitochondria are the powerhouse of a cell; they extract energy from fat and carbohydrates to produce the cell's usable form of energy – ATP.

Where does metabolized fat go?

As fat is metabolized its energy is released when complex chemical reactions break the bonds between its basic elements. The elements are transformed to carbon dioxide and water. The metabolism of fat is a relatively slow process and oxygen must be present to complete the reaction. Oxygen supply is an important principle to understand if you want to burn fat fast!!

How can more fat be metabolized?

How much fat is burned during exercise depends on the ability of the cardiovascular system to deliver enough oxygen to the cells in sufficient time. Delivery of oxygenated blood via the arteries and capillaries speeds up as we exercise, but there are limitations. For example, many athletes can have twice as many capillaries innervating the muscles than an average person. Arteries and capillaries act like highways for oxygenated blood to travel to cells, more "highways" carrying oxygen means more fat can be burned at all times, one reason athletes stay so lean!

To speed up fat metabolism and burn off fat stores we need to supply cells with sufficient oxygen during exercise. Having billions of muscle cells all burning fat will give the benefit of greater fat loss over a shorter period of time!

There are ways to naturally increase oxygen supply to cells to encourage fat metabolism:

- Improve oxygen uptake in the lungs by performing gentle breathing exercises every day, learn to breathe in a rhythmic pattern, yoga and pranayam will be best for this!
- When exercising try to fill a greater portion of the lungs with air – many people have a habit of shallow breathing and don't use the full capacity of the lungs.
- Exhaling twice as quickly as inhaling, also pushing more air out than normal helps to expel more carbon dioxide and drive more oxygen into the blood.
- Increase fitness levels to help develop a greater number of capillaries (small veins) to the cells.

Aerobic exercise is fat metabolism?

The word aerobic means "with oxygen" it refers to exercise that is gentle enough to give muscle cells time to burn fat. When exercise is easy sufficient oxygen can be supplied without taxing the cardiovascular system.

At a low exercise pace there is a much greater chance a higher percentage of fat will be burned, however, exercising at lower levels doesn't burn many total calories that's why instructors advise longer sessions of activity. Although it wouldn't be much of a contribution to weight loss if a half hour walk only burns 100 calories even if 95% of those

calories were fat. It would be better if 300 calories were burned and still have up to 90% fat utilization.

If fitness levels are increased its possible to burn twice as many calories during the same time and still utilize a high percentage of stored fat.

D. HAZARDS OF OBESITY

Weighing too much may increase your risk for developing many health problems. If a person is overweight or obese he may be at risk for:

- Type 2 diabetes
- Heart disease and stroke
- Cancer
- Sleep apnea
- Osteoarthritis
- Gallbladder disease
- Fatty liver disease
- Digestive problems

Type 2 diabetes

Type 2 diabetes used to be called adult-onset diabetes or non insulin-dependent diabetes. Type 2 diabetes is a disease in which blood sugar levels are above normal. High blood sugar is a major cause of early death, heart disease, kidney disease, stroke and blindness.

How is it linked to overweight?

More than 80 percent of people with type 2 diabetes are overweight. It is not known exactly why people who are overweight are more likely to suffer from this disease. It may be that being overweight causes cells to change, making them less effective at using sugar from the blood. This then puts stress on the cells that produce insulin (a hormone that carries sugar from the blood to cells) and makes them gradually fail.

What can weight loss do?

You can lower your risk for developing type 2 diabetes by losing weight through diet reduction and increasing the amount of physical activity you do. If you have type 2 diabetes, becoming more physically active can help you utilize sugar as energy and control your blood sugar levels. Losing weight and exercising more may also allow you to reduce the amount of diabetes medication you take.

Heart disease and stroke

Heart disease means that the heart and circulation (blood flow) are not functioning normally. If you have heart disease, you may suffer from a heart attack, congestive heart failure, sudden

cardiac death, angina (chest pain), or abnormal heart rhythm. During a stroke, blood and oxygen do not flow normally to the brain, possibly causing paralysis or death.

How is it linked to overweight?

People who are overweight are more likely to suffer from high blood pressure, high levels of triglycerides (blood fats) and LDL cholesterol (a fat-like substance often called the "bad cholesterol"), and low levels of HDL cholesterol (the "good cholesterol"). These are all risk factors for heart disease and stroke.

What can weight loss do?

Losing 5 to 15 percent of your weight reduces your immediate chances for heart disease or having a stroke. If you weigh 90 kg, this means losing as little as 4.5 kg. Weight loss may improve your blood pressure, triglyceride, and cholesterol levels; improve how your heart works and your blood flows.

Cancer

What is it?

Cancer occurs when cells in one part of the body, such as the colon, breast etc grow abnormally or out of control and possibly spread to other parts of the body, such as the liver etc.

How is it linked to overweight?

Being overweight may increase the risk of developing several types of cancer, including cancers of the colon, esophagus, and kidney. Overweight is also linked with uterine and postmenopausal breast cancer in women. Gaining weight during adult life increases the risk for several of these cancers. It is not known exactly how being overweight increases cancer risk. It may be that fat cells make hormones that effect cell growth and lead to cancer. Also, eating or physical activity habits that may lead to being overweight may also contribute to cancer risk.

What can weight loss do?

Avoiding weight gain may prevent a rise in cancer risk. Weight loss, and healthy eating and physical activity habits, may lower cancer risk.

Sleep Apnea

What is it?

Sleep apnea is a condition in which a person stops breathing for short periods during the night. A person who has sleep apnea may suffer from daytime sleepiness, difficulty concentrating and even heart failure.

How is it linked to overweight?

The risk for sleep apnea is higher for people who are overweight. A person who is overweight may have more fat stored around his or her neck. This may make the airway

smaller. A smaller airway can make breathing difficult, loud (snoring), or stop altogether. In addition, fat stored in the neck and throughout the body can produce substances that cause inflammation. Inflammation in the neck may be a risk factor for sleep apnea.

What can weight loss do?

Weight loss usually improves sleep apnea. Weight loss may help to decrease neck size and lessen inflammation.

Osteoarthritis

What is it?

Osteoarthritis is a common joint disorder. With osteoarthritis, the joint bone and cartilage (tissue that protects joints) wear away. Osteoarthritis most often affects the joints of the knees, hips, and lower back.

How is it linked to overweight?

Extra weight may place extra pressure on joints and cartilage, causing them to wear away. In addition, people with more body fat may have higher blood levels of substances that cause inflammation. Inflammation at the joints may raise the risk for osteoarthritis.

What can weight loss do?

Weight loss can decrease stress on your knees, hips, and lower back, and lessen inflammation in your body. If you have osteoarthritis, losing weight may help improve your symptoms.

Gallbladder disease

What is it?

Gallstones are clusters of solid material that form in the gallbladder. They are made mostly of cholesterol and can sometimes cause abdominal or back pain.

How is it linked to overweight?

People who are overweight have a higher risk for developing gallbladder disease and gallstones. They may produce more cholesterol, a risk factor for gallstones. Also, people who are overweight may have an enlarged gallbladder, which may not work properly.

What can weight loss do?

Weight loss – especially fast weight loss (more than 1kg per week) or loss of a large amount of weight – can actually increase your chance of developing gallstones. Modest, slow weight loss of about 1 kg a week is less likely to cause gallstones.

Fatty Liver Disease

What is it?

Fatty liver disease occurs when fat builds up in the liver cells and causes injury and inflammation in the liver. It can sometimes lead to severe liver damage, cirrhosis (build-up of scar tissue that blocks proper blood flow in the liver), or even liver failure. Fatty liver disease

is like alcoholic liver damage, but it is not caused by alcohol and can occur in people who drink little or no alcohol.

How is it linked to overweight?

People who have diabetes or "pre-diabetes" (when blood sugar levels are higher than normal but not yet in the diabetic range) are more likely to have fatty liver disease than people without these conditions. And people who are overweight are more likely to have diabetes. It is not known why some people who are overweight or diabetic get fatty liver and others do not.

What can weight loss do?

Losing weight can help you control your blood sugar levels. It can also reduce the build-up of fat in your liver and prevent further injury. People with fatty liver disease should avoid drinking alcohol.

Digestive Problems

In obesity, the metabolic rate may slow down, resulting in poor absorption of nutrients from the gastrointestinal tract. Bowels become sluggish, and this may result in constipation. Chronic constipation may be associated with straining at passing stools and engorgement of blood vessels in the rectal area, resulting in internal or external hemorrhoids. Hemorrhoids may cause irritation and/or a burning sensation in the anal area or passing of blood in stools. Drinking enough fluids and eating vegetables may reduce this complication. In addition, incidence of colon or rectal cancers increases with obesity in both male and female populations.

Being overweight is also accompanied by poor digestion of food and having a full feeling after eating. Poor digestion may result in gas and burping. Hiatus hernia, whereby part of the stomach lies in the chest due to a defect in the diaphragm, may result in abdominal pain, gas, and heartburn. Similarly, colon polyps may develop in the lower part of the bowel due to weakness in the bowel muscles causing blood in the stools, abdominal pain, a bloated feeling, or a perforation in the bowel.

Gastroesophageal reflux or what is sometimes called GERD. This problem occurs when the lower esophageal sphincter does not close properly and stomach contents leak back-or reflux-into the esophagus.

Heavy people also tend to have higher cholesterol and low HDL levels and develop resistance to insulin.

E. ASSESSMENT OF OBESITY

There are several methods used worldwide to establish a correct weight, over weight, and obesity. Such methods include:

- Height weight
- Brocas
- Body mass
- Body fat measurement (skin fold).
- Other simple

Each of these methods are indicative, and are to be used separately and individually, since they differ marginally from each other in conclusion. Therefore to come to an assessment, use any one method.

Height Weight Range

a) Average Weight and Height of Children (6- 18years)

Average height and weight of boys and girls at different ages

For each weight a range of 2 kgs may be provided in addition to the above to account for body structure difference.

Age (Years)	Indian				European			
	Male		Female		Male		Female	
	Height (cms)	Weight (kgs)	Height (cms)	Weight (kgs)	Height (cms)	Weight (kgs)	Height (cms)	Weight (kgs)
4	98	14	96	13	102	16	102	16
5	104	16	104	15	107	19	107	18
6	118	22	117	21	112	22	112	20
7	123	24	122	24	117	25	117	22
8	127	26	126	26	122	28	122	24
9	133	30	132	29	127	31	127	26
10	138	32	138	33	132	34	132	28
11	143	35	144	36	137	37	137	30
12	148	38	150	42	142	40	144	35
13	154	42	153	44	147	43	151	40
14	161	48	155	46	152	46	158	45
15	165	52	155	48	159	51	165	50
16	168	55	155	49	166	56	165	50
17	168	59	156	49	174	61	166	51
18	169	62	157	50	181	66	167	52

1. **Height Weight Chart of Indian Adults**

Standard Height and Weight for Indian Men & Women

European adults are allowed 5 kgs additional due to larger structures.

The percentage (%) of body weight in excess of the weight range defines the degree of obesity as follows.

Height		Male weight (kgs)		Female weight(kgs)	
Cms	Inches	Min	Max	Min	Max
152	5.0	55	65	45	55
155	5.1	56	66	46	56
157	5.2	57	67	47	57
160	5.3	58	68	48	58
162	5.4	59	69	49	59
165	5.5	60	70	50	60
167	5.6	61	71	51	61
170	5.7	62	72	52	62
172	5.8	63	73	53	63
175	5.9	64	74	54	64
177	5.10	65	75	55	65
180	5.11	66	76	56	66
182	6.0	67	77	57	67

% Body weight in excess	***Degree of Obesity***
10% above standard weight	over weight
20% above standard weight	obese
50% above standard weight	severely obese
100% above standard weight	grossly obese

Brocas Index

The formula for Brocas index is height in centimetres minus 100 is equal to the ideal weight in kgs. For example if an individual's height is 163 cms or (1.63 Mtrs), then minus 100 from the height and in case the weight is in excess of 63 cms, the person is considered overweight. Experience has shown that while Brocas index is relevant as a Maximum weight for the males, for the females, from this formula – minus 5 kgs to get to the ideal weight. This method is extensively used as a rough measurement of being overweight. Thereafter 20% above ideal weight is considered obese.

Body Mass Index

In this method the weight in kgs is divided by the height in Mtrs X 2, i.e.

$$\frac{\text{Wt in Kilogram}}{(\text{Height in Meters}) \times (\text{Height in Meters})}$$

For example if an individual is 95 kilogram in weight and has a height of 1.80 mtrs, the calculation is – 95 kilograms / 1.80 x 2 (3.60 mtrs) = 26.38

WHO Reference Table for BMI

Height (cms)	BMI							
	16.0	17.0	18.5	20.0	22.0	25.0	30.0	40.0
	Thinness			Normal		Overweight		
Body Weight (Kg)								
140	31.4	33.3	36.2	39.2	43.1	49.0	58.8	78.4
142	32.3	34.3	37.3	40.3	44.4	50.4	60.5	80.7
144	33.2	35.3	38.4	41.5	45.6	51.8	62.2	82.9
146	34.1	36.2	39.4	42.6	46.9	53.3	63.9	85.3
148	35.0	37.2	40.5	43.8	48.2	54.8	65.7	87.6
150	36.0	38.2	41.6	45.0	49.5	56.3	67.5	90.0
152	37.0	39.3	42.7	46.2	50.8	57.8	69.3	92.4
154	37.9	40.3	43.9	47.4	52.2	59.3	71.1	94.9
156	38.9	41.4	45.0	48.7	53.5	60.8	73.0	97.3
158	39.9	42.4	46.2	49.9	54.9	62.4	74.9	99.9
160	41.0	43.5	47.4	51.2	56.3	64.0	76.8	102.4
162	42.0	44.6	48.3	52.5	57.7	65.6	78.7	105.0
164	43.0	45.7	49.8	53.8	59.2	67.2	80.7	107.6
166	44.1	46.8	51.0	55.1	60.6	68.9	82.7	110.2
168	45.2	48.0	52.2	56.4	62.1	70.6	84.7	112.9
170	46.2	49.1	53.5	57.8	63.6	72.3	86.7	115.6
172	47.3	50.3	54.7	59.2	65.1	74	88.8	118.3
174	48.4	51.5	56.0	60.6	66.6	75.7	90.8	121.1
176	49.6	52.7	57.3	62.0	68.1	77.4	92.9	123.9
178	50.7	53.9	58.6	63.4	69.7	79.2	95.0	126.7
180	51.9	55.1	59.9	64.8	71.3	81	97.2	129.6
182	53.0	56.3	61.3	66.2	72.9	82.8	99.4	132.5
184	54.2	57.6	62.6	67.7	74.7	84.6	101.6	135.4
186	55.5	58.8	64.0	69.2	76.1	86.5	103.8	138.4
188	56.6	60.1	65.4	70.7	77.8	88.4	106.0	141.4
190	57.8	61.4	66.8	72.2	79.4	90.3	108.3	144.4

For easy reference and calculation of BMI values corresponding to recommended cut-offs, first find the height of the individual in the left hand column. The weights given in the row for that height correspond to various recommended cut-off values for adult BMI.

Interpretation of BMI values:

- BMI< 16.00 indicates grade 3 thinness
- BMI 16.0-16.99 indicates grade 2 thinness
- BMI 17.0-18.49 indicates grade 1 thinness
- BMI 18.5-24.99 is the normal range
- BMI 25.0-29.99 indicates grade 1 overweight
- BMI 30.0-39.99 indicates grade 2 overweight
- BMI> 40.00 indicates grade 3 overweight

Skin fold measurement test

Various skin fold calipers have been devised such as the harpenders calipers, the large calipers and also the MRNL calipers to measure total body subcutaneous (under the skin) fat. The skin fold is measured at the triceps (back of the arm) abdomen, (above the hip), sub scapular (upper back) and the bicep (middle) are and the total of the four measurements in millimeter (mm) is read as percentage of body fat as against the following table.

Total skin fold measurement in mm	% of total body fat
15 – 45 mm	8 – 22 %
46 – 75 mm	23 – 30 %
76 – 150 mm	31 – 40 %
151 – 170 mm	41 – 45 %

Generally speaking Up to 22% body fat is normal and acceptable for males, up to 30% is acceptable for female. Grade I obesity is evaluated up to 40% fat and grade II obesity is evaluated up to 45% fat.

Other simple methods

They include for example the **mirror test**. In this you may simple stand nude in front of a mirror to self assess whether or not you are fat. In the **belt test**, you simply measure your stomach at the navel, and if it is larger than your upper chest measurement (above the breast in ladies) then you are over fat in the abdomen. In the **pinch test** you simply pinch the roll of flesh in the abdomen region and in case it is more than 1 inch thick, it is indicative of being over fat.

F. VARIABLES IN WEIGHT LOSS

Adipose tissue in adults consists of about 75 percent fat, 23 percent water, and small amounts of protein and mineral salts. Each kilogram of adipose tissue represents 7,000 kcal (1 pound = 3,500 kcal). An individual who consumes 100 kcal in excess daily ingests an excess of 3,000 kcal by the end of 1 month. Theoretically, this would result in a weight gain of 0.4 kg monthly, or 4.8 kg (about 10 lb) in a year. The weight gain from consistently overeating by this amount over a 5 to 10 year period would be considerable. It requires about 2 teaspoons of butter, or two 1-inch squares if fudge, or an oatmeal cookie to supply the additional 100 kcal each day.

Conversely, the loss of 1 kg of adipose tissue means that the diet would be deficient by 7,000 kcal for the total time period of the weight loss. A young women requiring 2,000 kcal a day to meet her energy needs who consumes a diet that supplies only 1,200 kcal has a weekly deficit of 5,600 kcal, and the predicted adipose tissue loss would be 5600, 7000 or 0.7 kg (1.6 pounds).

Weight loss does not always follow the predicted straight line for several reasons:

- The type of diet may influence losses. On very low carbohydrate diet rapid weight loss occurs initially due principally to losses of sodium, potassium, and water; on more conventional diet, such losses are less conspicuous.
- As weight loss continues, the basal metabolic rate per unit of active tissue mass declines, resulting in a slower rate of weight loss.
- The energy cost of activity decreases as a function of lower body weight. In weight control efforts, individual eating practices and levels of physical activity function together determine body weight and body fat. The ultimate goal of any weight loss program should be the establishment of permanent lifestyle changes in both food consumption and physical activity patterns for the attainment and maintenance of healthful body weight and fat.

- No single approach will prove successful for all overweight individuals. The factors that contribute to one person's obesity may differ from the conditions that influence another's weight problem. Thus, a weight control plan must be individualized to incorporate personal weight-related problems, needs, behaviors and lifestyle practices.

In this book, we consider Obesity & Weight Management from three aspects:

Firstly, we suggest the Diet & Exercise Chapter to those who are over weight, but not debilitating Obese (i.e., up to 50% above standard weight or up to Grade II obesity, i.e., BMI below 40) with no other obesity related risk factors (i.e., HBP, Diabetes, etc)

Thereafter, in case the individual is over 50% above the standard weight, or has a BMI above 40 and also has other obesity related ailments, then on the advice of the treating Physician, an appropriate drug related therapy may be added to the Lifestyle Change weight loss program of Diet & exercise.

Finally, in these cases where obesity is in excess of 100% over ideal weight and BMI above 40, this status has persisted for over 5 years with no success in other methods (Diet, Exercise, etc), then perhaps in these cases, surgery may prove to be the most beneficial.