# Body Composition Measures of Adult Females (19 – 34 years)

**Vijayalakshmi, M**

**(12PFN022)**

**Thesis submitted to**

**Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore- 641 043**

**In Partial Fulfilment of the Requirement for the**

**Degree of Master in Food Science and Nutrition**

**March, 2014**

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S. Kamalam

**Signature of the Supervisor**

M. Lakshmi 31/3/14

**Signature of the**
**Head of the Department**

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# I INTRODUCTION

The current population of India, with 1.21 billion people stands as the second most populous country, representing almost 17.31 per cent of the world's population, which means one out of six people on this planet live in India (www.worldpopulationstatistics.com/india-population-2013).

Every year, India adds more people than any other nation in the world to its population and in fact the individual population of some of its states is equal to the total population of many countries. As per the Census of India (2011), the growth rate of Tamil Nadu population is 6.07 per cent per year and 377.1 million people live in urban areas. There was an increase of 90.97 million males and increase of 90.99 million females (Shinde, 2011).

More than 50 per cent of India's current population is below the age of 25 and over 65 per cent below the age of 35. Health status during the young adult years has received little attention compared with adolescence. Although young adults are sometimes grouped with adolescents, the contextual influences that shape risky behavior, health outcomes and access to care changes during the young adult years. The critical health issues of young adulthood includes reproductive health, mental health, obesity and access to health care.

As the pandemic of overweight around the globe continues to rise, many developing countries face a double burden of over nutrition and under nutrition. Obesity is a global epidemic and is defined as excess fat accumulation to the extent that health is impaired.

Asians have higher upper body adiposity and higher visceral fat for a given BMI when compared with the Western population. BMI is based on only weight and height, both of which change greatly during growth and development, a high BMI can reflect increases in either fat mass or fat-free mass. Body fat percentage (BF %), and body fat distribution differs across populations (Habeeb, 2013).

Obesity has emerged as a major disorder associated with many metabolic diseases in both developed and developing countries. Although obesity has a genetic etiology, the major precipitating factor is environmental, mostly related to sedentary lifestyle and a consequence of an energy imbalance where food intake has exceeded over a considerable period. Now – a – days obesity has become

the biggest health problem, which affects a person physically and psychologically obesity has become an epidemic in many parts of the world. During the last three – decades, the greatest increase in obesity has been observed in populations that have been undergoing demographic transition, nutrition transition and socio – economic transition (Sundhera and Sidhu, 2012).

Excess adiposity is the major weight related heath concern upto the seventh decade of life but an increased lifespan indicates the importance of lean tissue loss. Fat and lean components of the body including total body water (TBW) and Fat Free Mass (FFM) are important constituents that link obesity, aging and chronic disease (NCHS, 2000).

Epidemiological studies have shown that the ideal BMI may differ for different populations. A positive association between obesity and the risk of developing type 2 diabetes has been consistently observed in many populations. In our population, an interaction between upper-body adiposity and general adiposity increased the risk at lower tertiles of BMI in both men and women (Chamukuttan *et al.,* 2003).

In developing countries obesity, which presents greater health risks, is more common among people with a higher socio – economic status, those living in urban regions and among middle-aged women. In developed countries however, obesity is increasing among all age groups, and is associated with lower socio – economic status, especially among women. Environmental factors, including family, peer group, school, neighborhood, and societal issues, can either support or challenge young people's health or well-being (Saasi, 2010).

The pathogenesis of obesity is not well understood, but is probably multifactorial, involving a complex interaction of genetic, hormonal and environmental factors. An evolutionary origin of obesity is possible, making the body store excessive amounts of energy in adipose tissue, a capacity which in earlier times was essential for survival in periods of food deprivation and for female fertility and viability of offspring. Body fatness and body size is highly related to blood pressure (http://hyper.ahajournals.org).

Malnutrition in women can result in reduced productivity, slow recovery from illnesses, increased susceptibility to infections and a heightened risk of adverse pregnancy outcomes. A woman's nutritional status has important

implications for her health as well as the health of her children (Mandal *et al.*, 2011).

The prevalence of overweight and obesity as a public health issue is well established in adult women, however, the distribution and storage of adipose tissue as well as the metabolic consequences of elevated levels of adiposity appear to be impacted by sex status. It is well established that females store greater amounts of adipose tissue compared to males, whether expressed as an absolute amount or in relation to body weight. With regard to central adiposity, comparing subcutaneous and visceral depots, women are more likely to have a larger subcutaneous deposit (Evans, 2012).

Fat mass consist of two types of fat: essential and non – essential fat. The second component of body composition, lean mass, refers to bones, tissues, organs and muscle. Essential fat is the minimal amount of fat necessary for normal physiological function. For males and females, essential fat values are typically considered to be three per cent and 12 per cent, respectively. Fat above the minimal amount is referred to as non - essential fat. It is generally accepted that a range of 10-22 per cent for men and 20-32 per cent for women is considered satisfactory for good health. Thus in most persons, Lean mass makes up 70-90 per cent of the body composition, and in adults there is a relationship between Lean mass and stature (Wells, 2007).

Regarding nutrition, both positive and negative changes in energy balance usually involve changes in both lean mass and fat mass. Generally the changes are in the same direction, though the relative contribution of lean mass and fat mass to the total weight change is dependent of the initial content of body fat.

Appetite regulation involves a complex interaction between the central nervous system, signaling peptides and hormones and the gastrointestinal tract. Many developing countries now report the onset of type 2 diabetes at young age. This trend towards younger age of onset implies a huge additional burden to the individuals and society and necessitates a lifetime approach to prevention. Weight may fluctuate throughout the day depending on the time of day, hydration status or what we are wearing. In contrast, body composition reveals the relative proportions of fat and lean mass in the body.

Body weight alone is not a definite assessment of body composition. Excess fat that is concentrated near the waist a condition generally referred to as “apple” shape greatly increase the risk of disease.

Measurement of body composition has become an important procedure in nutritional assessment. A variety of techniques have been developed which can accurately measure the two major compartments of the body, the fat free mass (FFM) and the fat mass (FM). But the golden standard methods are very expensive and require expertise.

Bioelectrical Impedance Analysis (BIA) is a widely used method for estimating body composition. The technology is relatively simple, quick, and non invasive. Using values of TBW derived from BIA, it may be possible to estimate fat-free mass (FFM) and body fat (adiposity). In addition to its use in estimating adiposity, BIA is beginning to be used in the estimation of body cell mass and TBW in a variety of clinical conditions.

A body composition within the recommended range suggests that have less risk of developing obesity-related diseases such as diabetes, high blood pressure, and even some cancers. Body composition can be seen from five different perspectives; atomic, molecular, cellular, tissues and whole body. Body composition refers to percentage of body fat, or the percentage of your total weight made up of fat mass. Alternatively, bone, connective tissue, muscle and internal organs are fat-free and termed lean mass. Lean mass is superior to fat mass and should be maintained through healthy food choices and regular exercise.

Bioelectrical Impedance Analysis (BIA) was developed in the 1960s and has emerged as one of the most popular methods for estimating relative body fat. BIA is based on the conduction of an electrical current through the body. Using the assumption of a conductive material constant resistance, and estimating the length of the conductive path from an individual’s height, total body water can be calculated from impedance measuring through the flow of a small current. Body composition is then estimated by assuming that total body water constitutes a fixed percentage of lean mass (usually 73 per cent). Bioimpedance technology is an impedance measurement technology and has great potential in clinical applications.

Bioelectrical Impedance Analyzer (BIA) produces a close estimate of fat mass in a wide range of body compositions. BIA is a non – invasive measurement of body composition and particularly useful in large epidemiologic studies. BIA has many advantages compared with other methods such as, it is inexpensive, simple, fast, safe, portable and easy to perform as well as requires minimum operating training. Instead of using the common indicators for obesity such as BMI, WC, WHR, BIA is used to determine the body fat percentage. Other obesity indicators do not measure percentage body fat because of their inability to distinguish fat from muscle (Li and Li, 2013).

Today, Bio Impedance measurements provide an important method for the non invasive investigation of tissue structure and properties for monitoring physiological changes.

The body composition analysis is the clinical assessment of tissue and fluid distribution in the human body. The body is modeled as a series of tissue and fluid compartments. Fat Mass (FM) is the total amount of stored lipids in the body and consists of the following types of fat: subcutaneous fat and visceral fat. Subcutaneous fat is located directly beneath the skin which serves as an energy reserve and acts as insulation against outside cold. Visceral fat is located deeper within the body and serves as an energy reserve and as cushion between organs.

Fat Free Mass (FFM), also known as Lean Body Mass, is the total amount of nonfat (lean) present in the parts of the body. It consists of approximately 73 per cent water, 20 per cent protein, six per cent minerals and one per cent ash. Fat free mass is further divided into body cell mass and extracellular mass: Body Cell Mass (BCM) contains all metabolically active tissue (living cells) of the body, including muscle cells, organ cells, and immune cells. BCM includes the “living” portion of fat cells, but not the stored fat lipids. BCM also includes water inside living cells. This water is called Intracellular Water (ICW). The body water is by the cell membrane into extracellular water and intracellular water. The main extracellular and intracellular electrolytes are sodium and potassium respectively. Extracellular mass contains all the metabolically inactive parts of the body, such as bone minerals and blood plasma (Tondare and Patil, 2012).

Underweight status represents depleted body fat and or lean tissue store. Chronic illness affects the absorption, metabolism or loss of nutrients may account to significant amount of weight loss resulting from the catabolism of fat and

muscle tissue. Inadequate energy and nutrient intake, which may be associated with limited food resources, emotional stress, restricted diets, lifestyle habits is the most common cause of low weight for height (http://www.epi.vmn.edu/let/pubs/adol_books.htm).

The higher percentage of body fat (above 25 per cent for women) can lead to the risk of developing life threatening chronic diseases like high blood pressure, high cholesterol, diabetes, sleep apnea, cardiovascular diseases, gallstones, osteoarthritis and certain cancers. Micronutrient deficiencies and fluid/electrolyte imbalance can lead to increased risk of anemia, low work output, fractures, illness, loss of reproductive function and serious conditions such as dehydration and starvation.

The medical complications of a very low body fat (below 20 per cent) affects almost all body functions including the cardiovascular diseases, endocrine, reproductive, skeletal, gastrointestinal, renal and central nervous systems with the possibility to develop conditions such as heart damage, gastrointestinal problems, shrinkage of internal organs, abnormalities in immune system and growth, reproductive disorders, loss of muscle tissues and damage to the nervous system.

At this juncture, it is very essential to conduct studies on body composition measures among young adult females since, not many studies have been done by using Bio Electrical Impedance. Hence the present study has been carried out with the following objectives

**OBJECTIVES**

- Assess the body composition of the selected adult females of 19-34 years.
- Assess the nutritional status of the selected subjects.
- Find association between body composition, anthropometry, and energy balance.

## II. REVIEW OF LITERATURE

The review of literature pertaining to the study entitled **"Body Composition Measures of Adult Females (19 – 34 years)** is presented under the following headings:

A. Prevalence of underweight, overweight and obesity
B. Health status and lifestyle pattern of the selected adults
C. Association of anthropometric measurements to underweight, overweight and obese adults
D. Body composition measures and methods for adults
E. Dietary changes among adults
F. Complication of underweight, overweight and obesity

### A. PREVALENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY

Underweight and overweight situations have coexisted in all countries around the world; many developing countries face the dual challenge of continuing underweight and overweight (Kim, 2010). In the short term, active under nutrition results in weight loss, a condition termed wasting or underweight. Wasting is a severe form of under nutrition, but only a small per cent of undernourished persons in the world become wasted (UNICEF, 2009). Overweight and obesity are the fifth leading risks for global deaths. Atleast 2.8 million adults die each year as a result of being overweight or obese (http://www.who.int/mediacentre//actsheet/fs3//en).

The prevalence of overweight and obesity tends to increase, accompanied by rises in non – communicable diseases which cause around two - third of all mortality. The populations of a number of countries currently undergoing health transition such as Thailand, Philippines, Singapore and Malaysia – exhibit sizeable rates of both underweight and overweight. These countries face a double burden of under and over nutrition occurring simultaneously among different population groups (Arnald and Parasuraman, 2009).

Globally, 6.7 per cent of the population is underweight, 25.7 per cent are overweight and 8.9 per cent are obese (Moore *et al.,* 2010). Obesity as one of the most neglected health problems affecting the globe (Geethanjali *et al.,* 2013). In

Northeast Saudi Arabia, it was observed that overall, 34.5 per cent of the students were overweight and 10.3 per cent were obese (Allam *et al.,* 2012).

The rising prevalence of obesity is a worldwide problem affecting not only the developed world but also developing nations such as South Africa. Excess body fat deposition is caused by an imbalance between energy expenditure and there are many genetic and environmental factors that can influence this balance (Ali *et al.,* 2009). In adults, they are associated with an increased risk of developing various non – communicable diseases ($NCD_s$), including hypertension, coronary heart disease, diabetes, stroke and some forms of cancer (Swarnalatha and Amirthaveni, 2013).

In a study conducted in Malaysia the prevalence of overweight and obesity among medical students revealed that out of 290 students who participated in the study 14.8 per cent, 15.9 per cent and 5.2 per cent were overweight, pre – obese and obese(Gopalakrishnan *et al.,* 2012). The overall prevalence of CHD was 28.3 per cent conditions of the young women's were more sever and their severity decreases with increasing age of these women. Results have been compared with recent reports from the 18 states of India (Mandel *et al.,* 2011).

Among female university students in Karachi, the prevalence of being underweight was completely high (Sirang *et al.,* 2013). The prevalence of underweight, it continues to be the most prevalent public health nutrition problems in the regions of Bangladesh, Nepal and India (Balarajan and Villamor, 2009).

In India which has more undernourished people than any other country in the world, a new problem is emerging, obesity, especially among children and teenagers. Experts warn that diabetes and heart disease could rise dramatically in the next 25 years unless government tackles the person. In India 20 per cent of adult population is overweight (CESCR, 2008).

More than one – quarter of women in Punjab, Kerala and Delhi are overweight or obesity. Tamilnadu and Goa also have a high prevalence of overweight and obesity (more than 20 per cent). Less than 10 per cent of women in 12 states are overweight or obesity, including most states in central, east and northeast regions of the country (www.http://text.nlm.nih.gov).

According to NFHS –3 in India, overweight and obesity are three times higher in urban areas than in rural areas are more common among women (Swarnalatha and Amirthaveni, 2013). The proportion of men who are overweight or obese is lowest in Nagpur and highest in Hyderabad (25 per cent). Overweight or obesity among women ranges from 19 per cent in Nagpur to 39 per cent in Chennai. Even in slum areas, however overweight and obesity are major problems (www.http://text.nlm.nih.gov).

## B. HEALTH STATUS AND LIFE STYLE PATTERN OF ADULT FEMALES

Health status of women is a matter of great concern in the contemporary world, since multiple roles played by women give rise to serious health and nutritional problems. The health of Indian women is intrinsically linked to their lifestyles. Physical inactivity resulting in decreased energy expenditure and over fatness is a major cause for deteriorating health status (Patel, 2013).

The morbidity and health status of a population indicates the actual wealth of a nation. Quality nutrition is a pre requisite in maintaining good health. Choosing foods from various food groups in adequate amounts combined with the right amount of physical activity is the key to health (Ramesh and Vinod, 2013). The behavioral pattern established during developmental periods help determine young people's current health status and their risk for developing Chronic Disease in adulthood (Lawrence *et al.,* 2009).

One of the possible reasons for the rise in prevalence of obesity in South Africa is the migration of population from rural to urban areas, which has been shown to be associated with significant lifestyle changes particularly the increased availability and therefore consumption of caloric dense and fatty food (Pieter and Vorster, 2008). Irregular diet and restaurant visits more than once a week and a family history of obesity increased the risk of overweight and obesity (Selvaraj and Sivaprakasam, 2013). The findings of this study indicated that consumption of processed and ready to eat categorized foods was increasing even in rural populations (Rathnamma and Prakash, 2013 and Swarnalatha and Amirthaveni, 2013).

Study results of Patel (2013) reveal that difference in the type of lifestyle in urban and semi urban region play important role for the health status of adult's females. Lack of physical activity is associated with an increase in the prevalence of overweight and obesity (Gaba *et al.*, 2009). According to TanSijie *et al.,* (2012) the effects of supervised exercise training was studied at the exercise intensity at which the maximum fat oxidation occurred in the body composition and cardio respiration function in overweight young exercise prescription for overweight young females.

Nutritional status may also be defined as a result of interaction of body composition, energy balance and body functionality. Body composition assessment in terms of lean body mass and fat mass is the best long term indicator of nutritional status. The occupationally sedentary women are prone to obesity (Kaur *et al.*, 2012). To multiply the effects of physical activity on human health, if is recommended to increase moderate physical activity to above 300 minutes or vigorous physical activity above 150 minutes a week, eventually to suitably combine these. Implementing exercise programme and events is essential to increase physical and psychological health status of students (Habib *et al.,* 2012).

Age was found to be a crucial factor associated with anthropometry and body composition of the subjects. Preservation of muscle mass and prevention of sarcopenia through appropriate diet and exercise can be a useful strategy to increase functional independence and to decrease the prevalence of age associated chronic diseases among populations with sedentary life (Kaur *et al.*, 2012, Bala and Verma, 2013).

## C. ASSOCIATION OF ANTHROPOMETRIC MEASUREMENTS TO UNDERWEIGHT, OVERWEIGHT AND OBSE ADULT FEMALES

Anthropometric measurements of human body reflect changes in morphological variation due to inappropriate food intake or malnutrition. Waist circumference is a sensitive indicator to detect obesity. Asian Indian phenotypes have high body fat with relatively less BMI, less than body mass and marked abdominal obesity (Kaur *et al.*, 2012). South Asian women appear to have higher fat mass at the same levels of BMI as women from other ethnicities (Jackson *et*

*al.,* 2009). Body mass Index and waist circumference are the most common part of the metabolic syndrome, it has been shown that peripheral fat deposition is associated with less severe, and central obesity related to more severe, cardiovascular disease.

Saranya and Kowsalya (2013) reveal that diabetics with normal BMI showed higher waist hip ratio and visceral fat area was higher in normal, overweight and obese diabetics. Waist circumference (WC) is an important component of the most recent and frequently applied diagnostic criteria for the metabolic syndrome. However, measuring WC doesn't reliably between a large waist due to increase in subcutaneous adipose tissue versus visceral fat; this distinction requires CT or MRI (Fauci *et al.,* 2008)

The risk can be determined by measuring waist circumference and by calculating a waist to hip circumference ratio. In general, a waist to hip circumference ratio >0.9 for men and >1.0 for women carries an increased risk for morbidity. (Pischon *et al.,*, 2008). Leahy and Siobhon, 2011 showed that fat tissue mass, and its distribution to be age and sex specific.

Funkunaga *et al.,* (2013) showed that data obtained from normal Japanese youth and revealed the extent that maturation influences anthropometry and body composition. This may contribute to enabling us to discern specific abnormal growth in anthropometry and body composition, which can be associated with increased risk of some chronic disease. However, body mass index (BMI), the metric used to quantify obesity, does not adequately represent fat tissue mass (FTM); a metric that quantifies obesity according to FTM is required. (Leahy and Siobhan, 2011)

## D. BODY COMPOSITION MEASURES AND METHODS FOR ADULTS

Body Composition refers to percentage of body fat, or the percentage of total weight made up of fat mass. Alternatively, bone connective tissue, muscle and internal organs are fat free and termed lean mass. Lean mass is superior to fat mass and should be maintained through healthy food choices (Ross, 2010). Obesity may not be as high in India as in the West, but the body composition and metabolism of Indians makes them especially prone to adiposity and its

consequences. Body composition varies among individuals as a result of difference in the body density and degree of obesity (Venkatramana, 2009).

For a given BMI Asian Indians have higher body adiposity and higher visceral fat (Braulio *et al.,* 2010). The distinction of fat has importance in determination or risk. A central distribution of fat, as is more typical of men, carries a higher risk for morbidity. A more peripheral distribution, as in hips and thighs in women, carries a lesser risk (Pischon *et al.,* 2008). In adults risk factors for metabolic disease includes the body composition parameters are total body fat and fat distribution.

Promoting weight with fat lean mass loss should be implicated because muscle is important tissue in the body particularly from a metabolic standpoint (Josse, 2011). Greater muscle mass is associated with increased strength and power, as well as better metabolic health and decreased risk for chronic disease.

Body composition reveals the relative proportions of fat and lean mass in the body. Essential fat is the minimal amount of fat necessary for normal physiological function. For males and females essential fat values are typically considered to be 3 per cent and 12 per cent, respectively. Fat above the minimal amount is referred to as non essential fat. It is generally accepted that a range of 20-32 per cent for women is considered satisfactory for good health. Bone mineral content (BMC) is differs for men and women. The age related loss of BMC is greater in women (Esmat, 2012).

**1. Bioelectrical Impedance**

The bioelectrical impedance method works by meaning the speed of low electrical currents as they pass through the body. Since fat is resistant to the flow of electrical current, higher amounts of body composition will resist the flow of the current. This method is easy, fast and expensive. This method can be inaccurate if water balances are low such as during dehydration or following heavy exercises; the stomach and bladder need to be empty (Dana *et al.,* 2008).

2. **Skin Fold Thickness**

Calipers are used to pinch the subcutaneous fat at several locations such as the back of the arm, abdominals and thighs. This method is prescribing that the amount of subcutaneous fat is in direct proportions to the total body fat. This method is fast and inexpensive, and it is fairly easy, provided the inaccurate if the person performing the skinfold thickness test is not properly trained this method can usually be obtained through doctor, personal trainers and some gyms.

3. **Underwater Weighing**

The underwater weighing method uses the difference between the height and weight underwater to figure out body density. The premise is that the denser the fat by this method. This is accurate, but does have its limitations. It cannot be used for anyone who cannot hold breath for a determined period of time and it cannot be used for children.

4. **Air Displacement (Otherwise known as Bod Pod)**

The air displacement method places an individual into a closed chamber and measures the air displacement calculation. Body density; its premise is the denser you are the less fat you have. This method is accurate and easier on the test subjects than the underwater weighing method, but it is expensive and availablility may be in an issue.

5. **Dilution**

The dilution method is typically injected, but can occasionally be ingested depending on the testing site's method of use; it measures the concentration of a water soluble substance in the bloodstream. Its premise is the more of the substance that has mixed with body's water, the less body fat and greater amount of lean tissue is present. This method is accurate; it is expensive, it is invasive; and it may involve radioactive substances.

6. **Dual Energy X Ray Absorptiometry (DEXA)**

The dual energy X-ray absorptiometry or DEXA uses X-rays to measure body composition. One X-ray can accurately measure bone mineral mass, total body

mass and total percentage of body fat. DEXA is accurate but very expensive. It requires the individual to lie still for the length of the X-ray and it does not differentiate between visceral fat and subcutaneous fat.

**7. Computerized Tomography (CT)**

Computerized tomography uses X-rays to literally visualize the amount of fat and lean tissues. This method is useful for measuring the total amount of visceral fat and subcutaneous fat, but it is very expensive.

**8. Magnetic Resonance Imaging (MRI)**

The magnetic resonance imaging method or MRI uses magnetic fields to create an image of the internal body. It is highly accurate; it measures visceral fat; and it is expensive, but easier to access than some of the other more accurate methods.

**9. Ultrasound System**

The Ultrasound test was conducted via the body matrices pro system. Scans were done with the gelled wand placed at a $90^0$ angle at the abdomen, chest/ pectorals and thigh for males and thigh, triceps and suprailliac for females. These locations are used in the prediction equations supplied by the manufacturer in their software. Care was taken to avoid compression of the subcutaneous fat as the wand was removed in a small circle over the locations to provide local averaging. Until the machine read the scan. After the scans were performed and confirmed as read, participant were then categorized depending on training history into standard, athletic, or elite fitness for the percentage body fat determinations (Johnson, 2012).

Air Displacement Plethysmography (ADP) may provide a partial alteration to body density ($B_d$) and therefore body composition measurement compared to conventional hydro densitometry ($H_d$). The ADP system has the potential of providing an accurate and practical method of quantifying body fat.

## E. DIETARY CHANGES AMONG ADULTS

Dietary habits of young adults are affected by the fast food market. As a consequence, overweight and obese are increasingly observed among the young. Obesity in combination with unhealthy lifestyle, such as smoking and physical inactivity, may increase the risk of chronic diseases. (Yahia *et al.,* 2008). Poor eating habits and limited physical activity can likely increase the risk for osteoporosis, obesity, hyperlipidemia, diabetes and cancer later in life (Franko *et al.,* 2008)

Consumption of refined and fast foods along with the lifestyle modification and stress has compounded to the problem of premenstrual syndrome in majority of women. Various studies have pointed out that there are alterations in iron, calcium and magnesium levels among women with and without premenstrual syndrome (Suba and Devi, 2013).

Verma and Bala, 2013 study reveals that fifty percent people were followed five meal patterns. Among them most of them were obese. The dietary survey revealed that cereals, GLV and fats and oils, sugars were consumed on it daily basis by all the respondents. Increasing prevalence of obesity and insulin resistance in Urban Asian Indian young adults. Nutritional strategies for reducing Saturated Fatty Acid intake and balancing the omega – 3 / omega – 6 Poly Unsaturated Fatty Acids ratio should be urgently applied in Asian Indians (Gupta *et al.,* 2010).

Breakfast is considered to be an important daily food meal and skipping breakfast can cause deficiency of nutrients substances which are required for the brain; with subsequent reduction in mental function and their study reveals that lack of appetite, and time were the most important factors for skipping breakfast (Selvi *et al.,*2013 and Wilson, 2013). Identifying eating disorders, early and ensure students acquire healthy eating attitudes early is likely to have a positive effect in later years (Lalla, 2013).

Overweight and obese should focus on energy balance with lifestyle modifications designed to reduce daily energy intake and increases physical activity (Dhir *et al.,* 2013). When energy intake is greater than energy expenditure

the balance between energy input and energy output can be quantity of dietary intake, environmental and genetic inputs and physiological and psychological status will affect this balance (Ali *et al.,* 2009).

## F. COMPLICATIONS OF UNDERWEIGHT, OVERWEIGHT AND OBESITY

Nutritional problems are substantial in every state in India, but they are particularly widespread in several adjoining states in central and eastern India. More than 40 per cent of women are too thin in Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh and Orissa. In 13 states, more than 35 per cent of women are too thin. (www.htt://text.nlm.gov). Obesity is a serious disease that is associated with an increased risk of diabetes, hypertension, heart disease, stroke and cancer, among other diseases (Nirav and Eric, 2012).

Anaemia, common in Indian women having under nutrition with various diseases. neuropathy organic foods, mainly uncooked vegetables, fruits, sprouts, without added preservatives, salt, sugar, spices increases alkalinity of blood estimates toxins and highly beneficial to constitute protective nourishment. (Pal and Baski, 2013)

China today leads the world with its largest number of diabetes subjects (92 million) with report to any other given country followed by India (40.9 million). It has been established that in India, this number is expected to increase to 69.9 million by the year 2025. (Cruz and Matthay, 2009). Excess abdominal fat has shown to be strongly associated with increased risk of many obesity related conditions including insulin resistance type II diabetes, dyslipidemia, hypertension, the metabolic syndrome & CVD's (CDC, 2011).

Younger women in the age of 30 – 35 years are prone to diabetes because of sedentary lifestyle and wrong eating habits, according to a study. Population in western India tends to eat fried food and no fruits, due to which several people are seen to be at higher risk of diabetes and obesity. The International Diabetes Federation (IDF) estimates that currently 2, 85 million people around the world have diabetes mellitus which is expected to rise to 438 million within twenty years. Each year further seven million people will develop diabetes mellitus (Eckel *et al.,* 2010).

Coronary Heart Disease (CHD) incidence has increased irrespective of gender, age and swelling area. Positive associations have been established between body mass index, waist circumference, blood pressure, stress, life style and coronary heart disease. (Chauhan and Acri, 2013). Dyslipidemia is known risk factors for atherosclerotic cardiovascular disease and it appear that regional fat distribution play a role in determining the type of dyslipidemia present in an individual. The study determines the relationship between Nigerian populations (WHO, 2011).

# III METHODOLOGY

The methodology adopted in the study entitled, **"Body Composition Measures of Adult Females (19-34years)"** is dealt under the following headings:

A. Selection of area and subjects.
B. Formulation of interview schedule for data collection.
C. Assessment of nutritional anthropometry
D. Assessment of nutritional status of selected individuals.
E. Assessment of body composition of adult females using bioelectrical impedance analysis.
F. Computation of energy balance.
G. Interpretation and analysis of data.

## A.SELECTION OF AREA AND SUBJECTS:

The area selected for the study was Coimbatore district. For the conduct of the study, female subjects in the age group of 19-34 years who are studying and working in Avinashilingam Institute for Home Science and Higher Education of Women as well as women from outside the institution were selected.

The investigator explained the purpose, method and significance of the study to the institution authorities, students and concerned personnel to motivate them to extend their cooperation for the study. The selected adult women (N=200) were initially screened for underweight, normal, overweight and obesity. Oral and written consent was obtained from the participants through informed consent process (Plate 1).

## B. FORMULATION OF INTERVIEW SCHEDULE FOR DATA COLLECTION

The interview method of collecting data involves presentation of oral- verbal stimuli and reply in terms of oral- verbal responses. A specially designed interview schedule was used by the investigator to collect information on socio-economic background, health history, lifestyle pattern and dietary pattern of individuals (Kothari, 2011) (Appendix – I and Plate 1).

The socio- economic background included details on family size, type of family, birth order, occupation of the head of the family and monthly income. Information on health included family history, age of menarche of the individual and problems during menstrual cycle. The schedule contained questions pertaining to the life style pattern of the adult females. The dietary pattern was assessed comprehensively through the schedule which included questions regarding number of meals consumed in a day, foods consumed out of home, details on habit of skipping meals, food pattern during diseased conditions and consumption pattern of fast foods. The interview schedule was administered to all the 200 adult females and the data was collected.

### 1. Obtaining Ethical Clearance for the study

The application form explaining the experimental design and protocols used in the research study was submitted to the Institutional Human Ethics Committee (IHEC) Ethics Clearance of Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore was obtained (Appendix - II). The approval number for the same is AUW/IHEC-13-14/XPD-06 and the approval letter is given in Plate 1.

## C. ASSESSMENT OF NUTRITIONAL ANTHROPOMETRY

Nutritional anthropometry is measurement of human body at different age levels and degree of nutrition. Anthropometric measurements tell about the size and shape of the body. Growth retardation may be first response of the body towards nutritional deficiencies while appearance of clinical signs may be the final stage (ICMR, 2010).

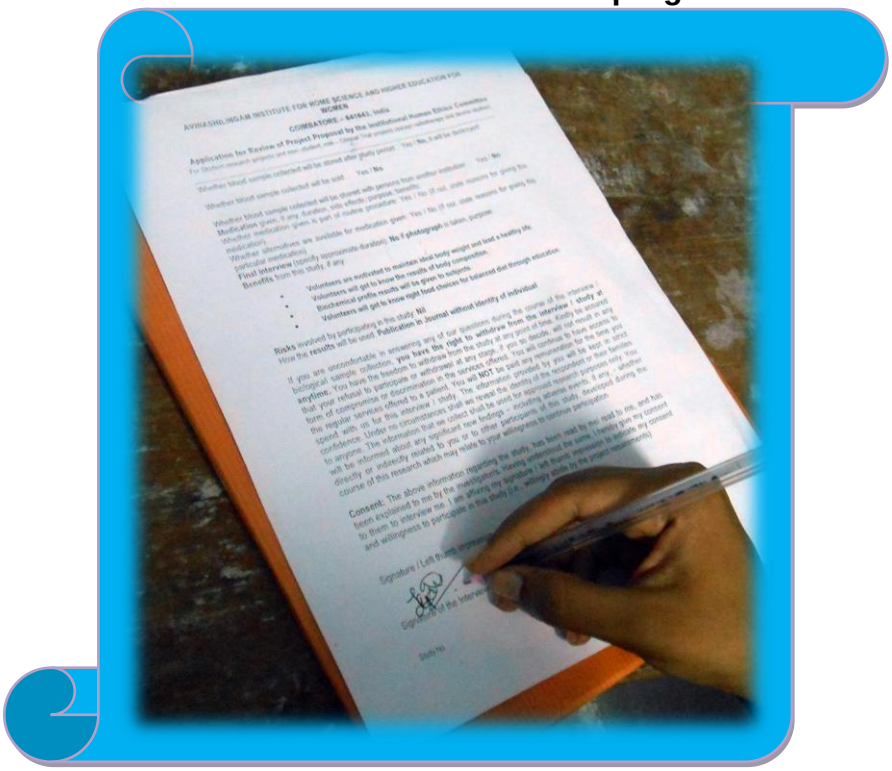
Anthropometric measurements of human body reflect changes in morphological variation due to inappropriate food intake or malnutrition (Srilakshmi, 2010). The following anthropometric measurements were taken.

### 1. Weight

Body weight is the most widely used and the simplest reproducible anthropometric measurement for the evaluation of nutritional status. It indicates the body mass and is a composite of all body constituents like water, mineral, fat,

# DATA COLLECTION

## Informed Consent Process in progress



## Filling Questionnaire

**Plate 1**

protein, bone, etc. Its potential is perceived not only by the health personnel, but also by the community, both the educated and illiterate alike (Bamji *et al.,* 2009).

### a. Measurement of weight

For measuring body weight, beam or lever actuated scales, with an accuracy of 50-100g, are preferred. Digital weighing scales are also available in India. However, it is essential that any type of weighing scale should be tested periodically for its accuracy with known standard weights (Plate 2).

## 2. Height

The height of an individual is influenced both by genetic and environmental factors. The maximum growth potential of an individual is decided by hereditary factors. The environmental factors, such as nutrition and morbidity, determine the extent of achievement of the genetic potential. Inadequate dietary intake and /or infections reduce nutrient availability at cellular level resulting in growth retardation. During periods of severe deprivation, linear growth rate slows down and leads to stunting in an individual. Since height is affected only by long-term nutritional deprivation, it is considered as an index of chronic or long-duration malnutrition (Bamji *et al.,* 2009).

### a. Measurement of Height

In adults, height is measured with a vertical measuring rod (anthropometer or Stadiometer). The subject should stand erect on a leveled surface, without shoes, looking straight with heels together and toes apart. The anthropometer rod should be placed behind the subject in the centre of the heels perpendicular to the ground. The investigator standing on the left side of the subject should firmly hold the chin of the subjects with his/ her left hand Frank horizontal plane. The moving head piece of the anthropometer should be placed in the sagital plane over the head of the subject applying a slight pressure to reduce the thickness of hair. The reading should be taken when the anthropometer rod is still in position. An average of three successive measurements is taken as the final measurement (Plate 2).

### 3. Body Mass Index (BMI)

Body fat can be estimated from Body Mass Index (BMI). BMI provides a reasonable indication of nutritional status of adults. It may also be used as an indicator of health risk (Low *et al.,* 2009). The BMI was calculated for all the subjects using the formula given below

$$BMI = \frac{\text{Weight in kg}}{\text{Height in m}^2}$$

### 4. Measurement of Waist Circumference

Waist circumference was measured using fire reinforced plastic tape. The tape should pass mid way between the lower rib margin and iliac crest. Adult women with > 88 cm considered as having abdominal obesity. The Asian cut offs for the adult women is 80cm (Plate 2).

### 5. Measurement of Hip Circumference

Hip circumference was measured with tape passing over maximum protuberance on buttocks (Plate 2).

### 6. Waist to Hip Ratio (WHR)

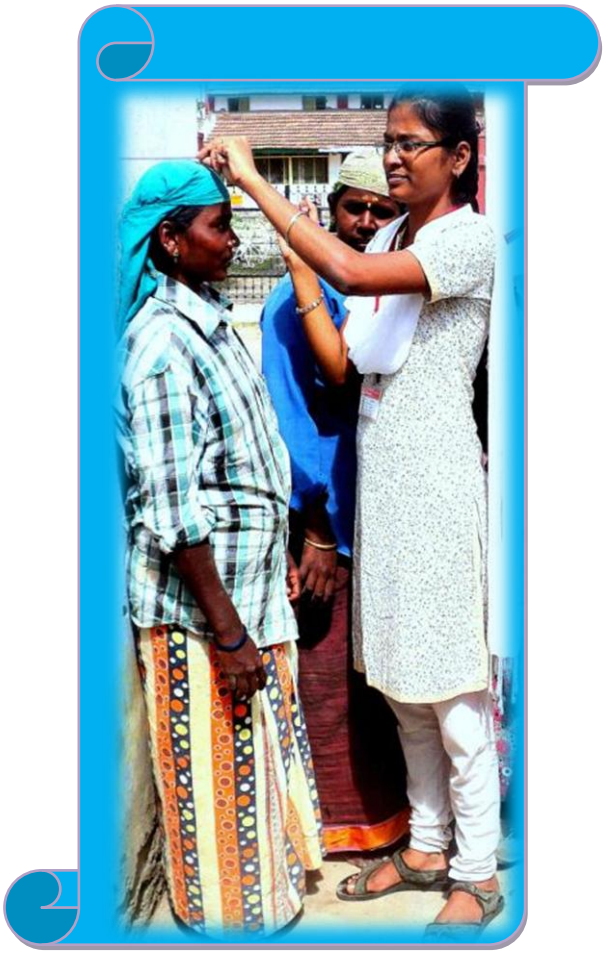
The predominant distributions of fat in an obese person whether in the upper part or the lower part of the body may determine the disease pattern. The ratio

of waist to hip ratio is an indicator of central obesity. The standard waist hip ratio (WHR) is 0.85 in women. The Waist Hip Ratio of adult females was calculated using the following formula (ICMR, 2010).

$$WHR = \frac{\text{Waist Circumference (cm)}}{\text{Hip Circumference (cm)}}$$

## ANTHROPOMETRIC MEASUREMENTS

### MEASUREMENT OF HEIGHT



### MEASUREMENT OF WEIGHT

### MEASUREMENT OF WAIST CIRCUMFERENCE

### MEASUREMENT OF HIP CIRCUMFERENCE

**Plate 2**

From the nutritional anthropometry data of 200 subjects, it was found that 23 per cent (n=46) of adult females were underweight, 36.5 per cent (n=73) were normal, 16 per cent (n=32) were overweight and 24.5 per cent (n=49) were obese. Based on their willingness given to participate in the study, sixty subjects were chosen for the indepth body composition studies.

## D. ASSESSMENT OF NUTRITIONAL STATUS OF SELECTED INDIVIDUALS.

The sixty volunteered subjects were further subjected to nutritional status assessment was done for the subsample of sixty subjects. Therefore sixty of them were selected for the further body composition and biochemical analysis.

### 1. Biochemical tests

Biochemical tests are useful tools not only for assessing nutritional status but also for deriving estimates of nutrient requirements. Biochemical tests can be conducted in easily accessible body fluids such as blood and urine. An ideal biochemical test should be specific, sensitive and indicative of tissue depletion at an early stage but not immediate dietary intake.

Biochemical test reveals current health status of the selected subjects. Biochemical tests namely haemoglobin test and measurement of blood glucose level were done. It helps to diagnose deficiency diseases at the subclinical stage.

### a. Blood Glucose

Blood samples (0.02ml) were collected using finger prick method for all the sub samples by using Glucometer (Plate 3).

### b. Blood Haemoglobin

Haemoglobin is a useful index to assess the overall nutritional status irrespective of its significant role in anaemia. Blood samples (0.02ml) were collected using finger prick method from all the subjects and analyzed for their haemoglobin using cyanomethaemoglobin method (Plate 3).

## 2. Food and nutrient intake

For a 24 hour recall, individuals were asked a series of questions systematically to ensure recollection and description of all food and drink consumed in the 24 hour before the interview, with an emphasis on the food consumption meal – by – meal and looking for day – to – day and seasonal variations.

24 hour recall method was used to obtain details regarding the food intake of the selected individuals. The nutrient intake was calculated for individuals using the 'Nutritive Value of Indian Foods' (ICMR) and compared with Recommended Dietary Allowances (ICMR, 2010).

## E. ASSESSMENT OF BODY COMPOSITION OF ADULT FEMALES USING INBODY720 ANALYZER - BIOELECTRICAL IMPEDANCE ANALYZER (BIA)

Nutritional assessment using anthropometry is now increasingly augmented through additional measurement of BIA. This technique is used to predict body composition based on the electrical conductive properties of the human body. The body composition of the selected sixty adult females was assessed using 'Bio Space, InBody720 – the precision body composition analyzer'. It works on the principle of Bioelectrical Impedance Analysis (BIA) (Plate 4).

### Principle

BIA is based on the concept that electrical flow is facilitated through hydrated fat free body tissues and extracellular water compared to fat tissue because of the greater electrolyte content (lower electrical resistance) of the – fat – free component. Consequently, impedance to the flow of electrical current will be directly related to the quantity of body fat.

InBody720 (1-1000 kHz; a Multifrequency bioelectrical impedance method) device that differentiates body weight into three components – total body water (Intracellular and Extracellular), dry mass (proteins and minerals) and body fat. The technology employs 8 contact electrodes (2 are positioned on the palm and on the thumb, another 2 are on the front part of the foot and on the foot's heel )

# BIOCHEMICAL ANALYSIS

**Finger Prick Method**

**Addition of Drapkins solution**

**Estimation of hemoglobin**

**Glucose estimation using Glucometer**

**Plate 3**

that enable us to analyze 5 basic body part ( left and right upper limb, trunk, and left and right lower limb ) independently from each other.

It was ensured that the subjects were well hydrated and had not carried out any physical exercise in the previous four to six hours. Further, it was ascertained that they had not consumed alcohol, caffeine or diuretics in the past 24 hours besides they were not suffering from fever and electrolyte imbalance. The subjects were asked to present themselves without food and water consumption for measuring their body composition. The subject was asked to remove any metal item on the body before getting onto the machine in order to diminish any alterations in the measurements. The subject was given electrolyte tissue to clean wipe their feet and palm before the test. The subject was then asked to stand on the analyzer by adjusting her foot in such a way that are placed correctly on the two electrodes provided near the feet and the weight is recorded. The subjects name, age, height and gender were entered by the user. Two electrodes are provided for the left and the right arm. The subject was asked to hold the electrodes by placing the thumb and the four fingers in the space provided and the subject was asked to stand motionless till the test done. Once the analysis is complete, the subject's result sheet is printed out (Plate 4).

**1. Body composition analysis**

InBody720 gives quantitative value for the various body compartments which equals the weight of each compartment, when added together they equal the person's weight. The values can be compared with the 'normal' values. A sample result sheet of the body composition analysis is attached (Annexure III) (Plate 4).

**a. Total Body Water (TBW)**

InBody 720 measures TBW separating it into intra-cellular and extra – cellular water.

Intra- Cellular = Water in the cells (Muscles are cells, so high muscle mass = high cells= high intracellular water).

Extra- Cellular = Water outside the cells (also high if intracellular water is high).

Total Body Water = All the water in the body and is 60 percent of total weight.

**b. Protein**

Protein consists of nitrogen and is the component of soft lean mass. A lack of protein implies a lack of muscle and / or poor nutrition.

**c. Mineral**

InBody720 analyzes two groups of minerals: osseous mineral and non-osseous minerals. Osseous mineral is bone mineral whereas non- osseous minerals are those found in all other parts of the body. Osseous mineral accounts for about 80 percent of the body's total minerals.

Mineral mass is closely related to soft lean mass. If you have more lean mass, the weight of bones strengthen which in turn, increase the bone mineral. InBody720 gives an estimate of bone mineral which has been validated against dual energy X - ray absorptiometry (DEXA). It can be used as a screening tool to detect changes in bone mineral. Low bone mineral is associated with osteoporosis.

**d. Body Fat Mass (BFM)**

Body Fat Mass can be stored under the skin, as well as in the abdomen. When a person's body fat mass is higher than the standard range, they are clinically obese. 100 per cent normal Body Mass refers to the Body Fat Mass that a person should maintain for his/ her standard weight.

## BODY COMPOSITION ANASLYSIS

**InBody720 Body Composition Analyzer**


**Entering the data required for analysis**

**Body Composition Analysis in progress**

**Plate 3**

**e. Weight (kg)**

Weight consists of body water, protein, mineral and body fat mass.

Weight = Total Body Water + Protein Mass + Mineral Mass + Body Fat Mass. The 100 per cent normal weight refers to the ideal weight for a person given his/ her height. It is calculated using the BMI standard weight calculation method. Ideal weight differs from target weight.

| | |
|---|---|
| BMI ideal weight calculation Method ideal weight (kg) | = Ideal BMI x Height$^2$ ($m^2$) |

**f. Muscle – Fat Analysis (kg)**

The Muscle – Fat analysis consists of a comparison of weight, skeletal muscle mass, and body fat mass.

**g. Skeletal Muscle Mass (kg)**

100 per cent normal Skeletal Muscle Mass (SMM) refers to the quantity of Skeletal Muscle Mass for a person's standard weight. There are different types of muscle namely cardiac muscle, visceral muscle and skeletal muscle. However, it is the quantity of skeletal muscle that is the most changed through exercise. As such, InBody 720 displays skeletal muscle mass separately from soft lean mass.

**2. Application of Results to Subjects**

The picture below shows the application of results to subjects. Different body types, based on a balanced body composition


In the case of this body type, the body composition graphs form a slightly curved 'D'. This is the Ideal Body Composition state

At the opposite end of the health spectrum, we find the following graph shape, a ‘C’ shape. In this case, the person’s weight is within the normal range. However their muscle mass is low and body fat mass is high. This person may be recommended to achieve a ‘D’ shape by losing Body Fat Mass while gaining SMM.

This type is exemplified by a person whose weight is within the standard range, but yet cannot be regarded as being in ideal health. For this type, the length of the SMM graph is shorter than the standard range. An examinee of this type will also exhibit a ‘C’ shape. However, this person should be identified as having a weak body, and as being obese. People who belong to this type usually lack exercise or proper nutrition. This person may be recommended to achieve a ‘D’ shape by gaining SMM and examining their diet.

If a person displays a straight line, it shows that the values are below the normal range. They would be underweight and have a weak body. Poor nutrition like this, continuing for a long period of time, may result in health problems. However, body fat not only has energy – storing function in our body but also assists the absorption of fat soluble vitamins, and maintains healthy skin and hair. In addition, it is an essential building block for cell membranes. Therefore this person needs to be careful not to lose more body fat.

Athletes are usually included in the overweight muscle type. As such, such people can easily be included in the obese category when BMI alone is used. This person does not need to undertake weight control measures.

### 3. Obesity Diagnosis

InBody 720’s Obesity diagnosis uses BMI (Body Mass Index) and PBF (Percent Body Fat) to determine obesity levels.

#### a. BMI (Body Mass Index, kg/ $m^2$)

The formula is BMI = Weight (kg) / Height ($m^2$). BMI has been applied in the general medicine, dietary, and sports medicine fields as the main means of diagnosing obesity. However, this method is flawed and cannot be applied to adults with high levels of SMM. Children, pregnant females and those over the

age of 65. Also there can be occasions when weight is normal, but fat mass is too high and muscle mass is too low. BMI will not detect this as being a health issue.

**b. Percent Body Fat (per cent)**

Percent Body Fat indicates the percentage of body fat to body weight.

Percent Body Fat (per cent) = Body Fat Mass (kg) / Body Weight (kg) x 100.

The standard range of Per cent Body Fat for males is 10-20 per cent, and 18-28 per cent for females.

**c. Waist – Hip Ratio (WHR)**

Waist – Hip ratio (WHR) is determined by dividing the waist circumference at the line of the navel by the maximum hip circumference. It is a useful indicator for looking at the distribution of body fat. InBody 720 uses its impedance index to provide an estimation of persons WHR. Males and Females found to 0.95 and 0.90 respectively in WHR are considered to suffer from abdominal obesity.

Adults who have abdominal obesity tend to have excessive visceral fat (increased fat stored around the abdominal organs internally) and this has been linked with an increased risk of developing cardiovascular disease, high blood pressure and diabetes in later life.

**d. Lean Balance**

There are two bar graphs for each body part in the lean balance graph. The two graphs have different meanings. The number at the end of the upper bar graph is the amount in kg of soft lean mass in each area.

If the upper bar graph reaches 100 per cent, it means that the person has ideal soft lean mass for his or her ideal weight. If the lower bar graph reaches 100 per cent, it denotes the ideal soft lean mass for the person in relation to his or her actual weight. The number besides the lower bar graph shows that ratio as a percentage.

**e. Visceral fat**

Visceral fat is the fat potentially stored around your abdominal organs and a high visceral fat over a long period of time puts a person at a greater risk of

developing Cardiovascular disease, type 2 diabetes, high lipids and hypertension. It is related to high percentage body fat and high waist hip ratios.

**4. Weight Control**

The target weight set by the InBody720 is different from the ideal weight. This is because an ideal weight only considers the height, whereas target weight also takes into account soft lean mass and body fat mass.

The reality is that two people of the same height and weight who have different body composition will have different target weights.

**5. Fitness Score**

Every body starts off at 80; you lose points for too much fat or too little muscle, and gain points for more muscle. Used as a motivational scoring tool. As body composition changes with exercise, the fitness score should increase.

**6. Body Composition History - Additional Data**

**i. Obesity Degree**

Obesity Degree is the percentage above or below ideal weight. Normal range allows for 10 percent above or below – i.e. 90-110 per cent. Therefore this person is 3 per cent under ideal weight.

**ii. BCM (Body Cell Mass)**

Body Cell Mass is the amount of cells in the body. A screening tool to monitor reduction in muscle mass due to muscle wasting process secondary to disease or poor nutrition.

**iii. BMC (Bone Mineral Content)**

Screening tool to monitor bone mineral. Linked to osteoporosis especially relevant to women reaching the menopause. Weight bearing exercise and weight lifting exercise has been shown to improve bone mineral. Those people with high skeletal muscle mass have higher bone mineral. BMC has been validated by DEXA.

### iv. BMR (Basal Metabolic Rate)

Base Metabolic Rate (BMR) is the minimum amount of energy required to sustain vital functions whilst at rest. InBody uses a formula based on fat free mass rather than just height and weight. This is more accurate and reflects the effect of gaining muscle mass and the resultant increase in BMR when people take up more exercise.

### v. DRV (Daily Reference Value)

When individuals prepare the menu for their diet, based on the necessary daily amount of energy record, InBody720's BMR function can be very useful.

**Daily reference Value = BMR X Activity factor**

**Activity Factors Used Account for the Thermic Effect of Exercise**

| | |
|---|---|
| Confined to bed | 1.2 |
| Ambulatory, low activity | 1.3 |
| Average activity | 1.5 ~ 1.75 |
| High activity | 2.0 |

### vi. AC (Arm Circumference)

Estimation of the circumference of the upper part of the left arm.

### vii. AMC (Arm Muscle Circumference)

Estimation of the circumference of the upper muscle of the left arm. The soft lean mass of the upper arm is the fastest reflection of an individual's nutritional status and also tells us about where people store fat under the skin as subcutaneous fat.

## F. COMPUTATION OF ENERGY BALANCE

The regulation of body weight is dependent on a balance nutrient intake and utilization, although there are some other important factors. In the regulation of energy balance, nutrient intake and energy (E) expenditure are related in the formula (Eastwood, 2003).

$$\Delta E = E_{in} - E_{out}$$

### 1. Resting Energy Expenditure (REE)

Basal Metabolic Rate (BMR) indicates the minimum energy required to sustain vital functions while at rest. InBody720 makes it possible to estimate BMR using a known regression equation based on FFM. FFM is known to be closely related to BMR.

BMR is usually calculated using indirect calorimetry, which in turn, employs oxygen demand. However, InBody720 calculates BMR based on Fat Free Mass as follows:

**REE = 21.6 X FFM (kg) + 370 (FFM = Fat Free Mass, kg)** (John and Cunningham, 1991)

The PAL values proposed by ICMR expert group (2010) was used for calculation of PAL of individuals, sedentary or light activity lifestyle – 1.53, active or moderately active lifestyle – 1.8, vigorous or vigorously active lifestyle – 2.3.

### 2. Energy intake

The actual food intake of the selected sixty subjects was determined from twenty four hour recall method. The energy intake was calculated for the individuals after calculating the carbohydrate, protein and fat intake using the nutritive value of Indian Foods (ICMR, 2010).

From the above data, the energy balance was calculated by finding the difference in the energy intake and energy expenditure of the individuals.

## G. INTERPRETATION AND ANALYSIS OF DATA

The data was consolidated and tabulated in which mean, standard deviation and percentage were computed. The data was analyzed using the software SPSS version 15.0. Comparisons were made between various parameters of four groups using t – test. Correlation between anthropometric measurements, body composition parameters, and biochemical parameters were derived using Karl Pearson's co – efficient of correlation. Probability at both 0.05 and 0.01 levels of significance was considered to draw conclusions.

## RESEARCH DESIGN

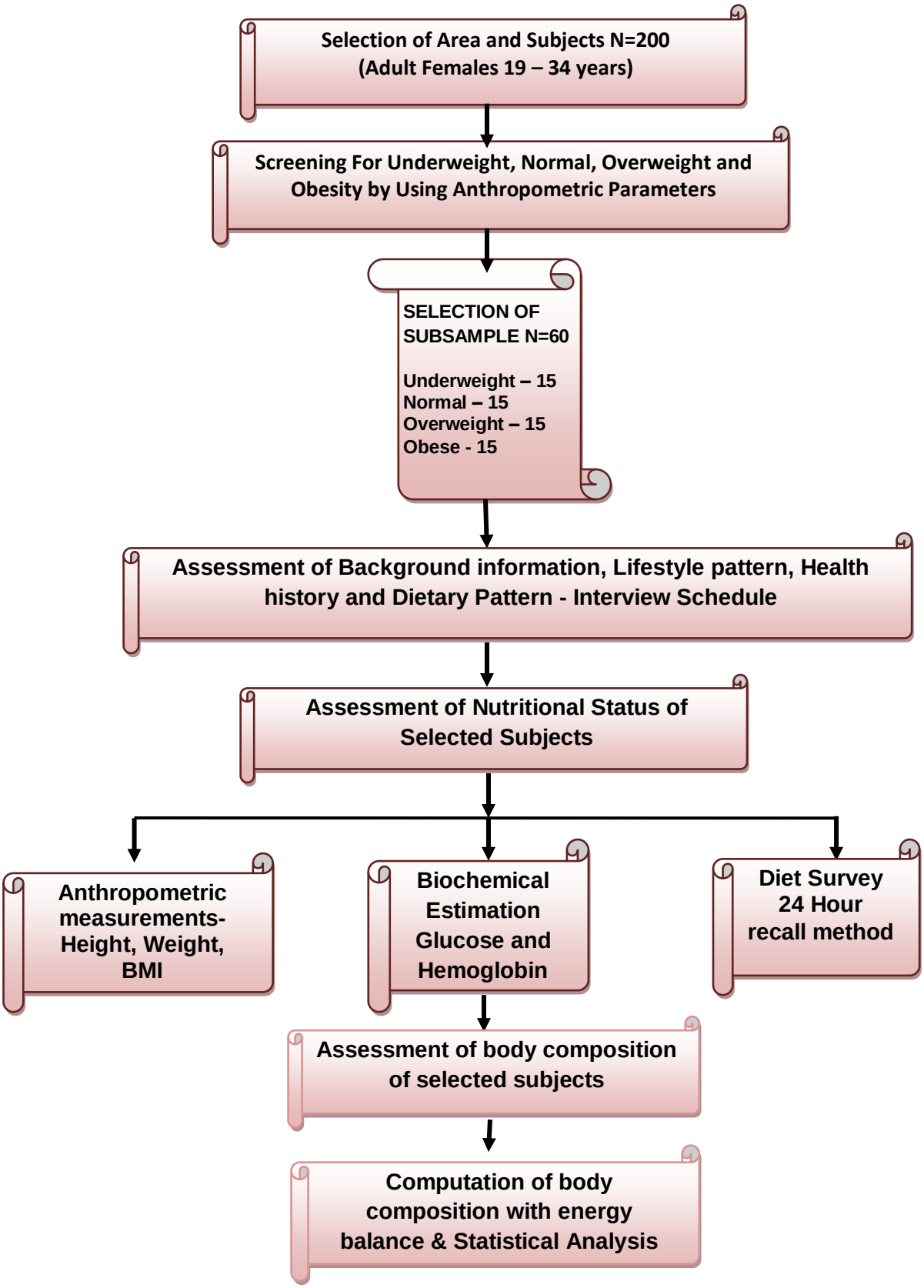



Figure 1

## III RESULTS AND DISCUSSION

The results pertaining to the present study entitled "**Body Composition Measures of Adult Females (19 – 34 years)"** are presented and discussed under the following headings:

A. BMI category with age distribution.
B. Socio – economic background and health history of the selected subjects.
C. Lifestyle pattern and dietary pattern of the selected subjects.
D. Modification of dietary habits among selected subjects.
E. Nutritional status of the selected subjects
F. Body composition parameters of the selected subjects
G. Energy balance of the selected subjects

### A. BMI CATEGORY WITH AGE DISTRIBUTION

### 1. BMI category with age distribution

Table I gives the BMI category of subjects with distribution age and also represented in Figure 2.

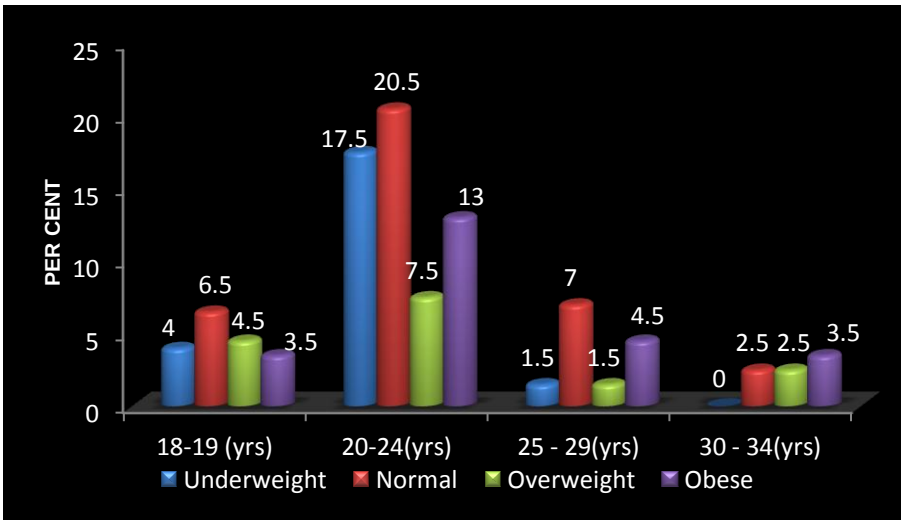
**TABLE I**
**BMI CATEGORY WITH AGE DISTRIBUTION**

**N = 200**

| Age (years) | Underweight | | Normal | | Overweight | | Obese | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % |
| 18 – 19 | 8 | 4 | 13 | 6.5 | 9 | 4.5 | 7 | 3.5 | 37 | 18.5 |
| 20 – 24 | 35 | 17.5 | 41 | 20.5 | 15 | 7.5 | 26 | 13 | 117 | 58.5 |
| 25 – 29 | 3 | 1.5 | 14 | 7 | 3 | 1.5 | 9 | 4.5 | 29 | 14.5 |
| 30 – 34 | - | - | 5 | 2.5 | 5 | 2.5 | 7 | 3.5 | 17 | 8.5 |

Among the college students, most of them were doing Post Graduation and Master of Philosophy and they belong to the age groups of 20 – 24 years and 25 – 29 years. It is evident from the above table that 58.5 per cent of the subjects were under the age group of 20 – 24 years, 18.5 per cent of them were 18 – 19 years and 25 – 29 years were only 14.5 per cent.

**Figure 2**
**Age Distribution with BMI of selected subjects**




## 2. Incidence of underweight, overweight and obesity among selected subjects

A total number of 200 adult females in the age group of 19 – 34 years were screened for underweight, overweight and obesity using anthropometric measurements namely height, weight , BMI and Waist Hip Ratio (WHR) as parameters. The results are presented in Table II.

**TABLE II**
**INCIDENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY AMONG SELECTED SUBJECTS**

**N=200**

| BMI CATEGORY | Asian cutoff value* | NUMBER | % |
|---|---|---|---|
| Underweight | <18.5 | 46 | 23 |
| Normal | 18.5-22.9 | 73 | 36.5 |
| Overweight | 23-24.9 | 32 | 16 |
| Obese | >25 | 49 | 24.5 |

(Low *et al., 2009),* http://apps.who.int/bmi/index.jsp?intropage=intro_3html

Body mass Index is an anthropometric measurement to distinguish the incidence of underweight and overweight and obese category. It is evident from the above table that 23 per cent of adult females were underweight, 36.5 per cent were normal, 16 per cent were overweight and 24.5 per cent were obese. The results are related to a study which was conducted by Sangeetha and Sindhu,

(2013), in which 23.01 per cent of subjects underweight and 15.25 per cent were overweight.

## B. SOCIO – ECONOMIC BACKGROUND AND HEALTH HISTORY OF THE SELECTED SUBJECTS.

### 1. Socio – Economic Background of Selected Subjects

The personal details of the individuals are presented in Table III

**TABLE III**

**PERSONAL DETAILS OF THE SELECTED SUBJECTS**

| Details | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | | Total N=60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Religion** | | | | | | | | | | |
| Hindu | 14 | 93.3 | 12 | 80 | 10 | 66.6 | 14 | 93.3 | 50 | 83.4 |
| Muslim | - | - | 1 | 6.7 | 1 | 6.7 | - | - | 2 | 3.3 |
| Christian | 1 | 6.7 | 2 | 13.3 | 4 | 26.7 | 1 | 6.7 | 8 | 13.3 |
| **Type of family** | | | | | | | | | | |
| Nuclear | 9 | 60 | 12 | 80 | 10 | 66.7 | 9 | 60 | 40 | 66.7 |
| Joint | 6 | 40 | 3 | 20 | 5 | 33.3 | 6 | 40 | 20 | 33.3 |
| **Birth Order** | | | | | | | | | | |
| **1** | 7 | 46.6 | 4 | 26.6 | 7 | 46.6 | 7 | 46.6 | 25 | 41.7 |
| **2** | 6 | 40 | 10 | 6.7 | 3 | 20 | 6 | 40 | 25 | 41.7 |
| **3** | 1 | 6.7 | 1 | 6.7 | 4 | 26.7 | 1 | 6.7 | 7 | 11.6 |
| **> 4** | 1 | 6.7 | - | - | 1 | 6.7 | 1 | 6.7 | 3 | 5 |
| **Family size** | | | | | | | | | | |
| 1 – 4 | 11 | 73.3 | 10 | 66.7 | 8 | 53.4 | 11 | 73.3 | 40 | 66.7 |
| 5 – 7 | 4 | 26.7 | 5 | 33.3 | 7 | 46.6 | 4 | 26.7 | 20 | 33.3 |
| > 8 | - | - | - | - | - | - | - | - | - | - |

Socio – economic factors influences health status of the population. Religion may influence the food intake and it may be stated that 83.4 per cent of the subjects were Hindus, 3.3 per cent were Muslims and 13.3 per cent were Christians. The results are related to findings of Shrivastava *et al.,* (2013), where 87 per cent of subjects were Hindus by religion.

In nuclear family, priority is more among the child and food intake was relatively higher compared to joint family because of many children, there is no priority so it will influence the health status of the population. In the present study around 66.7 per cent of the subjects belonged to nuclear family and 33.3 per cent belonged to joint family, and also 66.7 per cent of their family members were 1 to 4 number and 33.7 per cent of their family members were between 5 to 7 in number.

Birth order plays an important role to develop obesity as well as underweight among population, because first child always get more preference among parents. The data depicts that the subjects were born at first and second order was 41.7 per cent both. Around 11.6 per cent of the subjects were born at third or more than fourth order.

The socio – economic background of the selected subjects is presented in Table IV and in Figure 3.

**FIGURE 3**
**Occupation of the Head of the families**

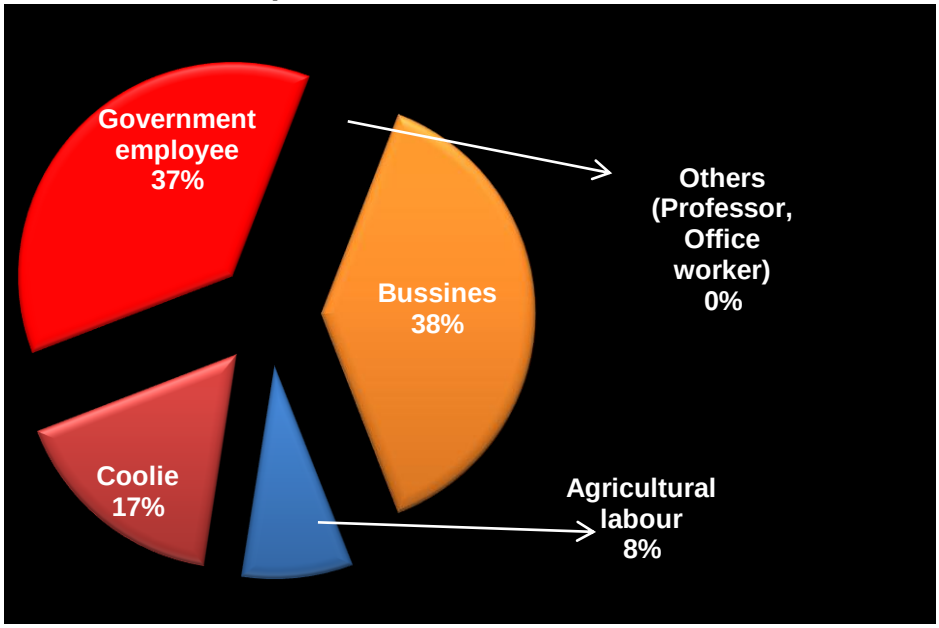


**TABLE IV**

**SOCIO – ECONOMIC BACKGROUND OF SELECTED SUBJECTS**

| Details | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | | Total N=60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Occupation of the head of the family** | | | | | | | | | | |
| Agricultural | - | - | - | - | 5 | 33.3 | - | - | 5 | 8.3 |
| labour | 2 | 13.3 | 5 | 13.3 | 1 | 6.7 | 2 | 13.3 | 10 | 16.7 |
| Coolie | 7 | 46.7 | 3 | 46.7 | 5 | 33.3 | 7 | 46.7 | 22 | 36.7 |
| Government employee | 6 | 40 | 7 | 40 | 4 | 26.7 | 6 | 40 | 23 | 38.3 |
| Business | - | - | - | - | - | - | - | - | - | - |
| Others | | | | | | | | | | |
| **Monthly income (Rs)** | | | | | | | | | | |
| 3000 – 5000 | - | - | 2 | 13.3 | 3 | 20 | - | - | 5 | 8.3 |
| 5000 – 10,000 | 3 | 20 | 4 | 26.7 | 5 | 33.3 | 3 | 20 | 14 | 25 |
| >10,000 | 12 | 80 | 9 | 60 | 7 | 46.7 | 12 | 80 | 40 | 66.7 |
| **Occupation of the Subjects** | | | | | | | | | | |
| Sedentary work | 15 | 100 | 15 | 100 | 15 | 100 | 15 | 100 | 60 | 100 |

Monthly income will influence the purchasing power of the foods as it is directly related to the nutritional status of the members. It is noticed from the above table that 38.3 per cent of head of the family are involved in business, 36.7 per cent were government employees, 16.7 per cent were coolie workers and 8.3 per cent of them were agricultural labourers. Sedentary activity lifestyle results in obesity and overweight of individuals. It is revealed that all the subjects were doing sedentary activity like studying and teaching. A growing number of population urban women are following sedentary lifestyle and a gradual slowing down of metabolic rate (Kaur *et al.*, 2012) is observed.

## 2. Health History Pattern of Selected Subjects

Table V and Figure 4 depicts the family history about illness pattern of selected subjects.

**TABLE V**
**FAMILY HISTORY ABOUT ILLNESS PATTERN OF SELECTED SUBJECTS**
**N=60**

| Details* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Family history** | | | | | | | | |
| Obesity | 2 | 13.3 | 1 | 6.7 | 3 | 20 | 2 | 13.3 |
| Diabetes Mellitus | 3 | 20 | 6 | 40 | 3 | 20 | 11 | 73.3 |
| Hypertension | 2 | 13.3 | 1 | 6.7 | 5 | 33.3 | 5 | 33.3 |
| Cardio Vascular Disease | 1 | 6.7 | 1 | 6.7 | 2 | 13.3 | 3 | 20 |
| Arthritis | - | - | 3 | 20 | 4 | 26.7 | 2 | 13.3 |
| Cancer | - | - | 2 | 13.3 | 1 | 6.7 | 1 | 6.7 |
| No illness Observed | 8 | 53.3 | 6 | 40 | 5 | 33.3 | 1 | 6.7 |

*Multiple responses

Family history of illness will reflect on the health of their children. It is essential to know about their parents and grandparents illness history, it will protect them to avoid such type of health complaints in future years for them. In 53.3 per cent of the underweight subjects family history did not reveal any health complaints in their family and also 40 per cent of the normal weight subjects were also not exposed to any health complaints.

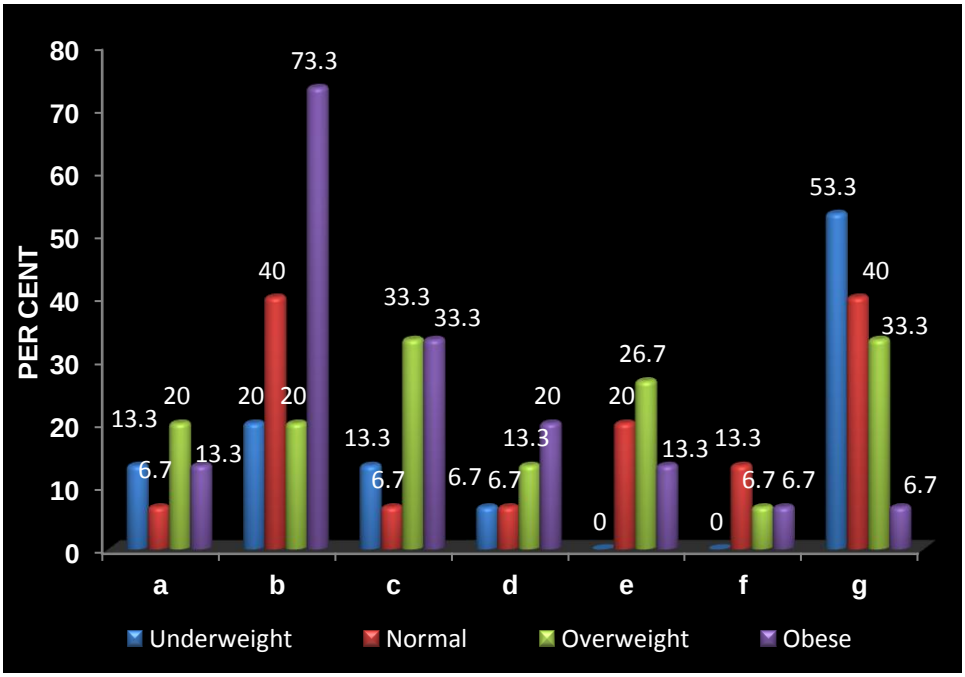
Overweight and obesity is a genetic factor if their parents have their children receiving opportunity was more. It is evident from the above table that 20 per cent of the overweight subject's family history showed obesity and 13.3 per cent of both obese and underweight subject's family history also showed obesity in their family history.

Even though diabetes mellitus is not a communicable disease, if their parents or relatives have there is a more chance for getting diabetes mellitus. In the above table diabetes mellitus was seen in 73.3 per cent of the obese subject's family history and 40 per cent of the normal weight subject's family history.

Hypertension is the foremost prevailing condition among population. It is highly related to their environmental situation and their mental changes. In the above table 33.3 per cent of the obese as well as overweight subject's parents and their grandparents showed hypertension. Arthritis was seen among elderly people. Around 26.7 per cent of the overweight subject's family history showed their exposure to arthritis and also 20 per cent of the normal subjects also revealed the condition.

**FIGURE 4**

**Family Health History of the subjects**




**a. Obesity** **c. Hypertension** **e. Arthritis**
**b. Diabetes mellitus** **d. Cardiovascular disease**
**f. Cancer** **g. No illness occurred**

Table VI represents the health history of the selected subjects.

**TABLE VI**

**HEALTH HISTORY OF THE SELECTED SUBJECTS**

**N=60**

| Details | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Recent illness occurred *** | | | | | | | | |
| Fever | 6 | 40 | 1 | 6.7 | 2 | 13.3 | 3 | 20 |
| Gastro Intestinal Disturbances | 1 | 6.7 | 1 | 6.7 | 1 | 6.7 | 1 | 6.7 |
| Food Poisoning | 1 | 6.7 | 1 | 6.7 | - | - | 1 | 6.7 |
| Jaundice | 1 | 6.7 | 2 | 13.3 | 6.7 | 6.7 | - | - |
| Others | - | - | 1 | 6.7 | - | - | - | - |
| No recent illness | 8 | 53.4 | 13 | 86.6 | 73.3 | 73.3 | 10 | 66.7 |
| **Age of Menarche** | | | | | | | | |
| <11 | - | - | - | - | 3 | 20 | 4 | 26.6 |
| 12 | 1 | 6.7 | 4 | 26.6 | 8 | 53.4 | 2 | 13.3 |
| 13 | 4 | 26.6 | 5 | 33.3 | 4 | 26.6 | 8 | 53.4 |
| 14 | 5 | 33.3 | 6 | 40 | - | - | 1 | 6.7 |
| 15 | 5 | 33.3 | 3 | 20 | 6 | 40 | 3 | 20 |
| **Problems during Menstruation *** | | | | | | | | |
| Excessive bleeding | 1 | 6.7 | 1 | 6.7 | 1 | 6.7 | 2 | 13.3 |
| Irregular menstruation | 1 | 6.7 | 4 | 26.6 | 1 | 6.7 | 3 | 20 |
| Physical discomfort | 6 | 40 | 1 | 6.7 | 2 | 13.3 | 6 | 40 |
| $PVOD_s$ | - | - | - | - | - | - | 2 | 13.3 |
| Other problem | - | - | 2 | 13.3 | - | - | - | - |
| No problem | 7 | 46.7 | 7 | 46.7 | 11 | 23.3 | 4 | 26.6 |

*Multiple responses (PVODs **-** Polycystic Ovarian Disease Syndrome)

Women are the nature's gift to their family as well as nations. It is important to preserve their health status. In the above table it is shown that 86.6 per cent of the normal and 53.4 per cent of the underweight subjects not given away any health complaints. Approximately 40 per cent of the underweight subjects and 20 per cent of obese subjects had recently suffered with fever. Only 13.3 per cent of subjects had suffered from jaundice. Menarche is an important milestone in the development of female. It is considered a distinct benchmark for sexual maturation. It is apparent from the above table that 53.4 per cent of the overweight and obese subjects had attained their menarche at the age of 12 and

13. Around 40 per cent of the overweight and normal subjects had attained their menarche at the age of 15 and 14. It correlates with Khatoon and Verma (2011) study which shows that age of menarche as 15 for their subjects.

Hormonal changes may influence menstrual cycle and may end ups in giving compliant during menstruation. It is clear from the above table that 46.7 per cent of the underweight and normal subjects did not report any problem during menstruation. Around 40 per cent of the obese and underweight subjects had reported physical discomfort during menstruation.

## C. LIFESTYLE PATTERN AND DIETARY PATTERN OF THE SELECTED SUBJECTS

### 1. Stress Pattern and the Management of Stress by the Selected Subjects

Now – a – day's stress makes one uncomfortable to eat and work naturally thereby affecting dietary intake. Around 46.7 per cent of the underweight subjects showed family stress and 40 per cent of the normal subjects also suffer the same. Around 33.3 per cent of the overweight subjects suffered by occupational stress and 33.3 per cent of underweight and normal subjects were having other personal stresses which they were not ready to reveal.

Stress management is a good remedy to maintain mind healthy. In normal and obese subjects stress was managed by hearing music in 46.7 and 53.4 per cent respectively. Around 40 per cent of the overweight subjects sleep was a mode to reduce stress. Around 33.3 per cent of the obese subjects were shouting while they are in stress. Around 6.7 per cent of the normal subjects used dancing as a means to manage stress.

### 2. Lifestyle Pattern Adopted by the Selected Subjects

The lifestyle pattern of the subjects is discussed in Table VII.

**TABLE VII**

**LIFESTYLE PATTERN ADOPTED BY THE SELECTED SUBJECTS**

| Details | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | | Total N=60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Mode of travel** | 5 | 33.3 | 5 | 33.3 | 11 | 73.4 | 6 | 40 | 27 | 45 |
| Walk | 9 | 60 | 7 | 46.7 | 2 | 13.3 | 2 | 13.3 | 20 | 33.3 |
| Bus | - | - | - | - | - | - | 2 | 13.3 | 2 | 3.3 |
| Bicycle | 1 | 6.7 | 3 | 20 | 2 | 13.3 | 5 | 33.4 | 11 | 18.3 |
| Others | | | | | | | | | | |
| **Sleep in day per hours** | | | | | | | | | | |
| < 6hrs | 1 | 6.7 | 1 | 6.7 | 5 | 33.3 | 5 | 33.3 | 12 | 20 |
| 6 – 8 hrs | 14 | 93.3 | 14 | 93.3 | 9 | 60 | 10 | 66.7 | 47 | 78.3 |
| > 8 hrs | - | - | - | - | 1 | 6.7 | - | - | 1 | 1.7 |
| **Habit of sleeping in the afternoon** | | | | | | | | | | |
| Daily | - | - | 3 | 20 | 1 | 6.7 | 1 | 6.7 | 5 | 8.3 |
| Weekends | | | | | | | | | | |
| Sometimes | 3 | 20 | 2 | 13.4 | 1 | 6.7 | 2 | 13.3 | 8 | 13.3 |
| Once in a week | 4 | 26.7 | 5 | 33.3 | 3 | 20 | 1 | 6.7 | 13 | 21.7 |
| No sleeping habit in the afternoon | 2 | 13.3 | - | - | - | - | - | - | 2 | 3.3 |
| | 6 | 40 | 5 | 33.3 | 10 | 66.7 | 11 | 73.3 | 32 | 53.3 |

Lifestyle pattern of the subjects reflects their health status. Walking may help individual lose weight and can maintain their weight. It is seen from the above table that 45 per cent of the subjects used walk as the mode of travel every day, 33.3 per cent of the subjects used travelling by bus and 18.3 per cent of the subjects used other vehicles like car, taxi for their mode of travel.

A study by Slater *et al.,* (2014) had shown that obesity contributes significantly by daytime sleeping people. Around 78.3 per cent of the subjects were sleeping 6 – 8 hours per day and 20 per cent of them sleeping less than 6 hours. Around 53.3 per cent of the subjects were not having the habit of sleeping during afternoon after having food. And 21.7 per cent of the subjects were having

the habit of sleep after having food. Only 8.3 per cent of the subjects used to sleep daily in the afternoon after consumption of food.

### 3. Activity Pattern Of Selected Subjects

Regular habit of doing exercise helps obese and overweight subjects to maintain weight as it leads to a healthy life. Around 93.3 per cent of underweight subjects did not exercise, 33.3 per cent of the overweight subjects were going for walk for 1 to 2 hours, 66.7 per cent and 33.3 per cent respectively go for walk to 4 hours. Around 20 per cent of both obese and overweight subjects were doing Yoga and meditation as part of their exercise. Only 6.7 per cent of the subjects were doing jogging as their regular exercise.

Leisure time activity plays an imperative role; it will reduce stress. A sound mind makes sound body. Around 96.7 per cent of the underweight subjects were spending their leisure time activity by watching television, 66.6 per cent of the overweight subjects were reading books as their leisure time activity. Around 53.4 per cent of the obese subjects were listening to music 20 per cent of obese subjects were doing craft work and 40 per cent of the subjects were doing other work like internet surfing, painting, playing with kids and cleaning rooms. Study result of Shrivastava *et al.,* (2013), reveal that 77.5 per cent do regular exercise and 37.7 per cent do yoga and meditation to maintain their normal weight.

### 4. Dietary pattern of the selected subjects

Table VIII represents the dietary pattern of the selected subjects.

**TABLE VIII**

**DIETARY PATTERN OF THE SELECTED SUBJECTS**

| Details | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | | Total N=60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No | % |
| **Dietary Pattern** | | | | | | | | | | |
| Vegetarian | 2 | 13.3 | 2 | 13.3 | 1 | 6.7 | 5 | 33.3 | 10 | 16.7 |
| Non-vegetarian | 13 | 86.7 | 11 | 73.4 | 13 | 86.6 | 9 | 60 | 46 | 76.7 |
| Ova- Vegetarian | - | - | 2 | 13.3 | 1 | 6.7 | 1 | 6.7 | 4 | 6.6 |
| **Meal Pattern per Day** | | | | | | | | | | |
| < 2 | 11 | 73.4 | 6 | 40 | 8 | 53.4 | 9 | 60 | 34 | 56.7 |
| 3 | 4 | 26.7 | 9 | 60 | 3 | 20 | 4 | 26.7 | 20 | 33.3 |
| > 4 | - | - | - | - | 4 | 26.7 | 2 | 13.3 | 6 | 10 |
| **Skipping Meals*** | | | | | | | | | | |
| Dislike food | 5 | 33.3 | 1 | 6.7 | 2 | 13.3 | 1 | 6.7 | 9 | 60 |
| Peer influence | 1 | 6.7 | 2 | 13.3 | 1 | 6.7 | 2 | 13.3 | 7 | 46.7 |
| Lack of appetite | 2 | 13.3 | 1 | 6.7 | 3 | 20 | 2 | 13.3 | 8 | 13.3 |
| Others | 3 | 20 | 2 | 13.3 | 1 | 6.7 | 4 | 26.7 | 11 | 18.3 |
| No habit of skipping meals | 4 | 26.7 | 9 | 60 | 7 | 46.7 | 6 | 40 | 26 | 43.3 |

*Multiple response

Dietary pattern of the subjects showed that 76.6 per cent of the subjects were non – vegetarians, 16.67 per cent of them were vegetarians and only 6.67 per cent were ova – vegetarians.

Skipping meals is one reason for over nourishment as well as under nourishment. Around 45 per cent of the subjects were not having the habit of skipping their meals, while other subjects were skipping their meals. Around 16.67 per cent of the subjects were not ready to skip meals. In Yahia *et al.,* (2008) study, 61.4 per cent of the subjects were having healthy habit of taking food as three meals in a day. From the above table 56.67 per cent of the subjects had only two meals in a day. And 33.3 per cent of the subjects had the habit of having three meals.

## D. MODIFICATION OF DIETARY HABITS AMONG SELECTED SUBJECTS.

### 1. Habit of consuming prepared foods by the selected subjects

Habit of consuming ready prepared foods of the selected subjects are represented in Table IX.

**TABLE IX**
**HABIT OF CONSUMING PREPARED FOODS BY THE SELECTED SUBJECTS**
**N = 60**

| Foods | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Sweets** | | | | | | | | |
| Daily | - | - | 3 | 20 | - | - | 2 | 13.3 |
| Weekly | 5 | 33.3 | 3 | 20 | 3 | 20 | 6 | 40 |
| Occasionally | 7 | 49.7 | 5 | 33.3 | 4 | 26.6 | 2 | 13.3 |
| Rarely | - | - | 1 | 6.7 | 3 | 20 | 2 | 13.3 |
| **Fried Foods** | | | | | | | | |
| Daily | - | - | 2 | 13.3 | 1 | 6.7 | 1 | 6.7 |
| Weekly | 6 | 40 | 3 | 20 | 4 | 26.7 | 4 | 26.7 |
| Occasionally | 4 | 26.7 | 7 | 49.7 | 4 | 26.7 | 4 | 26.7 |
| Rarely | 2 | 13.3 | - | - | 1 | 6.7 | 3 | 20 |
| **Salted Foods** | | | | | | | | |
| Daily | 3 | 20 | 3 | 20 | 6 | 40 | 5 | 33.3 |
| Weekly | 5 | 33.3 | 6 | 40 | 2 | 13.3 | 1 | 6.7 |
| Occasionally | 4 | 26.7 | 2 | 13.3 | 1 | 6.7 | 3 | 20 |
| Rarely | - | - | 1 | 6.7 | 1 | 6.7 | 3 | 20 |
| **Fruit Juices** | | | | | | | | |
| Daily | 3 | 20 | 2 | 13.3 | 1 | 6.7 | 3 | 20 |
| Weekly | 5 | 33.3 | 8 | 53.4 | 7 | 49.7 | 2 | 13.3 |
| Occasionally | 4 | 26.7 | 2 | 13.3 | 1 | 6.7 | 2 | 13.3 |
| Rarely | - | - | - | - | 1 | 6.7 | 5 | 33.3 |
| **Fast Foods** | | | | | | | | |
| Daily | - | - | 1 | 6.7 | - | - | - | - |
| Weekly | 1 | 6.7 | 4 | 26.7 | 4 | 26.7 | 5 | 33.3 |
| Occasionally | 4 | 26.7 | 2 | 13.3 | 3 | 20 | 7 | 49.7 |
| Rarely | - | - | 5 | 33.3 | 3 | 20 | - | - |
| **Beverages** | | | | | | | | |
| Daily | 1 | 6.7 | - | - | - | - | 4 | 26.7 |
| Weekly | 1 | 6.7 | 1 | 6.7 | 1 | 6.7 | 2 | 13.3 |
| Occasionally | 4 | 26.7 | 3 | 20 | 2 | 13.3 | 3 | 20 |
| Rarely | 6 | 40 | 8 | 53.4 | 7 | 46.6 | 1 | 6.7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Ready Prepared Foods** | | | | | | | | |
| Daily | - | - | 1 | 6.7 | - | - | 2 | 13.3 |
| Weekly | 1 | 6.7 | 1 | 6.7 | 3 | 20 | 5 | 33.3 |
| Occasionally | 4 | 26.7 | 2 | 13.3 | 2 | 13.3 | 4 | 26.6 |
| Rarely | 7 | 46.6 | 8 | 53.4 | 5 | 33.3 | 1 | 6.7 |
| No Habit of consuming the habit | 3 | 20 | 3 | 20 | 5 | 33.3 | 3 | 20 |

Ready to eat foods always makes a man unhealthy especially sedentary life pattern. It is clear from the above table that 33.3 per cent of the overweight subjects were not having the habit of consuming ready to eat foods. Around 49.7 per cent of the underweight subjects were consuming sweets sporadically and 40 per cent of the obese subjects were consuming sweets weekly. Bala and Verma, (2013) showed that obese females were taking more sweets compared to other groups of population.

In the present study, about 49.7 per cent of the normal subjects were consuming fried foods and 40 per cent of the underweight subjects were consuming fried foods. It was related to the reports of Yahia *et al.,* (2008) that fifty of the subjects were taking fried foods more than three times per week. Overweight and normal subjects take 40 per cent of salted foods daily and weekly. And fruit juice was taken by 53.7 per cent of normal subjects and 49.7 per cent of overweight subjects. Study results of Suba and Devi, (2013) reveal that consumption of refined and fast foods were the cause for premenstrual problems. In the above table, it may be seen that 49.7 per cent and 33.3 per cent of the obese subjects were taking fast foods occasionally and weekly.

## 2. Consumption of food from outside home of selected subjects

The consumption of food from outside home of selected subjects is represented in Table X.

**TABLE X**
**CONSUMPTION OF FOOD FROM OUTSIDE HOME OF SELECTED SUBJECTS**

**N = 60**

| Details* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Canteen** | | | | | | | | |
| Foods | 1 | 6.7 | 4 | 26.7 | 1 | 6.7 | 1 | 6.7 |
| Snacks | 6 | 40 | 5 | 33.3 | 6 | 40 | 5 | 33.3 |
| Others | - | - | - | - | 1 | 6.7 | 1 | 6.7 |
| **Hotel** | | | | | | | | |
| Foods | 2 | 13.3 | 8 | 53.4 | 2 | 13.4 | 8 | 53.4 |
| Non – Vegetarian | 4 | 26.7 | - | - | 10 | 66.7 | 3 | 20 |
| Others | - | - | 1 | 6.7 | 1 | 6.7 | 1 | 6.7 |
| **Vendors** | | | | | | | | |
| Foods | 1 | 6.7 | 1 | 6.7 | 3 | 20 | 2 | 13.3 |
| Others | 1 | 6.7 | 2 | 13.3 | 1 | 6.7 | - | - |
| Not consuming food from out | 8 | 53.4 | 6 | 40 | 2 | 13.3 | 4 | 26.7 |

***Multiple Response**

Eating outside is a popularly growing trend due to lack of time, lifestyle changes everybody moves to outside for their food. It may be noted from the above table that 53.4 per cent of the normal as well as obese subjects were consuming foods from hotel. Around 66.7 per cent of the overweight subjects were consuming non – vegetarian items from hotel. Around 40 per cent of the underweight and overweight subjects were consuming snacks like vada, bonda in the canteen. Around 20 per cent of the overweight subjects were consuming foods from the vendors. And 53.4 per cent of the underweight subjects did not have the habit of consuming outside from the home.

### 3. Consumption of Health Drinks of Selected Subjects

Now – a – day's consumption of health drinks among the young people has declined due to the introduction of carbonated beverages. Normal and underweight subject did not drink any health drinks. Around 66.7 per cent and 60 per cent of the normal as well as underweight subjects did not have the habit of

consuming health drinks. Around 26.7 per cent of the underweight and 20 per cent of both overweight as well as obese subjects were having the habit of drinking hot beverages like coffee, tea, milk, etc. Around 20 per cent of underweight and obese subjects had the habit of consuming fruit juices.

### 4. Modification of eating habits during special conditions of selected subjects

Modification of eating habits during special conditions of selected subjects is represented in Table XI.

**TABLE XI**
**MODIFICATION OF EATING HABITS DURING SPECIAL CONDITIONS OF SELECTED SUBJECTS**

**N = 60**

| Details* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Changing food pattern during Special conditions** | | | | | | | | |
| Underweight | 6 | 40 | 5 | 33.3 | 1 | 6.7 | 2 | 13.3 |
| Overweight | 2 | 13.3 | 4 | 26.7 | 4 | 26.7 | 6 | 40 |
| Holidays | 6 | 40 | 3 | 20 | 5 | 33.3 | 7 | 46.7 |
| Functions | 8 | 53.4 | 5 | 33.3 | 7 | 46.7 | 8 | 53.4 |
| Seasons | 2 | 13.3 | 5 | 33.3 | 3 | 20 | 3 | 20 |
| Not changing the food pattern | 7 | 46.7 | 7 | 46.7 | 5 | 33.3 | 7 | 46.7 |

*Multiple Responses

During special days and vacations our daily dietary pattern changes when compared to our regular schedule. Around 46.7 per cent of underweight, normal and obese subjects did not have the habit of changing their dietary pattern during special days. Around 53.4 per cent, 46.7 per cent and 53.4 per cent of the underweight, overweight and obese subjects were respectively changed their dietary pattern during any festival or functions. Around 40 per cent of the underweight as well as 46.7 per cent of the obese subjects had changed their consumption pattern during holidays.

## 5. Modification of eating habits during menstrual cycle of selected subjects

Modification of eating habits during menstrual cycle of selected subjects is given in Table XII.

**TABLE XII**
**MODIFICATION OF EATING HABITS DURING MENSTRUAL CYCLE OF SELECTED SUBJECTS**

**N = 60**

| Details* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Changing food pattern during Menstruation** | | | | | | | | |
| **Included** | 8 | 53.4 | 6 | 40 | 6 | 40 | 3 | 20 |
| Fruits | 3 | 20 | 4 | 26.7 | 3 | 20 | 3 | 20 |
| Vegetables | 1 | 6.7 | 5 | 33.3 | 3 | 20 | 1 | 6.7 |
| Others | | | | | | | | |
| **Avoided** | | | | | | | | |
| Oily foods | 4 | 26.7 | 4 | 26.7 | 2 | 13.3 | 4 | 26.7 |
| Bakery products | - | - | 1 | 6.7 | 1 | 6.7 | - | - |
| Spicy foods | 1 | 6.7 | 6 | 40 | 5 | 33.3 | - | - |
| Not Changing the food pattern during menstruation | 2 | 13.3 | 5 | 33.3 | 11 | 73.3 | 10 | 66.7 |

*Multiple Response

Due to psychological changes during menstruation there is a chance for rejecting the food. This may affect the health status of the females. During menstruation they were having the habit of changing their food pattern. In the above table it is evident that 66.7 per cent of the obese subjects were not having the habit changing their food pattern during menstruation. Nearly 40 per cent of the overweight as well as normal subjects included fruits. Around 33.3 per cent of the normal subjects were taking other foods like buttermilk, tender coconut water, etc. Around 26.7 per cent of the entire group except overweight subjects they were avoiding oily foods during their menses. Around 40 per cent of the normal as well as 33.3 per cent of the overweight subjects were avoiding spicy foods during

their menses. Around 26.7 per cent of the normal as well as overweight subjects were avoided bakery products due to its high calorie dense.

## 6. Modification of diet habits to maintain normal weight of selected subjects

Details on modification of diet habits to maintain normal weight of selected subjects is represented in Table XIII.

**TABLE XIII**
**MODIFICATION OF DIET HABITS TO MAINTAIN NORMAL WEIGHT OF SELECTED SUBJECTS**

**N = 60**

| Details* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | |
|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % |
| **Changing food pattern to maintain Normal weight Included** | | | | | | | | |
| Fruits | 9 | 60 | 8 | 53.4 | 8 | 53.4 | 9 | 60 |
| Vegetables | 8 | 53.4 | 10 | 66.7 | 6 | 40 | 2 | 13.3 |
| Others | 3 | 20 | 6 | 40 | 2 | 13.3 | 8 | 53.4 |
| **Avoided** | | | | | | | | |
| Oily foods | 6 | 40 | 11 | 73.4 | 4 | 26.7 | 5 | 33.3 |
| Bakery products | 1 | 6.7 | 2 | 13.3 | 2 | 13.3 | 2 | 13.3 |
| Sweets | 1 | 6.7 | 3 | 20 | 1 | 6.7 | 5 | 33.3 |
| Others | - | - | 4 | 26.7 | 1 | 6.7 | 3 | 20 |

* Multiple Response

Due to modernization, young individuals are concerned about their body structure and maintaining body weight. Around 53.4 per cent of the normal and overweight subjects and 60 per cent of the underweight and obese subjects were taking fruits to maintain their normal weight. Around 66.7 per cent of the normal subjects were taking vegetables in the form of salad to maintain their weight. Around 73.4 per cent of the normal subjects and 33.3 per cent of the obese subjects were avoiding oily foods for their weight maintenance. Around 13.3 per cent of the normal, overweight as well as obese subjects were avoiding bakery foods like puffs, cake, biscuits to get a normal weight. Around 20 per cent of the

obese subjects were avoiding other foods like potatoes, dried foods, non – vegetarian items, etc.

### 7. Precautions taken to maintain normal weight by the selected subjects

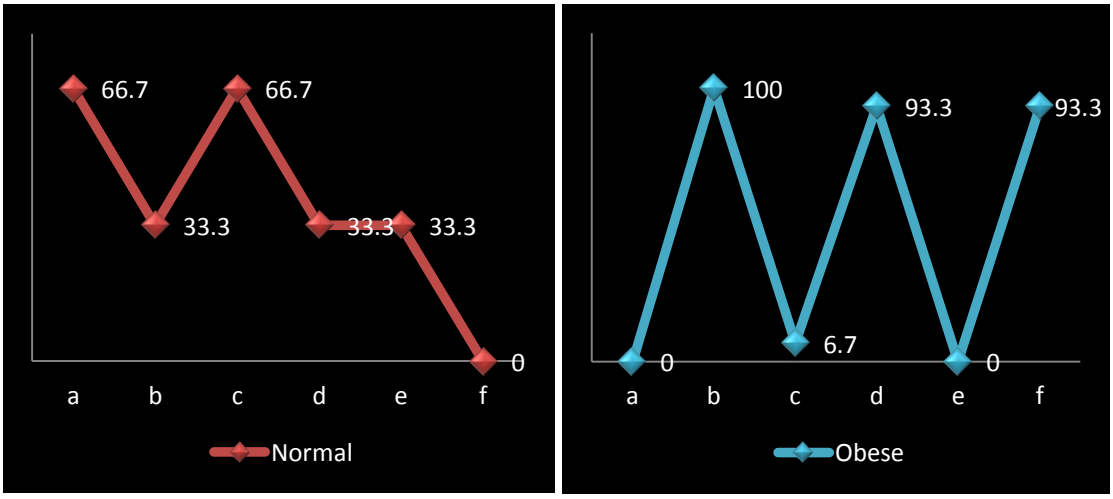
It is an essential to know that reducing excessive body weight maintains healthy life. About 60 per cent of the underweight subjects were not taking any precautions to improve weight gain, but 40 per cent of them consume energy dense foods, health drinks, nuts, etc. Around 33.3 per cent of the normal weight subjects skip meals and, exercise to lose their weight. Sirang *et al.,* (2013) study reveals that normal weight females undertake. Unnecessary weight loss measures around 53.4 per cent of the obese subjects and 7 per cent of overweight were doing exercise to maintain normal weight.

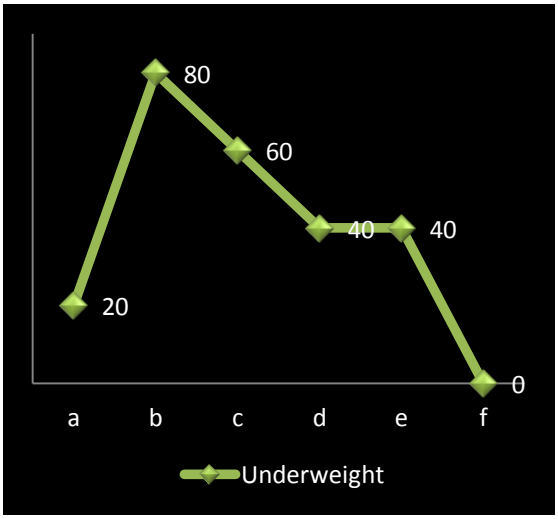
### 8. Perception of body weight of the selected subjects

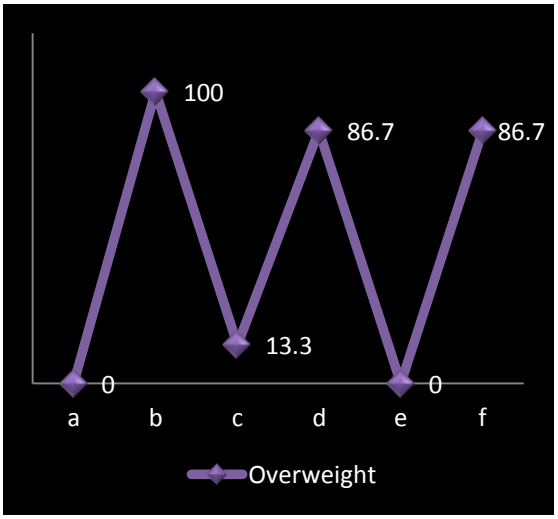
Perception of body weight of the selected subjects is represented in the figure 5.

**FIGURE 5**

**Perception of body weight of the subjects**






**a. Normal weight** **c. Comfortable feeling about body weight**

**b. Not normal weight** **d. uncomfortable feeling about body weight**

**e. Increase weight** **f. Reduce weight**

Results revealed that around 80 per cent of the underweight subjects did not have normal weight. Among this, 60 per cent of them were feeling comfortable recording their weight and 40 per cent of them were interested in increasing their weight, which coincides with the result of Sirang (2013).

**9. Changes in food pattern during illness of the selected subjects**

During illness conditions like fever, Gastro Intestinal Disorders (GIDs), Jaundice, Constipation, etc most of the subjects (73.3 per cent) were changing their dietary pattern. During Fever they had rasam rice, bread, kanji, etc. During GIDs they avoid spicy foods, heavy meal and they included curd rice, rice porridge, buttermilk, fruits, etc. And some of them (26 .7 per cent) did not change their dietary pattern in any condition and they follow the same as they followed.

**10. Food frequency of the selected subjects.**

Table XIV represents the food frequency of the selected subject

**TABLE XIV**

**FOOD FREQUENCY OF THE SELECTE SUBJECTS** **N=60**

| Foods | Frequency of consumption (in Percent) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Underweight (n-15) | | | | | Normal (n-15) | | | | | Overweight (n-15) | | | | | Obese (n-15) | | | | |
| | D | 2- 4 W | W | M | N | D | 2- 4 W | W | M | N | D | 2- 4 W | W | M | N | D | 2- 4 W | W | M | N |
| Cereals | 80 | 20 | - | - | - | 60 | 33 | 7 | - | - | 46 | 26 | 20 | - | 7 | 67 | 33 | - | - | - |
| Pulses | 53 | 27 | 20 | - | - | 53 | 47 | - | - | - | 60 | 27 | 13 | - | - | 53 | 47 | - | - | - |
| GLV | 13 | 20 | 54 | 13 | - | - | 40 | 40 | 13 | 7 | 7 | 13 | 27 | 20 | 33 | 7 | 33 | 40 | 20 | - |
| Roots & Tubers | - | - | 100 | - | - | - | - | 100 | - | - | - | - | 100 | - | - | - | - | 100 | - | - |
| Other Vegetables | 33 | 40 | 27 | - | - | 74 | 13 | 13 | - | - | 67 | 13 | 20 | - | - | 60 | 40 | - | - | - |
| Nuts & Oils | 33 | 13 | 20 | - | 33 | 7 | 40 | 40 | - | 13 | 20 | 27 | 27 | 13 | 13 | 20 | 33 | 20 | 33 | 13 |
| Fruits | 13 | 27 | 54 | 7 | - | 20 | 54 | 20 | 7 | - | 33 | 20 | 33 | 13 | - | 20 | 47 | 27 | 7 | - |
| Meat, Fish, Poultry & Egg | - | 7 | 74 | 7 | - | - | 20 | 54 | 7 | 7 | - | 13 | 40 | 20 | 20 | - | 7 | 40 | 7 | 7 |
| Milk & Milk Products | 100 | - | - | - | - | 100 | - | - | - | - | 100 | - | - | - | - | 100 | - | - | - | - |
| Fats | 40 | 20 | 20 | 20 | - | 54 | 20 | 20 | - | 7 | 60 | - | 7 | 20 | 13 | 40 | 13 | 40 | 7 | - |
| Sugars | 47 | 20 | 20 | - | 13 | 74 | 20 | - | - | 7 | 67 | 13 | 13 | - | 7 | 67 | 20 | 7 | 7 | - |
| Beverages | 40 | 7 | 7 | 27 | 20 | 7 | 40 | 13 | 7 | 23 | 13 | - | 13 | 13 | 60 | 33 | 13 | 7 | 40 | 7 |
| Prepared Foods | - | 33 | 7 | 13 | 47 | - | 27 | 27 | 7 | 40 | 27 | - | 13 | 13 | 47 | 7 | - | 20 | 53 | 20 |

From the above table it is evident that cereal consumption of underweight subjects daily intake were 80 per cent, 60 per cent,46 per cent and 67 per cent were underweight, Normal, overweight and obese subjects respectively. Consumption of pulses were 53 per cent daily for underweight, normal and obese subjects, whereas 60 per cent for overweight subjects. And 20 per cent of the underweight subjects had taken weekly once. Green leafy vegetable consumption taken by daily was 13 per cent for underweight subjects, 7 per cent for both overweight and obese subjects. And weekly consumption of GLV were for underweight, normal and overweight and obese subjects was 54 per cent, 40 per cent, 27 per cent and 40 per cent respectively.

Roots and tubers consumption for all the subjects were taken weekly once. Around 74 per cent, 67 per cent and 60 per cent of the normal, overweight and obese subjects respectively had daily in their diet. Around 33 per cent of the underweight subjects were taken nuts and oils daily. Consumption of fruits for underweight and normal subjects was 54 per cent weekly and 2 – 4 times in a week. Non – vegetarian consumption was 74 per cent for underweight subjects was weekly and 54 per cent for normal subjects. Around seven per cent of both normal and obese subjects were not taking non – vegetarian items. All the subjects were taken milk and milk products daily. Beverages were consumed by 40 per cent of the underweight subjects were daily. Around 60 per cent of the overweight subjects were not taking beverages. Around 47 per cent of the underweight subjects and 40 per cent of the normal subjects respectively did not consume prepared foods.

## E. NUTRITIONAL STATUS OF THE SELECTED SUBJECTS

Nutritional status of the selected subjects is presented and discussed below.

### 1. Correlation within anthropometric parameters among selected subjects

Table XV shows the correlation within the anthropometric parameters among selected subjects.

**TABLE XV**

**CORRELATION WITHIN ANTHROPOMETRIC PARAMETERS AMONG SELECTED SUBJECTS**

**N = 60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| Weight Vs BMI | 0.424 $^{NS}$ | 0.812** | 0.166 $^{NS}$ | 0.871** |
| Weight Vs WHR | 0.044 $^{NS}$ | - 0.026 $^{NS}$ | -0.480* | 0.483* |
| Weight Vs AC | - 0.056 $^{NS}$ | 0.912** | 0.596* | 0.864** |
| Weight Vs AMC | -0.085 $^{NS}$ | 0.880** | 0.785** | 0.892** |
| BMI Vs WHR | 0.073 $^{NS}$ | 0.282 $^{NS}$ | 0.195 $^{NS}$ | 0.723** |

** Significant at 1% level * Significant at 5% level $^{NS}$ Not Significant

Weight was positively correlated with body circumferences like arm circumference and arm mid circumference in all groups except underweight subjects. High positive and significant differences ($p < 0.01$) were noticed for all the parameters of obese subjects. For underweight subjects all the parameters showed no significant difference with weight like BMI, WHR, AC and AMC.

**2. Biochemical Parameters of the Selected Subjects**

**i. Glucose profile of the selected subjects**

In general the random glucose of all the subjects within the normal value of 80 -120 mg /dl (IDF, 2010). Underweight subjects had a mean glucose level of (84.87±2.83 g/dl), normal subjects had a mean glucose level (86.20±4.39). Overweight and obese subjects showed a relatively higher level but within the normal level (90.6 ±4.82 g/dl) and (98.53±8.47 g/dl) respectively.

**ii. Hemoglobin Results for the Selected Subjects**

Hemoglobin results for the selected subjects are represented in Table XVI.

**TABLE XVI**

**HEMOGLOBIN RESULTS FOR THE SELECTED SUBJECTS N=60**

| Hemoglobin Range* | Underweight n=15 | | Normal n=15 | | Overweight n=15 | | Obese n=15 | | Total N=60 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Normal >12g/dl** | 4 | 26.6 | 9 | 60 | 12 | 80 | 11 | 73.3 | 36 | 60 |
| **Mild 10 – 12g/dl** | 6 | 40 | 6 | 40 | 3 | 20 | 4 | 26.6 | 19 | 31.6 |
| **Moderate 7 – 10g/dl** | 5 | 33.3 | - | - | - | - | - | - | 5 | 8.4 |
| **Severe <7g/dl** | - | - | - | - | - | - | - | - | - | - |

*WHO 2009

From the above table it is evident that 60 per cent (n – 36) of the subjects had normal range of hemoglobin (>12g / dl). Around 31.6 per cent (n – 19) of the subjects are mild anemia having hemoglobin of (10 – 12g /dl). And 8.4 per cent (n – 5) of the subjects suffer with moderate (7 - 10g/dl). No subjects evidenced severe anemia (<7g/dl). The subjects with mild and moderate anemia were given diet counseling to include iron rich foods.

**2. Dietary intake of the selected subjects**

**i. Mean Nutrient intake of the selected subjects**

Mean nutrient intake of the selected subjects were represented in Table XVII.

## TABLE XVII

## NUTRIENT INTAKE COMPARISON WITH RECOMMENDED DIETARY ALLOWANCES

**N = 60**

| Nutrients | RDA* | Underweight n = 15 | | Normal n = 15 | | Overweight n = 15 | | Obese n = 15 | |
|---|---|---|---|---|---|---|---|---|---|
| | | Intake | Excess / Deficit | Intake | Excess / Deficit | Intake | Excess / Deficit | Intake | Excess / Deficit |
| **Protein (g)** | 50 | 41.51 | -8.49 | 65.96 | +15.96 | 65.19 | +15.19 | 102.70 | +52.7 |
| **Fat (g)** | 20 | 22.51 | +2.51 | 26.11 | +6.11 | 47.75 | +27.75 | 91.02 | +71.02 |
| **Energy (kcals)** | 1875 | 1131.33 | -743.67 | 1668.89 | -206.11 | 2164.3 | +289.3 | 3111.3 | +1875 |
| **Calcium (mg)** | 400 | 465.69 | +65.69 | 469.06 | +69.06 | 838 | +438.83 | 680.23 | +280.23 |
| **Iron (mg)** | 30 | 19.16 | -10.84 | 22.70 | -7.3 | 30.11 | +0.11 | 31.53 | +1.53 |

* ICMR, 2010.

From the above Table it is evident that for underweight subjects protein intake was deficit than RDA that was 8.49g. For fat, all the subjects take excess fat than RDA. Energy intake was deficit for both underweight as well as normal subjects, in case of calcium for all the subjects. And for Iron both underweight and normal subjects consumed less iron than the RDA.

## F. BODY COMPOSITION PARAMETERS OF SELECTED SUBJECTS

The mean of the various body composition parameters are given in Table XVIII and the results are represented in figure 6 and 7.

**TABLE XVIII**
**BODY COMPOSITION PARAMETERS OF SELECTED SUBJECTS**

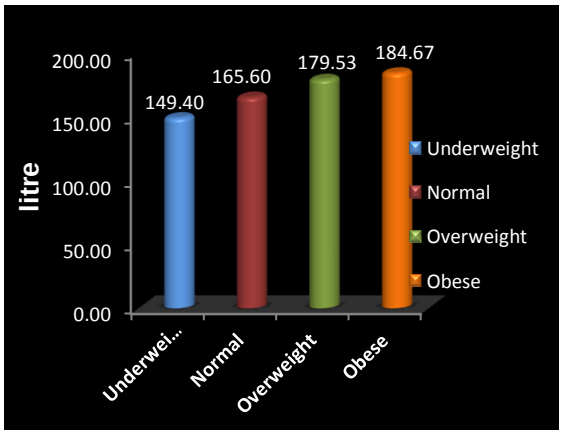
**N = 60**

| Parameters | Reference Range** | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|---|
| BFM (kg) | 10.5 – 16.8 | 9.26±3.12 | 17.57±2.62 | 22.11±2.53 | 28.92±9.50 |
| PBF (%) | 18 – 28 | 22.91±6.90 | 34.00±3.32 | 37.57±3.52 | 44.35±4.13 |
| FFM (kg) | 36.2 – 44.5 | 30.91±3.51 | 34.00±3.19 | 36.85±4.62 | 37.85±2.80 |
| TBW (l) | 26.5 – 32.7 | 22.41±2.01 | 24.84±2.33 | 26.93±3.35 | 27.70±2.07 |
| ICW (l) | 16.3 – 20.3 | 13.44±1.34 | 15.37±1.49 | 16.70±2.10 | 17.18±1.32 |
| ECW (l) | 10.2 – 12.4 | 8.97±2.01 | 9.46±0.85 | 10.22±1.26 | 10.53±0.77 |
| Protein (kg) | 7.2 – 8.8 | 8.52±7.02 | 6.65±0.64 | 7.23±0.91 | 7.43±0.57 |
| SMM (kg) | 19.9 – 24.3 | 15.52±1.73 | 18.01±1.91 | 19.80±2.75 | 20.40±1.71 |
| Mineral (kg) | 2.5 – 3.0 | 2.71±1.97 | 2.50±0.24 | 2.69±0.35 | 2.74±0.21 |
| BMC (kg) | 2.0 – 2.5 | 2.34±1.93 | 2.09±0.20 | 2.25±0.30 | 2.29±0.18 |
| BCM (kg) | 23.8 – 29.1 | 19.24±1.91 | 22.04±2.11 | 23.93±3.01 | 24.59±1.8 |
| VFA (kg) | <100 | 25.87±10.13 | 60.67±8.79 | 70.87±9.34 | 105.5±20.8 |
| ECF/TBF | 0.36 – 0.39 | 0.35±0.05 | 0.33±0.00 | 0.33±0.01 | 0.33±0.00 |
| ECW/TBW | 0.31 – 0.34 | 0.40±0.06 | 0.38±0.00 | 0.38±0.01 | 0.38±0.01 |

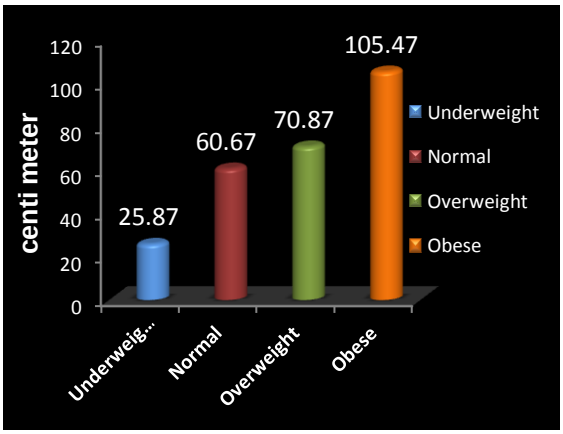
** Reference range as per InBody720 Body Composition Analyzer data for normal subjects

# BODY COMPOSITION ANALYSIS RESULT

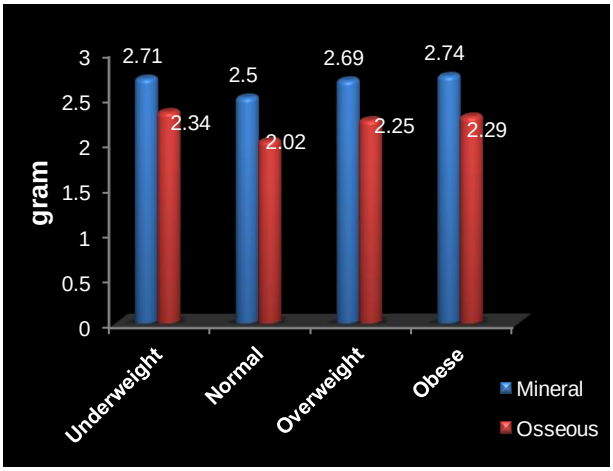
## TOTAL BODY WATER (l)



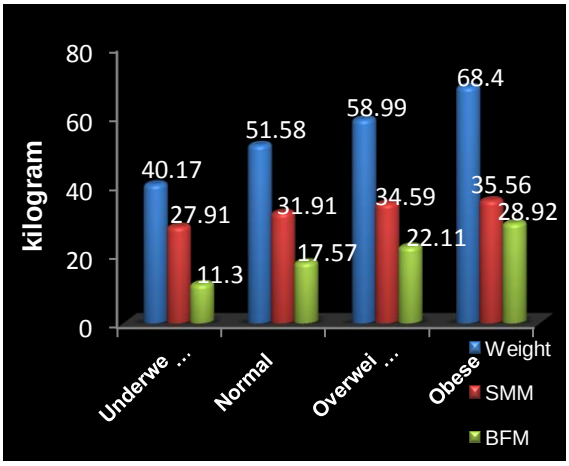

## VISCERAL FAT AREA ($cm^2$)




## BODY COMPOSITION ANALYSIS (g)




## MUSCLE - FAT ANALYSIS (kg)




## OBESITY DIAGNOSIS (%)

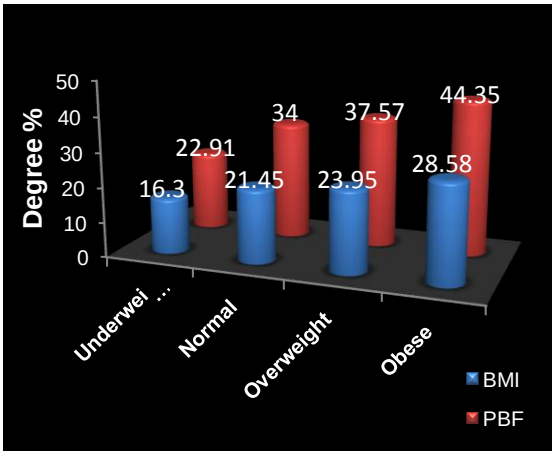
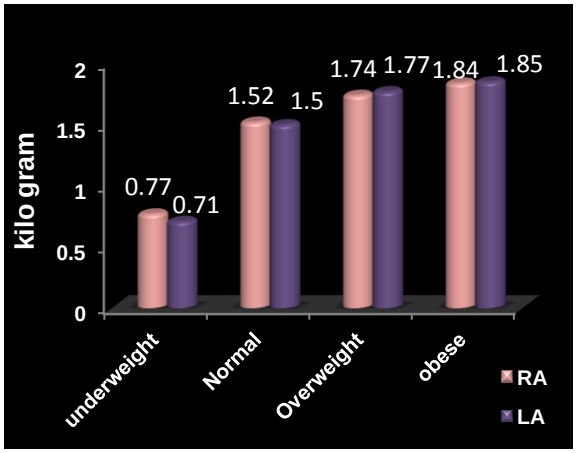


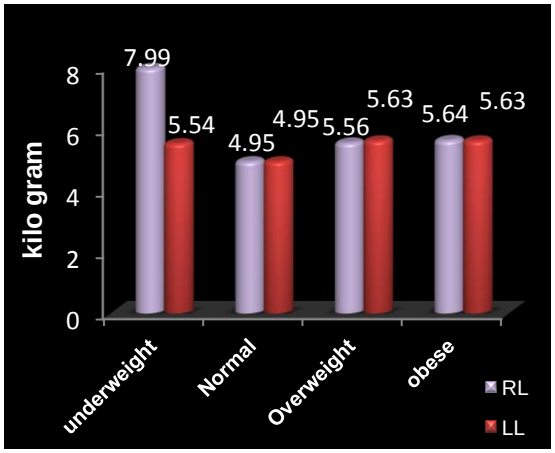

**Figure 6**

# BODY COMPOSITION ANALYSIS RESULT

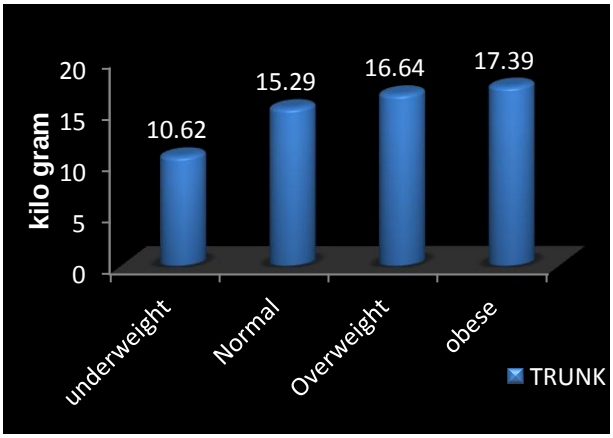
## Arm Balance (kg)



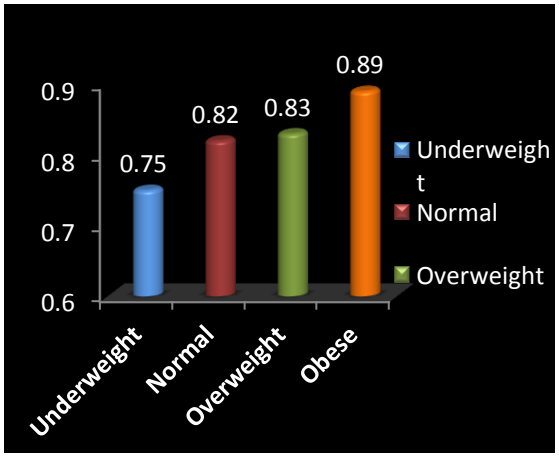

## Leg Balance (kg)



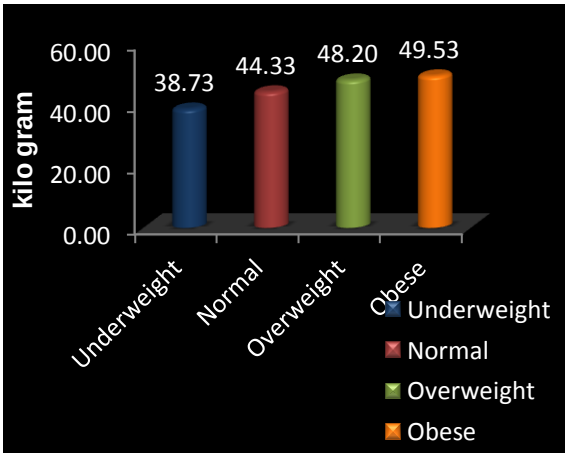

## Trunk (kg)




## Waist Hip Ratio




## Protein (kg)



It is evident from the above table that the mean body fat mass of all the subjects except underweight subjects (9.26±3.12) was more than the reference value. Percentage body fat was more than cut off values for all the subjects like 22.91±6.9, 34±3.32, 37.57±3.52 and 44.35±4.13 for underweight, normal, overweight and obese subjects respectively. Protein was normal for all the subjects except normal subjects (7.2 -8.8). Skeletal Muscle Mass was deficit for normal and underweight subjects (19.9 – 24.3). Visceral fat area for obese subjects were more than reference value (<100) others have less than that.

Table XIX represents the weight control by using body composition parameters for selected subjects.

**TABLE XIX**
**WEIGHT CONTROL BY USING BODY COMPOSITION PARAMETERS FOR SELECTED SUBJECTS**

**N = 60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| Target Weight (kg) | 49.83±2.61 | 50.47±3.18 | 51.73±4.89 | 50.79±3.25 |
| Weight Control (kg) | 9.65±2.08 | 1.13±2.29 | -7.27±1.47 | -24.95±27.87 |
| Fat Control (kg) | 2.33±2.78 | -6.01±2.18 | -10.21±2.14 | -18.87±6.15 |
| Muscle Control (kg) | 7.49±2.63 | 4.84±2.05 | 2.96±1.83 | 1.25±1.23 |
| Obesity Degree (%) | 80.00±4.66 | 101.60±4.66 | 113.53±2.50 | 135.47±15.88 |
| Fitness Score | 69.86±2.03 | 69.20±3.38 | 66.80±3.80 | 60.27±5.13 |

It is evident that the mean weight control data for the underweight subjects was 9.65±2.08 and for overweight and obese subjects was -7.27±1.47 kg and -24.95 kg respectively. It is clear that underweight have to improve their weight and obese and overweight subjects have to reduce their weight according to their target weight. Fat control measurements for all the subjects were high but compared to others, for an underweight subjects, it was relatively less. Strengthening muscle mass is very important for all the subjects. Muscle control data was 1.25±1.23 kg for obese subjects and for underweight subjects, it was 7.49±2.63kg. Obesity degree for obese subjects was higher than normal value, in

the range of 90 – 110. It is depicted that, for them there is a high degree of chance for getting obesity complications in later years. And for underweight subjects, it was below than the normal value 80.00 ±4.66. Fitness score is less than 70 means there is lack of muscle strengthen or incase of overweight, they need to exercise and follow diet control. The present study results show that normal category of subjects also have less than 70 scores. But the fitness score in an arbitrary figure only and individual body composition scores.

Table XX represents the statistical interpretation for comparison between body composition parameters of the selected subjects.

**TABLE XX**
**STATISTICAL INTERPRETATION FOR COMPARISON BETWEEN BODY COMPOSITION PARAMETERS OF THE SELECTED SUBJECTS**

**N = 60**

| Parameters | Normal Vs Underweight | Normal Vs Overweight | Normal Vs Obese | Overweight Vs Obese | Underweight Vs Obese |
|---|---|---|---|---|---|
| BFM (kg) | 7.906** | 4.818** | 4.460** | 2.685** | 7.616** |
| PBF (%) | 5.609** | 2.862** | 7.560** | 4.833** | 10.320** |
| VFA (kg) | 10.049** | 3.083** | 7.690** | 5.880** | 13.333** |
| FFM (kg) | 2.527* | 1.969* | 3.516** | 0.717 NS | 5.987** |
| TBW (l) | 3.060** | 1.988* | 3.560** | 0.755 NS | 7.112** |
| Protein (kg) | 1.025* | 2.013** | 3.530** | 0.719 NS | 0.597 NS |
| SMM (kg) | 3.730** | 2.073** | 3.611** | 0.717 NS | 7.757** |
| Mineral (kg) | 0.427 NS | 1.751* | 2.963** | 0.495 NS | 0.053 NS |
| BMC (kg) | 0.507 NS | 1.701* | 2.824** | 0.443 NS | 0.110 NS |
| BCM (kg) | 3.812** | 1.996* | 3.491** | 0.713 NS | 7.723** |

** Significant at 1% level * Significant at 5% level NS Not Significant

Results reveal that body fat mass, per cent body fat and visceral fat area was highly significant for almost all parameters when compared between the underweight, normal, overweight and obese individuals. Total body water, skeletal muscle mass and bone cell mass are highly significant for all the subjects except overweight and obese. The fat free mass for normal and obese subjects and underweight and obese subjects were found to be significant. Mineral, Bone mineral content, body cell mass and fat free mass was correlated to normal and

overweight subjects. Fat free mass, total body water, protein, skeletal muscle mass, mineral, bone mineral content and body cell mass was not significant for overweight and obese subjects. protein, mineral and body cell mass were not significant for obese and underweight subjects. Mineral and bone mineral content was not significant for underweight and normal subjects.

Table XXI represents the correlation between anthropometric and body composition parameters.

**TABLE XXI**
**CORRELATION BETWEEN ANTHROPOMETRIC AND BODY COMPOSITION PARAMETERS**

**N = 60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| Weight Vs BFM | 0.445* | 0.781** | 0.623** | 0.746** |
| Weight Vs PBF | 0.224 NS | 0.254 NS | -0.244 NS | 0.703** |
| Weight Vs FFM | 0.604** | 0.858** | 0.906** | 0.662** |
| Weight Vs TBW | 0.714** | 0.857** | 0.904** | 0.692** |
| Weight Vs Protein | -0.594** | 0.837** | 0.878** | 0.629** |
| Weight Vs SMM | 0.498* | 0.828** | 0.885** | 0.650** |
| Weight Vs Mineral | 0.205 NS | 0.873** | 0.945** | 0.391 NS |
| Weight Vs VFA | 0.316 NS | 0.603** | 0.578* | 0.827** |
| Weight Vs BCM | 0.498* | 0.840** | 0.883** | 0.648** |
| BMI Vs BFM | 0.359 NS | 0.620** | 0.456* | 0.731** |
| BMI Vs PBF | 0.285 NS | 0.201 NS | 0.391 NS | 0.931** |
| BMI Vs FFM | 0.105 NS | 0.708** | -0.034 NS | 0.238 NS |
| BMI Vs TBW | 0.102 NS | 0.710** | -0.047 NS | 0.277 NS |
| BMI Vs VFA | 0.427 NS | 0.565* | 0.608** | 0.881** |
| BMI Vs Protein | -0.071 NS | 0.679** | -0.073 NS | 0.206 NS |
| BMI Vs Mineral | 0.085 NS | 0.695** | 0.092 NS | -0.080 NS |
| BMI Vs BCM | 0.014 NS | 0.688** | -0.047 NS | 0.231 NS |
| WHR Vs BFM | 0.663** | -0.078 NS | -0.446* | 0.504* |
| WHR Vs PBF | 0.706** | -0.081 NS | -0.046 NS | 0.737** |
| WHR Vs FFM | -0.544* | 0.021 NS | 0.349 NS | -0.105 NS |
| WHR Vs VFA | 0.588* | 0.601* | 0.218 NS | 0.856** |

| | | | | |
|---|---|---|---|---|
| WHR Vs Protein | 0.079 NS | 0.024 NS | -0.330 NS | -0.111 NS |
| AC Vs Protein | 0.116 NS | 0.832** | 0.616** | 0.332 NS |
| AC Vs FFM | -0.716** | 0.846** | 0.611** | 0.351 NS |
| AC Vs BFM | 0.744**- | 0.635** | 0.250 NS | 0.649** |
| AC Vs Mineral | 0.988** | 0.820** | 0.574* | 0.007 NS |
| AMC Vs Protein | 0.129 NS | 0.921** | 0.938** | 0.483* |
| AMC Vs SMM | 0.664** | 0.908** | 0.937** | 0.505* |
| AMC Vs FFM | -0.722** | 0.928** | 0.923** | 0.492* |
| AMC Vs BFM | 0.717** | 0.477* | 0.101 NS | 0.676** |
| AMC Vs Mineral | -0.991** | 0.883** | 0.839** | 0.139 NS |

** Significant at 1% level * Significant at 5% level NS Not Significant

**1. Correlation between weight and body composition parameters**

There existed a significant correlation for almost all the body composition parameters. The relationship between per cent body fat, mineral and visceral fat area was not significantly correlated. A high degree of significance existed between weight and fat free mass, total body water and mineral content. Weight was positively correlated with body fat mass, skeletal muscle mass, body cell mass in obese subjects and the association with mineral was not significant.

**2. Correlation between BMI and body composition parameters**

Body Mass Index showed a high degree of correlation to body cell mass, total body water, fat free mass and protein was highly correlated for normal subjects and for other subjects, it was not correlated. Visceral fat area was highly correlated for overweight and obese subjects. BMI was not correlated with all the body parameters for underweight subjects.

**3. Correlation between Waist Hip Ratio (WHR) and body composition parameters**

Waist Hip Ratio showed high degree of correlation with body fat mass for underweight subjects, per cent body fat for underweight as well as obese subjects. WHR was negatively correlated with body fat mass and per cent body

fat for overweight subjects and fat free mass for underweight and obese subjects. WHR was correlated with body fat mass and visceral fat area for obese subjects, visceral fat area for underweight and normal subjects. WHR was not correlates with protein for overweight and obese subjects.

**4. Correlation between Arm circumferences and body composition parameters**

Arm circumferences were highly significant with skeletal muscle mass and fat free mass for all the subjects except for underweight and obese subjects. Arm circumference showed negative degree of correlation with mineral for underweight and normal subjects. Arm circumference was highly significant with body fat mass for all the subjects except for overweight and obese subjects.

**5. Correlation between Arm Mid Circumferences (AMC) and body composition parameters**

It is revealed that AMC was highly significant to skeletal muscle mass except for obese subjects. AMC was negatively correlated to fat free mass for underweight subjects and for others it was highly correlated. With AMC body fat mass was not significant for overweight subjects and significant for all other subjects. Mineral was negatively correlated to AMC for underweight subjects, not significant for obese subjects and highly correlated to normal and overweight subjects.

Table XXII represents the correlation within body composition parameters among selected subjects**.**

**TABLE XXII**

**CORRELATION WITHIN BODY COMPOSITION PARAMETERS AMONG SELECTED SUBJECTS**

**N = 60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| BFM Vs PBF | 0.971** | 0.800** | 0.604** | 0.660** |
| BFM Vs FFM | -0.444* | 0.349$^{NS}$ | 0.232 $^{NS}$ | 0.359 $^{NS}$ |
| BFM Vs TBW | -0.267 $^{NS}$ | 0.347 $^{NS}$ | 0.228 $^{NS}$ | 0.379 $^{NS}$ |
| BFM Vs Protein | -0.205 $^{NS}$ | 0.315 $^{NS}$ | 0.175 $^{NS}$ | 0.352 $^{NS}$ |
| BFM Vs Mineral | -0.674** | 0.396 $^{NS}$ | 0.368 $^{NS}$ | 0.122 $^{NS}$ |
| BFM Vs VFA | 0.876** | 0.620** | 0.537* | 0.733** |
| FFM Vs Protein | -0.413 $^{NS}$ | 0.997** | 0.997** | 0.995** |
| FFM Vs TBW | 0.953** | 1.000** | 1.000** | 0.999** |
| FFM Vs SMM | 0.035 $^{NS}$ | 0.990** | 0.998** | 0.996** |
| FFM Vs Mineral | 0.804** | 0.984** | 0.976** | 0.918** |
| TBW Vs ICW | 0.332 $^{NS}$ | 0.998** | 0.998** | 0.994** |
| TBW Vs ECW | 0.777** | 0.992** | 0.994** | 0.984** |
| Protein Vs SMM | -0.228 $^{NS}$ | 0.993** | 0.999** | 0.998** |
| Mineral Vs BMC | 1.000** | 0.999** | 0.999** | 0.997** |

** Significant at 1% level* Significant at 5% level $^{NS}$ Not Significant

Body fat mass was highly (0.01 levels) significant with per cent body fat. Body fat mass showed no significance with fat free mass for normal, overweight and obese subjects. Body fat mass with protein, total body water was not significant for all the subjects. Body fat mass showed high degree of correlation with visceral fat area for all the subjects except for overweight subjects. Protein showed no correlation for all the subjects. Mineral showed negative correlation with body fat mass for underweight subjects.

Fat free mass showed high degree of correlation with protein for all the subjects and not significance for underweight subjects. Fat free mass was highly significant for total body water for all the subjects. Skeletal muscle mass was not significant for underweight subjects.

Total body water highly correlated (0.01 levels) with intra cellular water for all the subjects except underweight subjects (0.332) and extra cellular water showed correlation with total body water. Protein showed high correlation (0.01 levels) with skeletal muscle mass for all the subjects and no statistical significance was observed (0.228) for underweight subjects.

## G. ENERGY BALANCE OF THE SELECTED SUBJECTS

### 1. Resting Energy Expenditure (REE kcals) and Daily Reference Value (DRV) for selected subjects

Resting energy expenditure and daily reference value energy for selected subjects is given in Table XXIII.

**TABLE XXIII**
**RESTING ENERGY EXPENDITURE (REE KCALS) AND DAILY REFERENCE VALUE (DRV) FOR SELECTED SUBJECTS**

**N=60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| REE* | 1037±75.85 | 1104±64.20 | 1166.03±99.78 | 1187.63±60.58 |
| DRV** | 1556.1±113.90 | 1656±102.94 | 1748±149.39 | 1780.7±91.36 |

***REE (kcals) = 21.6 X FFM (kg) + 370 (FFM = Fat Free Mass, kg) ***John and Cunningham, (1991). ****DRV = BMR X Activity factor.**

Mean Resting Energy Expenditure for underweight subjects were (1037 ±75.85), for overweight subjects it was (1166.03±99.78) higher and higher for obese subjects (1187.63±60.58). Mean Daily reference value for an underweight subjects were (1556.1±113.90) and for normal subjects were (1656±102.94) and little similar for overweight and obese subjects.

### 2. Energy balance of the selected subjects

Energy balance of the selected subjects is represented in Table XXIV.

**TABLE XXIV**
**ENERGY BALANCE OF THE SELECTED SUBJECTS**

**N=60**

| Parameters | Underweight n=15 | Normal n=15 | Overweight n=15 | Obese n=15 |
|---|---|---|---|---|
| **Intake (kcals)** | 1131.33±177.56 | 1668.89±136.53 | 2162.02±212.56 | 3111.31±666.78 |
| **Expenditure (kcals)** | 1037.4±75.85 | 1104±64.20 | 1165.33±99.78 | 1187.13±60.91 |
| **Balance (kcals)** | 93.75±196.83 | 564.49±143.50 | 995.99±256 | 1923.68±668.23 |

There existed a statistically significant difference between the energy intakes of four groups of subjects. A significant difference in energy intake of normal and underweight subjects was noted, and also for normal and obese subjects. The other groups when compared showed no statistical significance.

Table XXV represents statistical interpretation for comparison of energy balance among selected subjects.

**TABLE XXV**

**STATISTICAL INTERPRETATION FOR COMPARISON OF ENERGY BALANCE AMONG SELECTED SUBJECTS.**

**N=60**

| Parameters | Energy Intake | Energy Expenditure | Energy Balance |
|---|---|---|---|
| Normal Vs. Underweight | 0.460* | -0.101 NS | 0.523* |
| Normal Vs Overweight | 0.055 NS | -0.375 NS | -0.089 NS |
| Normal Vs Obese | 0.458* | -0.035 NS | 0.378 NS |
| Overweight Vs Underweight | -0.052 NS | 0.087 NS | -0.019 NS |
| Overweight Vs Obese | 0.074 NS | -0.194 NS | 0.058 NS |

** Significant at 1% level* Significant at 5% level NS Not Significant

Positive energy balance was seen among all the selected subjects, which indicate that their energy intake is greater than their energy expenditure.

From the foregoing results and discussion, it is evident that the incidence of underweight, overweight and obesity among the selected adult females were 23 per cent (n=49), 16 per cent (n=32) and 24.5 per cent (n=49) respectively. The anthropometric measurements and body composition measures showed significantly higher values among the overweight and obese adult females when compared to their normal counterparts. Though the normal subjects had a normal BMI, their body composition measures especially body fat mass, percentage body fat were above the standard. Similarly the biochemical values namely blood hemoglobin showed that mild anemia among obese, overweight and normal subjects. Thus there existed an association between energy balance, body composition and anthropometry. Further studies on large sample size are needed to generate data base on body composition of individuals.

# V. SUMMARY AND CONCLUSION

Women play a critical role in ensuring the health, nourishment and overall wellbeing of their entire family and it influences the health of the future generations. Body composition, the chemical or anatomical composition of the body, unlike body weight, has a profound influence on the health and longevity. Healthy body composition produces significantly better overall health not only with regard to body fat content but also in terms of protein, mineral and water content of the body.

The present study entitled **"Body Composition Measures of Adult Females (19 – 34 years)"** was aimed at assessing the incidence of underweight, overweight and obesity in adult females of 19 – 34 years, determining the body composition of selected subjects and finding the association between energy balance, body composition and anthropometry. In the methodology, two hundred adult females in the age group of 19 – 34 years from Avinashilingam Institute for Home Science and Higher Education for Women as well as women from outside the institution were screened for underweight, overweight and obesity using height, weight, Body Mass Index (BMI), waist circumference and hip circumference as parameters. Based on Asian cutoff reference value for underweight <18.5, normal 18.5 – 22.9, overweight 23 – 24.9 and obese > 25 (Low, *et al., 2009)*. Among the four groups of adult females, fifteen were selected from each group for further study. Oral and written consent was obtained from the participants and the study protocol was approved by the Institutional Human Ethics Committee of Avinashilingam University and the approval number was AUW/IHEC-13-14/XPD-06.

An interview schedule was formulated and data regarding socio – economic background, health history, lifestyle and dietary pattern were collected from the selected adult females. Further, nutritional status of the selected adult females was made through biochemical assessment (blood hemoglobin and blood glucose) and twenty four hour recall method was used to obtain details regarding the food and nutrient intake of adult females. Later the body composition of the selected subjects was assessed using 'Bio Space, InBody720 – the precision body composition analyzer'. The four main body composition components assessed were body fat, protein, mineral and total body water. Other parameters

assessed include Soft Lean Mass (SLM), Skeletal Muscle Mass (SMM), Per cent Body Fat (PBF), ratio of extra cellular water to total body water (ECW/TBW) and ratio of extra cellular fluid to total boy fluid (ECF/TBF), Body Cell Mass (BCM), Bone Mineral Content (BMC), Visceral Fat Area (VFA). Resting Energy Expenditure (REE) was estimated and BMR was calculated using the age and sex specific predictive equations. The energy balance of the selected adult females was calculated from the computed energy intake and energy expenditure data. The data was statistically appraised using the software SPSS version 15.0. Comparisons were made between various parameters of four groups using t – test. Correlations among anthropometric measurements, body composition parameters and biochemical parameters were derived using Karl Pearson's coefficient of correlation. Probability at both 0.05 and 0.01 levels of significance was considered to draw conclusions.

The salient findings of the study are summarized below:

- Among the selected subjects, 58.5 per cent of the subjects were under the age group of 20 – 24 years, 18.5 per cent of them were 18 – 19 years and 25 – 29 years were only 14.5 per cent (n=49).
- Among the selected subjects, 23 per cent (n=46) of adult females were underweight, 36.5 per cent (n=73) were normal, 16 per cent (n=32) were overweight and 24.5 per cent (n=49) were obese.
- Among the selected subjects, 83.4 per cent of the subjects were Hindus, 3.3 per cent were Muslims and 13.3 per cent were Christians. Around 66.7 per cent of the subjects belonged to nuclear family and 33.3 per cent belonged to joint family, and also 66.7 per cent of their family members were 1 to 4 in number and 33.7 per cent of their family members were between 5 to 7 in number. Most of them were born at first and second order. Around 11.6 per cent of the subjects were born at third or more than fourth order.
- Among the selected subjects, 38.3 per cent of head of the family were involved in business, 36.7 per cent were government employees, 16.7 per cent were coolie workers and 8.3 per cent of them were agricultural labourers and all the subjects were doing sedentary activity

- Among the selected subjects, 53.3 per cent of the underweight subjects, family history did not reveal any health complaints in their family and also 40 per cent of the normal weight subjects were also not exposed to any health complaints and 20 per cent of the overweight subject's family history showed obesity and 13.3 per cent of both obese and underweight subject's family history also showed obesity in their family history. Among the selected subjects, diabetes mellitus was seen in 73.3 per cent of the obese subject's family history and 40 per cent of the normal weight subject's family history.
- Among the selected subjects, 86.6 per cent of the normal and 53.4 per cent of the underweight subjects did not express any health complaints. Approximately 40 per cent of the underweight subjects and 20 per cent of obese subjects had recently suffered from fever. Around 53.4 per cent of the overweight and obese subjects had attained their menarche at the age of 12 and 13 years. Around 40 per cent of the overweight and normal subjects had attained their menarche at the age of 15 and 14 years.
- Among the selected subjects, 46.7 per cent of the underweight subjects showed family stress and 40 per cent of the normal subjects also suffer the same. Among the normal and obese subjects, stress was managed by hearing music in 46.7 and 53.4 per cent respectively. Among 40 per cent of the overweight subjects sleep was the mode to reduce stress.
- Among the selected subjects, 45 per cent of the subjects use walk as the mode of travel every day, 33.3 per cent of the subjects used travelling by bus and 18.3 per cent of the subjects were using other vehicles like car, taxi for their mode of travel. Around 53.3 per cent of the subjects were not having the habit of sleeping during afternoon after having food.
- Sleeping habit among the subjects was around 93.3 per cent among the underweight subjects who did not exercise, 33.3 per cent of the overweight subjects were going for walk for 1 to 2 hours, 66.7 per cent and 33.3 per cent respectively go for walk to 4 hours. Around 96.7 per cent of the underweight subjects were spending their leisure time activity by watching television, 66.6 per cent of the overweight subjects were reading books as their leisure time activity.

- Among the selected subjects, around 45 per cent of the subjects were not having the habit of skipping their meals, while other subjects were skipping their meals.
- Around 33.3 per cent of the overweight subjects were not having the habit of consuming ready to eat foods. Around 49.7 per cent of the underweight subjects were consuming sweets sporadically and 40 per cent of the obese subjects were consuming sweets weekly and 49.7 per cent of the normal subjects were consuming fried foods and 40 per cent of the underweight subjects were consuming fried foods.
- Among the selected subjects, 53.4 per cent of the normal as well as obese subjects were consuming foods from hotel. Around 66.7 per cent of the overweight subjects were consuming non – vegetarian items from hotel. Around 40 per cent of the underweight and overweight subjects were consuming snacks.
- Among the selected subjects, 66.7 per cent and 60 per cent of the normal as well as underweight subjects did not have the habit of consuming health drinks.
- Among the subjects, 46.7 per cent of underweight, normal and obese subjects did not have the habit of changing their dietary pattern during special days. Around 53.4 per cent, 46.7 per cent and 53.4 per cent of the underweight, overweight and obese subjects had respectively changed their dietary pattern during any festival or functions.
- Among the selected subjects, 66.7 per cent of the obese subjects were not having the habit changing their food pattern during menstruation. Nearly 40 per cent of the overweight as well as normal subjects included fruits.
- Among the subjects, 53.4 per cent of the normal and overweight subjects and 60 per cent of the underweight and obese subjects were taking fruits to maintain their normal weight. Around 66.7 per cent of the normal subjects were taking vegetables in the form of salad to maintain their weight. Around 73.4 per cent of the normal subjects and 33.3 per cent of the obese subjects were avoiding oily foods for their weight maintenance
- Among the subjects, about 60 per cent of the underweight subjects were not taking any precautions to improve weight gain and unnecessary weight

loss measures around 53.4 per cent of the obese subjects and seven per cent of overweight were doing exercise to maintain normal weight.

- During illness conditions like fever, Gastro Intestinal Disorders (GIDs), jaundice, constipation, etc most of the subjects (73.3 per cent) were changing their dietary pattern.
- The cereal consumption of was 80 per cent, 60 per cent, 46 per cent and 67 per cent among underweight, normal, overweight and obese subjects respectively. Consumption of pulses were 53 per cent daily for underweight, normal and obese subjects, whereas 60 per cent for overweight subjects.
- Green Leafy Vegetable (GLV) consumption was daily only by 13 per cent by underweight subjects, seven per cent for both overweight and obese subjects. Roots and Tuber consumption was seen once weekly among all the subjects. Around 74 per cent, 67 per cent and 60 per cent of the normal, overweight and obese subjects respectively had other vegetables daily in their diet.
- Consumption of fruits among underweight and normal subjects was 54 per cent weekly and 2 – 4 times in a week. Beverages were consumed by 40 per cent of the underweight subjects were daily. Around 60 per cent of the overweight subjects did not take beverages. Around 47 per cent of the underweight subjects and 40 per cent of the normal subjects respectively did not consume prepared foods.
- Weight was positively correlated with body circumferences like Arm circumference and arm mid circumference in all groups except underweight subjects. High positive and significant differences ($p < 0.01$) were noticed for all the parameters of obese subjects. For underweight subjects all the parameters tested were not found to be statistically significant with weight like BMI, WHR, AC and AMC.
- From the above table there was slight difference in the glucose level of underweight, normal, overweight and obese subjects. From the above table it is evident that 60 per cent (n – 36) of the subjects had normal range of hemoglobin (>12g / dl). Around 31.6 per cent (n – 19) of the subjects are mild anemia having hemoglobin of (10 – 12g /dl). And 8.4 per cent (n – 5)

of the subjects suffer with moderate (7 - 10g/dl). No subjects evidenced severe anemia (<7g/dl).

- For underweight subjects protein intake was found to be deficit when compare to RDA that was 8.49g. With regard to fat intake, all the subjects showed excess fat consumption than RDA. Energy intake was deficit for both underweight as well as normal subjects. In case of calcium all the subjects showed excess intake. And for Iron, both underweight and normal subjects consumed less iron than the RDA.
- Body fat mass of all the subjects revealed that except underweight subjects (9.26±3.12), the mean value was more than the reference value. Percentage body fat was more than cut off values for all the subjects like 22.91±6.9, 34±3.32, 37.57±3.52 and 44.35±4.13 for underweight, normal, overweight and obese subjects respectively. Protein was normal for all the subjects except normal subjects (7.2 -8.8). Skeletal Muscle Mass was deficit for normal and underweight subjects (19.9 – 24.3). Visceral fat area for obese subjects were more than reference value (<100).
- Weight control data for the subjects showed that underweight have to improve their weight and obese and overweight subjects have to reduce their weight according to their target weight. Fat control measurements for all the subjects were high but compared to others, for an underweight subjects, it was relatively less. Strengthening muscle mass is very important for all the subjects.
- Total body water, skeletal muscle mass and bone cell mass were highly significant for all the subjects except overweight and obese. The fat free mass for normal and obese subjects and underweight and obese subjects were found to be significant. Mineral, Bone mineral content, body cell mass and fat free mass was showed correlation to normal and overweight subjects. Fat free mass, total body water, protein, skeletal muscle mass, mineral, bone mineral content and body cell mass was not significant for overweight and obese subjects. Protein, mineral and body cell mass were not significant for obese and underweight subjects.
- The relationship between per cent body fat, mineral and visceral fat area showed no significant correlation. A high degree of significance existed

between weight and fat free mass, total body water and mineral content. Visceral fat area showed high degree of correlation for overweight and obese subjects. BMI was not correlated with all the body parameters for underweight subjects.

- WHR was negatively correlated with body fat mass and per cent body fat for overweight subjects and fat free mass for underweight and obese subjects. Arm circumferences were highly significant with skeletal muscle mass and fat free mass for all the subjects except for underweight and obese subjects. Mineral was negatively correlated to AMC for underweight subjects, not significant for obese subjects and highly correlated to normal and overweight subjects.
- Total body water highly correlated (0.01 levels) with intra cellular water for all the subjects except underweight subjects (0.332) and extra cellular water showed correlation with total body water. Protein showed high correlation (0.01 levels) with skeletal muscle mass for all the subjects and did not show significance (0.228) for underweight subjects.
- There existed a statistically significant difference between the energy intakes of four groups of subjects. A significant difference in energy intake of normal and underweight subjects was noted, and also for normal and obese subjects. The other groups when compared showed no statistical significance.
- Positive energy balance was seen among all the selected subjects, which indicate that their energy intake is greater than their energy expenditure.

From the results, it may be concluded that though the study was carried out with small sample size, the findings revealed the importance of body composition measurements in adult females and the association between body composition measures, biochemical parameters, energy balance and anthropometry. Further studies on larger sample size in all groups of population are recommended to create a database on body composition measures.

**Recommendations that emerge out of the study:**

- Data base generation for body composition measures of all age groups of population.

- Body composition measures of subjects with non – communicable disorders.
- Studies on body composition measures and its association to different physical activity level.
- Studies on body composition measures in metabolic syndrome.

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**APPENDIX I**

**AVINASHILINGAM DEEMEMED UNIVERSITY** அவினாசிலிங்கம் பல்கலைக்கழகம்
**(DEPARTMENT OF FOOD SCIENCE AND NUTRITION)**
(உணவியல் மற்றும் ஊட்டச்சத்து துறை)
**INTERVIEW SCHEDULE QUESTIONNAIRE FOR BODY COMPOSITION MEASURES OF ADULT FEMALES (19-34 YEARS)** இளம் (19-34 வயது) பெண்களின் உடல்கூறினை கண்டறிய நேர்காணல் கேள்விகள்

**I-SOCIO – ECONOMIC DATA** (சமூகப்பொருளாதார தகவல்**)**

1. Name(பெயர்):
2. Age(வயது):
3. Occupation(தொழில்):
4. Native address ( முகவரி):
   ☐ Coimbatore ☐ Other district ☐ other state
5. Religion (மதம் ):
   ☐ Hindu (இந்து) ☐ Muslim (முஸ்லீம்)
   ☐ Christian (கிறிஸ்துவம்) ☐ others (மற்றவை)
6. Family size(குடும்ப நபர்களின் எண்ணிக்கை):
   ☐ 1-4 ☐ 5-7 ☐ >8
7. Type of family(குடும்ப வகை):
   ☐ Nuclear family (தனி குடும்பம்) ☐ Joint family (கூட்டுக்குடும்பம்)
   ☐ Extended family (மிகப்பெரியக்குடும்பம்)
8. Birth order(பிறப்புவரிசை):
   ☐ 1 ☐ 2 ☐ 3
9. Occupation of the head of the family (மாத வருமானம்)
   ☐ Agricultural labour (விவசாயி) ☐ Coolie (கூலி)
   ☐ Government employee (அரசு ஊழியர்) ☐ Business (சுயதொழில்)
10. Monthly income of the family in rupees(குடும்பவருமானம் ரூபாயில்)
    ☐ > 3000 ☐ 3000-5000
    ☐ 5000 -10,000 ☐ 10,000(10,000க்கும்அதிகமாக)

**II ANTHROPOMETRIC MEASUREMENTS**

**1.** Height (உயரம்) (cm):
**2.** Weight எடை (kg):
**3.** BMI உடல் எடை விகிதம் (kg/m2):
**4.** Waist circumference வயறு சுற்றளவு (cm):
**5.** Hip circumference இடுப்பு சுற்றளவு (cm):
**6.** Waist Hip Ratio (WHR வயறு இடுப்பு விகிதம்):

**III HEALTH HISTORY**

1. Did you suffer from any of the following disease recently? (தாங்கள் தற்போது ஏதேனும் பின்வரும் நோயினால் பாதிக்கப்பட்டு உள்ளீரா?)
   ☐ Yes (ஆம்) ☐ No (இல்லை) if yes, mention ஏதேனும் இருப்பின், குறிப்பிடுக
   ☐ Gastro intestinal disorders (வயறு கூடல் சம்மந்தமான உபாதைகள்)

☐ Fever (காய்ச்சல்) ☐ Food poisoning (உணவு விஷமாதல்)

☐ Jaundice (மஞ்சள் காமலை) ☐ others (வேறு ஏதேனும்)

2. Does any of your family members suffer from (உங்கள் குடும்ப உறுப்பினர் ஏதேனும் பின்வருவனவற்றால்பாதிக்கப்பட்டு உள்ளாரா?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, mention ஏதேனும் இருப்பின், குறிப்பிடுக

☐ Obesity (உடல் பருமன்) ☐ Diabetes mellitus (சர்க்கரைநோய்)

☐ Hypertension (உயர் ரத்த அழுத்தம்) ☐ Cancer (புற்று நோய்)

☐ Arthritis (மூட்டுவலி) ☐ cardiovascular disease (இதயகுழல் நோய்)

3. Age of menarche (பூப்படைந்த வயது)

4. Problems during menstrual cycle (மாதவிடாய் சுழற்சி போது ஏற்படும் சிக்கல்கள்)

☐ Excessive bleeding (மேலும் இரத்தப்போக்கு) ☐ other problem (பிற சிக்கல்)

☐ Irregular menstruation (ஒழுங்கற்ற மாதவிடாய்)

☐ Physical discomfort (உடல் அசௌகரியம்)

☐ Polycystic ovarian (கருப்பை கரு பிரச்சனை)

☐ No problem (பிரச்சனை இல்லை)

**IV LIFE STYLE PATTERN**

1. How do you travel to college/work daily? (அன்றாடம் கல்லூரி எவ்வாறுபயணம் செல்வாய்?

☐ By walk (நடைபயிற்சி மூலம்) ☐ By bus (பஸ்மூலம்)

☐ By bicycle (சைக்கிள் மூலம்) ☐ others (பிற)

2. How many hours do you sleep in a day? (ஒரு நாள் நீங்கள் எத்தனை மணி நேரம் தூங்கவீர்கள்?

☐ < 6 hours (6 க்கும் குறைவாக மணி நேரம்) ☐ 6-8 (6-8மணி நேரம்)

☐ >8hours (8 க்கும் அதிகமான மணி நேரம்)

3. Do you sleep soon after having food? (நீங்கள் உணவு உண்ட பிறகு விரைவில் தூங்க வீர்களா?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, ஆம், எனில்

☐ Daily (தினசரி) ☐ Weekends (வார இறுதிகளில்)

☐ Sometimes (சில நேரங்களில ☐ once in a week (வாரத்திற்கு ஒரு முறை)

4. Stress pattern(மன அழுத்தம் முறை)

☐ Peer pressure (நண்பர்கள் அழுத்தம்) ☐ Family stress (குடும்ப மன அழுத்தம்)

☐ Occupational stress (தொழில் அழுத்தம்) ☐ others (மற்றவை)

5. How do you manage stress? (எப்படி மன அழுத்தத்தை சமாளிப்பீர்கள்?

☐ By music (நடனம் மூலம்) ☐ By dance (இசை மூலம்)

☐ By shouting (கத்துவது மூலம்) ☐By sleep (தூங்குவது மூலம்)

6. Do you have any idea about the normal body weight? (உங்களுக்கு சாதாரண உடல் எடையை பற்றி ஏதாவது தெரியுமா?)

☐ Yes (ஆம்) ☐ No (இல்லை)

if yes, mention the foods to be included and avoided to maintain normal weight(சாதாரண எடையை பராமரிக்க தவிர்க்கப்பட வேண்டும் உணவுகள் குறிப்பிடுக)

| Foods (உணவுகள்) | Included (சேர்க்ககூடியவை) | Avoided (தடுக்கவேண்டியவை) |
|---|---|---|
| | | |

7. Do you think that you are normal weight? நீங்கள் சரியான உடல் எடை உள்ளவரா?

☐ Yes (ஆம்) ☐ No (இல்லை)

8. Did you feel uncomfortable feelings about your bodyweight? உங்கள் எடையை பற்றி சங்கடதினை உணர்ந்து இருக்கிறீர்களா?

☐Yes (ஆம்) ☐No (இல்லை)

9. Are you interested in reducing the bodyweight? நீங்கள் எடை குறைக்கும் ஆர்வம் உள்ளவரா?

☐ Yes (ஆம்) ☐ No (இல்லை)

If yes mention the steps you have taken any ஆம், எனில் நீங்கள் எந்த எடுத்த நடவடிக்கைகள்

☐Medicine (மருத்துவம்) ☐ Exercise (உடற்பயிற்சி)

☐Dieting (உணவு உணவுக்கட்டுப்பாடு)☐ Skipping Meal (உணவை தவிர்த்தல்)

☐Consuming Less or No Sweet (குறைவாக அல்லது இனிப்பு சாப்பிடுவதில்லை)

☐Consumption of Vegetable Salad (காய்கறி கலவை) ☐ others (மற்றவை)

11. Do you have the habit of consuming ready prepared foods? நீங்கள் தயாரிக்கப்பட்ட உணவுகளை சாப்பிடும் பழக்கம் இருக்கிறதா?

☐Yes (ஆம்) ☐No (இல்லை) if yes, mention the type foods ஏதேனும் இருப்பின், குறிப்பிடுக

| Items (பொருட்கள்) | Daily (தினமும்) | Weekly ( வாராந்திரம் ) | Occasionally (எப்போதாவது ) | Rarely ( அரிதாக ) |
|---|---|---|---|---|
| Sweets ( இனிப்பு )<br>Fried Items ( வறுத்த பொருட்கள் )<br>Salted Foods (உப்பு உணவுகள் )<br>Fast Foods( துரித உணவுகள் )<br>Beverages (பானங்கள்)<br>Fruits ( பழங்கள் )<br>Ready to eat foods ( ஏற்கனவே சமைத்த உணவுகள்) | | | | |

12. Do you have the habit of doing exercise? நீங்கள் உடற்பயிற்சி செய்யும் பழக்கம் உள்ளவரா?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, mention any ஆம் என்றால்

☐ Walking (நடைபயிற்சி) ☐ Jogging (மிதமாக ஓடுதல்)

☐ Yoga and Medication யோகா மற்றும் தியானம் ☐ others (மற்றவை)

13. How many time you will do exercise in a day. நீங்கள் உடற்பயிற்சி செய்யும் நேரம்.

☐ 1-2 hours ( 1-2மணி நேரம்) ☐ 3-4 hours (3-4 மணி நேரம்)

☐ 5-6hours (5-6 மணி நேரம்) ☐ more than 6 hours (6 மணிக்கும்அதிகமாகநேரம்)

14. Mention your leisure time activity உங்கள் ஓய்வு நேர நடவடிக்கை

☐ Listening Music (இசை கேட்டு) ☐ Reading Books (புத்தகங்கள்)

☐ Watching TV (டிவி பார்த்து) ☐ Craft Work (கைவினைவேலை)

☐ Others (மற்றவை)

**V DIETARY PATTERN**

1. Are you a நீங்கள் ஒரு

☐ Vegetarian (சைவம்) ☐ Non- Vegetarian (அசைவம்)

☐ Ova- Vegetarian (முட்டை உண்ணும் சைவம்)

2. How many meals do you consume in a day? ( நீங்கள் ஒரு நாள் எத்தனை முறை சாப்பிடுவீர்கள்? )

☐ <2 ☐ 3 ☐ >4 ☐ No

3. Do you have the habit of skipping meals? நீங்கள் உணவை கைவிடுதல் பழக்கம் உள்ளதா?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, give reason ஆம் என்றால், காரணம் கொடுக்க

☐ Do not like the food (உணவு பிடிக்காது

☐ Fighting with others (மற்றவர்களுடன் சண்டை)

☐ Appetite (பசியின்மை) ☐ Others (மற்றவை)

4. Do you eat food outside? நீங்கள் வெளியே சாப்பிடும்உணவு பழக்கம் உண்டா ?

☐ Yes (ஆம்) ☐ No (இல்லை)

if yes mention the source of you purchased.ஆம், என்றால் நீங்கள் வாங்கிய பொருட்கள்

| Source ( வாங்கும் இடம்) | Items (வாங்குபவை) | Frequency முறை | | |
|---|---|---|---|---|
| | | Daily ( தினமும்) | Weekly (வாராந்திரம்) | Rarely ( அரிதாக) |
| Canteen ( சிற்றுண்டி சாலை) Hotel ( உணவுவிடுதி ) Vendors (விற்பனையாளர்கள் | | | | |

5. Do you consume health drinks? நீங்கள் சுகாதார பானங்கள் குடிப்பீர்களா ?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, mention ஆம் என்றால்

☐ Hot beverages (சுடு பானம்) ☐ Health drinks (சுகாதார பானம்)

☐ Cold beverages (குளிர் பானம்) ☐ Fruit Juices (பழசாறு)

6. Do you modify your eating habits according to the following conditions? பின் வரும் நேரங்களில் எவ்வாறு உண்பீர்கள் ?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes, mention the condition ஆம் என்றால்

| Conditions ( நிபந்தனை ) | Mention ( என்ன வகை) |
|---|---|
| Underweight ( எடைகுறையும் போது ) Overweight ( அதிக எடை உள்ளபோது) Holidays(விடுமுறை போது) Functions (விழாக்காலம்) Seasons ( பருவங்கள் ) | |

7. What type of food do you consume during menstruation? நீங்கள் மாதவிடாயின் போது என்ன வகை உணவு உண்பீர்கள் ?

☐ Yes (ஆம்) ☐ No (இல்லை if yes mention the food included and avoided ஆம் என்றால்

| Foods (உணவுகள்) | Included ( சேர்க்ககூடியவை ) | Avoided ( தடுக்கவேண்டியவை ) |
|---|---|---|
| | | |

8. Do you follow food pattern during disease conditions? பின் வரும் நேரங்களில் எவ்வாறு உண்பீர்கள் ?

☐ Yes (ஆம்) ☐ No (இல்லை) if yes mention ஆம், என்றால்

| Conditions ( நிபந்தனை ) | Included ( சேர்க்ககூடியவை) | Avoided ( தடுக்கவேண்டியவை ) |
|---|---|---|
| Fever (காய்ச்சல் )<br>Gastrointestinal disorders (இரைப்பை கோளாறுகள்)<br>Constipation( மலச்சிக்கல் )<br>General weakness ( பொது பலவீனம் ) | | |

9. Food frequency table (உணவு அதிர்வெண் அட்டவணை)

| S.No | Foods (உணவுகள்) | Daily தினமும் | 2-4 times in a week வாரம் 2-4 முறை | Once in a week (வாரம் ஒரு முறை | Once in a month (மாதம் ஒரு முறை) | Never எப்போதாவது |
|---|---|---|---|---|---|---|
| 1 | Cereals (தானியங்கள் ) | | | | | |
| 2 | Pulses ( பருப்பு வகை) | | | | | |
| 3 | GLV ( கீரைகள் ) | | | | | |
| 4 | Other vegetable ( பிற காய்கறிகள் | | | | | |
| 5 | Nuts and oilseeds ( கொட்டை , எண்ணெய் வித்துக்கள் ) | | | | | |
| 6 | Fruits (பழங்கள்) | | | | | |
| 7 | Meat, poultry and fish ( இறைச்சி , | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | கோழி மற்றும் மீன் ) | | | | | |
| 8 | Fat and oils ( கொழுப்பு மற்றும் எண்ணெய் ) | | | | | |
| 9 | Sugars ( சர்க்கரைகள் ) | | | | | |
| 10 | Beverages ( பானங்கள் ) | | | | | |
| 11 | Prepared foods தயாரிக்கப்பட்ட உணவுகள் | | | | | |

10. Three day recall method ( 3 நாள் உண்ணும் முறை )

| Menu (உணவுகள் ) | DAY நாள்-1 | DAY 2 நாள்-2 | DAY 3 நாள்-3 |
|---|---|---|---|
| Early morning (அதிகாலை ) | | | |
| Breakfast ( சிற்றுண்டி) | | | |
| Midmorning ( மதியத்திற்கு முன்பு ) | | | |
| Lunch ( மதியம்) | | | |
| Evening (சாயங்காலம் ) | | | |
| Dinner (இரவு ) | | | |
| Supper ( தூங்கும் முன் ) | | | |

# INSTITUTIONAL HUMAN ETHICS COMMITTEE

*Avinashilingam*
Institute for Home Science and Higher Education for Women
*University*
(Estd. u/s 3 of UGC Act 1956)



2nd January 2014

To
Ms. Vijayalakshmi M
Department of Food Science and Nutrition
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Madam,

Ref : Your proposal No. AUW.IHEC.2013:21 entitled "Body Composition Measures of Adult Females (19-34 years)" submitted for approval of the IHEC on 6th December 2013

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No.AUW.IHEC.2013:21 entitled "Body Composition Measures of Adult Females (19-34 years)" submitted by you. The Approval number for the same is AUW/IHEC-13-14/XPD-06.

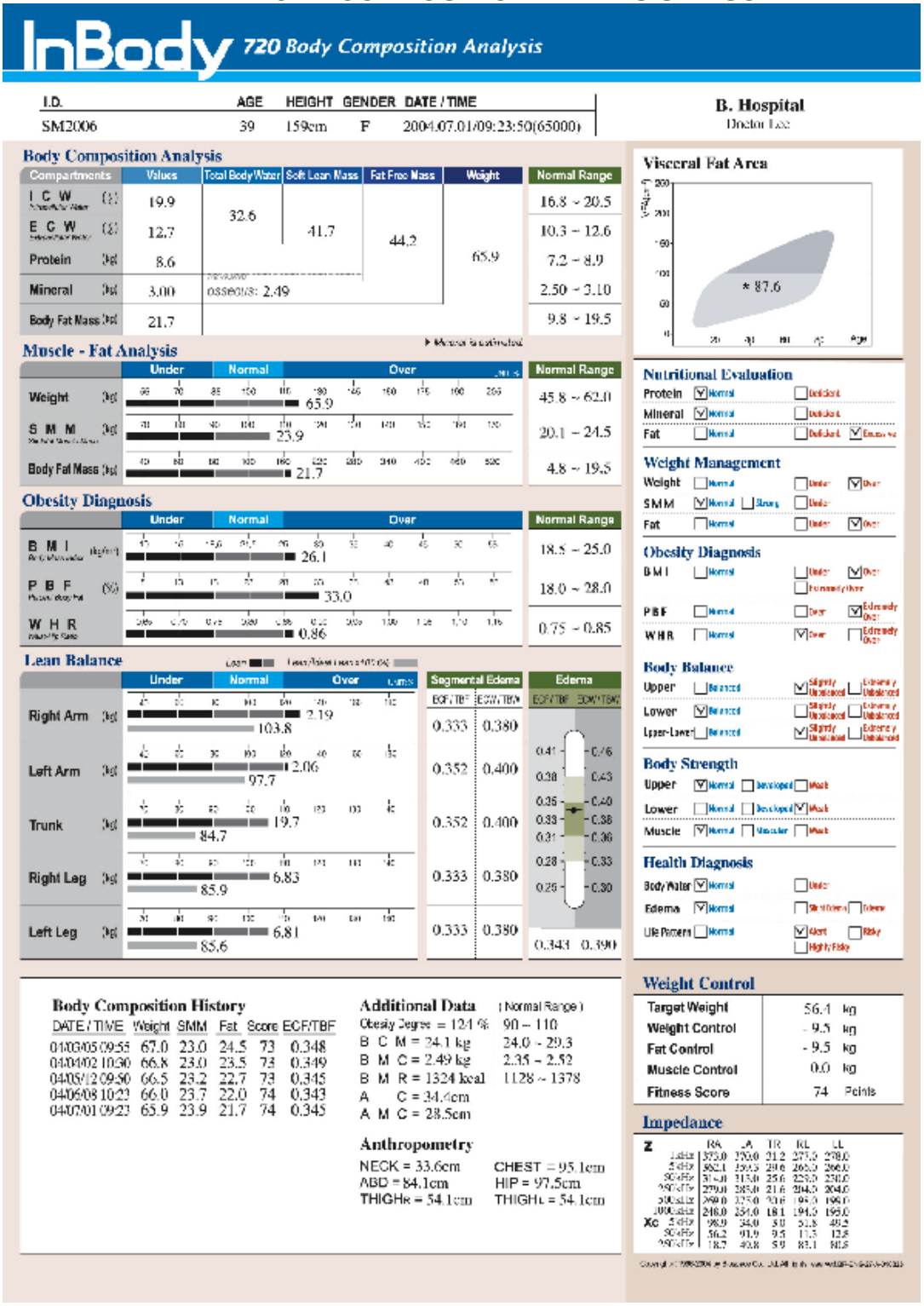
We wish you all the best in your research endeavours.

Regards,

Dr.P.R.Padma
Member Secretary

Institutional Human Ethics Committee

# APPENDIX III
# BODY COMPOSITION ANALYSIS RESULT



InBody 720 Body Composition Analysis

| I.D. | AGE | HEIGHT | GENDER | DATE / TIME |
|---|---|---|---|---|
| SM2006 | 39 | 159cm | F | 2004.07.01 09:23:50(65000) |

B. Hospital
Doctor Lee

**Body Composition Analysis**

| Compartments | Values | Total Body Water | Soft Lean Mass | Fat Free Mass | Weight | Normal Range |
|---|---|---|---|---|---|---|
| I C W (L) | 19.9 | 32.6 | 41.7 | 44.2 | 65.9 | 16.8 ~ 20.5 |
| E C W (L) | 12.7 | | | | | 10.3 ~ 12.6 |
| Protein (kg) | 8.6 | | | | | 7.2 ~ 8.9 |
| Mineral (kg) | 3.00 | osseous: 2.49 | | | | 2.50 ~ 3.10 |
| Body Fat Mass (kg) | 21.7 | | | | | 9.8 ~ 19.5 |

▶ Mineral is estimated.

**Muscle - Fat Analysis**

| | Under | Normal | Over | Normal Range |
|---|---|---|---|---|
| Weight (kg) | | 65.9 | | 45.8 ~ 62.0 |
| S M M (kg) | | 25.9 | | 20.1 ~ 24.5 |
| Body Fat Mass (kg) | | 21.7 | | 4.8 ~ 19.5 |

**Obesity Diagnosis**

| | Under | Normal | Over | Normal Range |
|---|---|---|---|---|
| B M I (kg/m²) | | 26.1 | | 18.5 ~ 25.0 |
| P B F (%) | | 33.0 | | 18.0 ~ 28.0 |
| W H R | | 0.86 | | 0.75 ~ 0.85 |

**Lean Balance**

| | Under | Normal | Over | Segmental Edema ECF/TBF | Segmental Edema ECW/TBW | Edema ECF/TBF | Edema ECW/TBW |
|---|---|---|---|---|---|---|---|
| Right Arm (kg) | | 2.19 / 103.8 | | 0.333 | 0.380 | | |
| Left Arm (kg) | | 2.06 / 97.7 | | 0.352 | 0.400 | | |
| Trunk (kg) | | 19.7 / 84.7 | | 0.352 | 0.400 | | |
| Right Leg (kg) | | 6.83 / 85.9 | | 0.333 | 0.380 | | |
| Left Leg (kg) | | 6.81 / 85.6 | | 0.333 | 0.380 | | |
| | | | | | | 0.343 | 0.390 |

**Visceral Fat Area**




**Nutritional Evaluation**

| | | | |
|---|---|---|---|
| Protein | ☑ Normal | ☐ Deficient | |
| Mineral | ☑ Normal | ☐ Deficient | |
| Fat | ☐ Normal | ☐ Deficient | ☑ Excessive |

**Weight Management**

| | | | |
|---|---|---|---|
| Weight | ☐ Normal | ☐ Under | ☑ Over |
| S M M | ☑ Normal ☐ Strong | ☐ Under | |
| Fat | ☐ Normal | ☐ Under | ☑ Over |

**Obesity Diagnosis**

| | | | |
|---|---|---|---|
| B M I | ☐ Normal | ☐ Under | ☑ Over<br>☐ Extremely Over |
| P B F | ☐ Normal | ☐ Over | ☑ Extremely Over |
| W H R | ☐ Normal | ☑ Over | ☐ Extremely Over |

**Body Balance**

| | | | |
|---|---|---|---|
| Upper | ☐ Balanced | ☑ Slightly Unbalanced | ☐ Extremely Unbalanced |
| Lower | ☑ Balanced | ☐ Slightly Unbalanced | ☐ Extremely Unbalanced |
| Upper-Lower | ☐ Balanced | ☑ Slightly Unbalanced | ☐ Extremely Unbalanced |

**Body Strength**

| | | | |
|---|---|---|---|
| Upper | ☑ Normal | ☐ Developed | ☐ Weak |
| Lower | ☐ Normal | ☐ Developed | ☑ Weak |
| Muscle | ☑ Normal | ☐ Muscular | ☐ Weak |

**Health Diagnosis**

| | | | |
|---|---|---|---|
| Body Water | ☑ Normal | ☐ Under | |
| Edema | ☑ Normal | ☐ Slightly Edema | ☐ Edema |
| Life Pattern | ☐ Normal | ☑ Alert | ☐ Risky<br>☐ Highly Risky |

**Body Composition History**

| DATE / TIME | Weight | SMM | Fat | Score | ECF/TBF |
|---|---|---|---|---|---|
| 04/03/05 09:55 | 67.0 | 23.0 | 24.5 | 73 | 0.348 |
| 04/04/02 10:30 | 66.8 | 23.0 | 23.5 | 73 | 0.349 |
| 04/05/12 09:50 | 66.5 | 23.2 | 22.7 | 73 | 0.345 |
| 04/06/08 10:23 | 66.0 | 23.7 | 22.0 | 74 | 0.343 |
| 04/07/01 09:23 | 65.9 | 23.9 | 21.7 | 74 | 0.345 |

**Additional Data** (Normal Range)

| | | |
|---|---|---|
| Obesity Degree | = 124 % | 90 ~ 110 |
| B C M | = 24.1 kg | 24.0 ~ 29.3 |
| B M C | = 2.49 kg | 2.35 ~ 2.52 |
| B M R | = 1324 kcal | 1128 ~ 1378 |
| A C | = 34.4cm | |
| A M C | = 28.5cm | |

**Anthropometry**

| | |
|---|---|
| NECK = 33.6cm | CHEST = 95.1cm |
| ABD = 84.1cm | HIP = 97.5cm |
| THIGHR = 54.1cm | THIGHL = 54.1cm |

**Weight Control**

| | | |
|---|---|---|
| Target Weight | 56.4 | kg |
| Weight Control | - 9.5 | kg |
| Fat Control | - 9.5 | kg |
| Muscle Control | 0.0 | kg |
| Fitness Score | 74 | Points |

**Impedance**

| Z | RA | LA | TR | RL | LL |
|---|---|---|---|---|---|
| 1kHz | 375.0 | 370.0 | 21.2 | 273.9 | 278.0 |
| 5kHz | 302.1 | 299.5 | 29.6 | 265.0 | 266.0 |
| 50kHz | 301.0 | 313.0 | 25.6 | 225.0 | 230.0 |
| 250kHz | 279.0 | 285.0 | 21.6 | 204.0 | 204.0 |
| 500kHz | 269.0 | 275.0 | 20.0 | 194.0 | 196.0 |
| 1000kHz | 248.0 | 254.0 | 18.1 | 194.0 | 195.0 |
| Xc 5kHz | 98.0 | 94.0 | 8.0 | 52.6 | 49.5 |
| 50kHz | 36.2 | 41.9 | 9.5 | 11.3 | 12.8 |
| 250kHz | 18.7 | 20.8 | 5.9 | 83.1 | 80.6 |