Introduction
The body dimension, human evolution, race and cranial dimensions and intelligence were the four limited areas of research on which the biological anthropologists concentrated in the beginning. Later on their interest has been extended to comparative biology of man. Biological anthropologists are now interested not only in understanding human evolution through the study of biological variation in modern man, but also conducting studies relating to the understanding of the variation within and between populations based on several genetic markers viz., blood groups, serum and red cell proteins and enzymes, dermatoglyphics etc., throughout the world (Bhasin and Singh, 1998). In recent times, biological anthropologists were not only studying human variation but also conducting genetic epidemiological research pertaining to certain diseases and their associated risk factors (Majumdar and Rao, 1991; Blangero and Blangero, 1993). More recently the focus has been shifted to molecular genetics (Roberts, 1991; Venkatramana et al., 2001; Duggirala et al., 2004; Arya et al., 2004; Reddy et al., 2005).

In spite of much development in physical anthropological research, biological anthropologists are continuing to show their interest in understanding the population variation using environmentally sensitive anthropometric variables. The measurement of obesity and body composition using these anthropometric variables is also of great interest to physical anthropologists. World Health Organization (WHO) states that "anthropometry is the single most universally applicable, inexpensive and non-invasive method to assess the size, proportion, composition of the human body" (WHO, 1995). The obesity and body composition are considered in many metabolic and physiological studies, as they provide information on energy stores, risk factors for pathological process (Prijutmoko, 1993) and prognosis in a variety of acute and chronic illness (Prijutmoko, 1993; Roubenoff and Kehayias, 1991).

World Health Organization (WHO, 2003) observed that the non-communicable diseases (NCD) constitute a serious and increasing health hazard both in developed and developing countries. Nearly 60% of deaths globally are now due to NCDs. The risk factors like hypertension, hypercholesterolemia, smoking, low physical activity, overweight and obesity are playing a major role in causing epidemiological diseases such as diabetes (Gordon et al., 1977; Bose, 1992), coronary heart disease (CHD) (Foster and Burton, 1985; Ghosh et al, 2003, 2004),
respiratory complications, dyslipidaemia, osteoarthritis of large and small joints, sleep apnoea (Seidell and Bouchard, 1997), hypertension (Bose and Taylor, 1998; Vague et al., 1998) and cancer (Murray and Lopez, 1996). Because of its causative nature in several chronic non-communicable diseases, it is of great interest to measure body composition and obesity and its associated risk factors among the general populations.

The study of human body composition is a branch of human biology which focuses on the *in vivo* quantification of body components, the quantitative relationships between components, and the quantitative changes in these components related to various influencing factors (Wang et al., 1992). Body composition is the relationship of percentage of body fat to lean body weight. The body is made up of many kinds of tissue - bone, muscle, body organs, water and body fat. Scientists have been studying body composition since the beginning of the 20th century, but research has increased dramatically in the last 25 years as methods for measuring and analyzing the body composition have grown in accuracy. There is growing evidence that clearly links body composition to health risks and the development of certain diseases. New researches indicate that fat loss, not weight loss can extend human longevity. By measuring body composition, a person's health status can be more accurately assessed and the effects of both dietary and physical activity programs are better directed.

The body composition has three interconnecting areas: body composition rules, body composition methodology, and body composition alterations (Fig. 1).

![Fig.1: The study of human body composition: Three research areas.](image-url)
The first area of early study was concerned with collecting quantitative information on body components. Because there were no in vivo methods for measuring various components in the last century, cadaver autopsy was the only way to obtain quantitative data on body composition.

The second area of early study focused on in vivo methods of measuring various body components. Daily urinary creatinine excretion was used by Shaffer and Coleman (1909) as an index of total body skeletal muscle mass. Skeletal muscle, the main source of urinary creatinine, was probably the first body component estimated by an in vivo method. Body fluids and relevant components were measured, in the early stage, by techniques based on indicator dilution principles. Keith et al. (1915) estimated blood volume using Vital Red and Congo Red as markers. von Hevesy and Hofer (1934) used deuterium ($^{2}$H$_2$O) to measure total body water, and Moore (1946) measured exchangeable sodium and potassium, which are mainly distributed in body fluids and, thus, could be measured by dilution methods. The famous principle of Archimedes (287–212 BC) was applied to body composition studies by Behnke et al. (1942) to estimate the relative proportions of fat and fat-free mass in the human body. Keys and Brozek (1953) suggested the more detailed densitometric method which is still widely applied today with modifications. Sievert (1951) demonstrated that the amount of radioactive isotope 40K in the human body is large enough to be detected and quantified by radioactive techniques, while Forbes et al. (1961) estimated fat-free body mass and total body fat from total body potassium by using a whole body 40K g-ray assay. Moore et al. (1963) applied another radioactive isotope, 42K, to quantify exchangeable potassium and body cell mass.

The third area focused on alterations in body composition caused by various influencing factors. Age was probably the first factor studied by early body composition researchers. Nutrition was another factor studied during the early stage of body composition research. Cathcart (1907) found that body nitrogen was lost during fasting, while Benedict et al. (1919) further pointed out that body nitrogen was lost due to a modest reduction in food intake. Later, additional factors influencing body composition, such as exercise, race, gender, and several diseases, were investigated by early body composition researchers. The early stage of the study of human body composition lasted as long as a century (1850s–1950s).
In the first area, which is inadequately formulated at present, five levels of increasing complexity are proposed: I. Atomic; II. Molecular; III. Cellular; IV. Tissue-system; and V. Whole body (Fig 2).

**Fig. 2:** The five levels of human body composition. ECF and ECS extracellular fluid and solids, respectively.

There are now many different methods available for making assessment of the several aspects of body composition. Classification by categories of techniques are available for the assessment of human body composition (Solomons and Mazariegos, 1995). The commonly used techniques measure the following.

**ANTHROPOMETRY**

Surface measurements

Standing height (stature)

Arms pan

Knee-height
Circumferences (different sites)

Thickness measurements

Skinfold thickness (different sites)

DILUTION METHODS

Deuterium dilution
Tritium dilution
Bromide dilution
Sulfate dilution

ELECTROMAGNETIC

Bioelectrical impedance analysis (mono frequency)
Bioelectrical impedance analysis (multi frequency)
Total body electroconductivity (TOBEC)

IMAGING

Single-photon
Dual-photon
Dual-X-ray
Computerized tomography (CT)
Infrared refractometry
Magnetic resonance imaging (MRI)

ENDOGENOUS RADIATION

Potassium 40 content
Whole body neutron activation analysis
BODY COMPOSITION MODELS

There are three body composition models. They are two, three and four compartment models. In two-compartment model: fat mass (FM) and fat free mass (FFM) are measured. In three-compartment model: FM, total body water (TBW) and fat free dry mass (FFDM) are measured and while in four-compartment model: FM, water, bone mineral and residual are measured.

The more traditional methods are based on a two-compartment model that simply divides the body into fat and fat-free mass. Hydrodensitometry (underwater weighing) is based on the two compartment model. Newer, more sophisticated techniques, such as dual energy x-ray absorptiometry (DEXA) measure the body as multiple compartments. This approach improves the accuracy of the calculation for determining the real density of fat-free mass. There is only one "direct" method of measuring body composition that is close to 100% accurate, and that is an autopsy performed post mortem. All other current methods for measuring body composition rely on "indirect" measurements techniques and are called in vivo methods – meaning they are performed on a living body.

The in vivo methods give estimates of percentage of body fat, fat-free mass, muscle, bone density, hydration, or other body components. Each method uses one or more measurable body components (such as skinfold thickness, resistance, etc.) to make educated predictions about the other components. These predictions are based on years of research that define statistical relationships between different body components. As early as 1921, Matiegka (1921) formulated an equation for calculating body fat from body measurements of surface area of six skinfold thicknesses. Brozek and Keys (1951) were the first to use the relationship between skinfold thickness and body density for assessing fat content. The skinfolds chosen were not ideal and their formula has not been widely used. Pascale et al. (1956) in the USA produced an equation, and Parizkova, (1961) in Czechoslovakia define a nomogram, for predicting fat content from skinfold thickness. Steinkamp et al. (1965) gave predicting equation based on measurements of body circumferences and skinfold thickness on subjects.
Most of the methods preferably be used for individuals assessment because most of them are expensive, time consuming and require special equipment and therefore they are not suitable for field or community studies. Hence body composition measured through anthropometry is the most universally used technique because of its simplicity, and easy way of carrying out among general populations. Further it has become easier to compare body composition between populations of different ethnicity and evaluate body composition as a marker of lifestyle, morbidity between these groups (Prijatmoko, 1995).

Among the Indian populations some studies were conducted by Satwanti et al. (1977, 1978, 1979, 1980, 1997 and 1999) to estimate body composition measures. Their findings (1977) supported the earlier workers that the regression equations predicting body density in young women are not universal and should only be applied to groups of individuals of similar ethnic composition. In another study (1978) on estimation of body fat and lean body mass from young Indian women, they opined that simple girth measurements could be substituted for skin fold thickness for predicting fatness and leanness. In a study published in the year 1979 using densitometric and anthropometric techniques, body fat, body water, bone mineral and cell solids were determined on young Indian women. Comparisons were made for these components between young Indian men and women. A clear cut sexual dimorphism was observed in the fat and water content of the body. A comparative study of fatness and leanness of the young women in various regions of the world displayed that the young Indian women were shorter and leaner compared to the young women in the western countries. Satwanti et al. (1980) demonstrated skinfold measurement were found to be better predictors of body fat than the weight-height indices, and this is in accordance with the findings of other workers (Brockett et al., 1956; Keys et al., 1972; Womersley and Durnin, 1977).

Variation in body composition of male and female was carried out by Satwanti et al. (1999). The differences in the inclination of regression lines for Asian and British girls are not as marked as were observed for Asian and British adults (Satwanti et al. 1997). The girls in both the groups were fatter than boys by skinfold and densitometric standard. The British boys were taller and heavier than the Asian boys, but there was no difference in their body fat content. The Asian girls
tend to be fatter than British girls. Asian girls also had larger skinfold thickness at most of the sites as compared to British girls. The two groups of boys showed little difference in most of the anthropometric variables. The two groups of girls were quite similar regarding their girth and diameters. The similar environmental conditions of Asian and British children that might have reduced the variation in their body compositions compared to the adult subjects who inhabited two entirely different environments.

The distribution fatness of subcutaneous fat was depicted from profiles of fatness in both the groups. It also depicted the intra and inter group variation in fat fold thickness. The thickness of skin fold varied in both the groups. The high altitude females although shared a common site of maximum fatness and of minimum fatness with plain females. The skin fold thickness changed in between. The pattern of subcutaneous fat was found to be more uniform in high altitude females and also relatively more fat seem to be in the trunk region (Satwanti Kapoor, 1999)

Indian women had more fat in spite of having lower mean body weight as compared to Indian males who were taller and heavier (Steele et al., 1950 and Mc Murry et al., 1958). On comparing the leanness-fatness of the young Indian women in various regions of the world, Indian women were found to be shorter and leaner than the American and European women.

Body height decreased with age both secularly and biologically. The reduction of body height was greater at higher ages. Body weight increased with age, the change being partly a cohort effect and partly an effect of age. Evidence of a reduced muscle mass in the arms with age was found. Body cell mass increased with age in some age strata. There was an increase in subcutaneous fat with age, both in the arms and in the trunk (Noppa et al., 1980).

The new standards can be used to differentiate those who are at risk of being obese and undernourished. It is recommended that assessment of anthropometric nutritional status and health status of contemporary adult and elderly populations be made with reference to the present standards in conjunction with age correction factors (Frisancho, 1984).
Bhasin and Singh (1991) reported body composition among five groups of Kashmiris. Body fat in case of age group 19+ years and above is highest in Dogra Rajputs, followed by Dogra Brahmins, Dogra Schedule caste, Tibetans and Gujjars. Percent body fat in Dogra Brahmins, Dogra Rajputs is higher than sea level population of Tamilnadu (Bharadwaj et al., 1973), whereas Dogra Scheduled castes, Tibetans and Gujjars show lower fat content than Tamilians. All the population groups show higher percent body fat than high altitude Ladakhis except Gujjars, who show lower percent of body fat.

Tyagi et al. (2005) study on body composition and fat distribution pattern of urban elderly females living in Delhi explained that the level of fatness expressed in whatever form increased with age and declined thereafter along with a redistribution of fat resulting in more android pattern of fatness. All the body girths, indices of body composition, profile of subcutaneous fat accumulation and sensitivity of each skinfold site showed an increasing fat deposition on trunk than on the appendages among test group females. The differential rate of fat accumulation at various sites in different age group females explains apparent differences in their physique and may have health consequences accordingly.

Ghosh and Bandopadhyay (2006) conducted a study on income, birth order, and anthropometry among adults living in Kolkata. Although the studied individuals enjoy similar physical environmental conditions and are characterized by similar traditional socio cultural behavior, family influences have an important effect on adult body dimensions, BMI, and body composition.

Body Mass Index (BMI), Arm muscle circumference (AMC), Arm muscle area (AMA), Body Density (BD), Percent body fat (%BF) and Fat Free Weight (FFW) were estimated among males of Andhra Pradesh (Venkatramana, 1987). The mean of the above variables in this populations is BMI = 20.19, AMC = 22.58, AMA = 1.79, BD = 0.058, %BF = 17.62, FFW = 44.70.

Forbes (1987) has suggested that the composition of tissue lost or gained varies according to the initial level of fatness. There is less fat in the tissue change at lower levels of initial fatness. Norgan (1994) concluded that low BMI approximates to low weight, FM and the functionally important FFM. There are significant differences in the relationship of body composition to BMI but for many purposes
and over the range of BMI 20-25 kg/m² these may not be important shape as
described by sitting height/total height (SH/S) ratios, affects the BMI and its
interpretation. To interpret BMI in terms of body composition more specifically it is
necessary to take into account sex, age and ethnicity.

Prijamoko and Strauss (1995) carried out a study on low-cost body
composition among Indonesian adults. Of these, the percent fat mass (%FM) by
anthropometry and bioelectrical impedance analysis (BIA) within genders for either
population were not significantly different. BMI, %Fat, triceps and suprailliac
skinfolds and abdominal hip ratio (AHR) were significantly higher in the Melbourne
population for both men and women, while biceps and subscapular skinfolds were
not different between the two groups.

Withers et al. (1998) observed that the differences between two compartment
hydrodensitometric and four compartment models were significantly associated with
biological variability in free fat mass (FFM) hydration. Differences between these
two models were not associated with inter individual variability in body mineral
mass (BMM), which provided only a marginal increase in accuracy.

Wagner and Heyward (2000) reviewed literature on the differences and
similarities between the two races relative to fat-free body mass (water, mineral, and
protein), fat patterning, and body dimensions and proportions. In general, blacks
have a greater bone mineral density and body protein content than do whites,
resulting in a greater fat-free body density. Additionally, there are racial differences
in the distribution of subcutaneous fat and the length of the limbs relative to the
trunk

Kwok et al. (2001) carried out a study on prediction of body fat by
anthropometry in older Chinese people. The results showed that the combination of
body mass index and upper-limb skinfold thickness (SFTs) give reliable prediction
of fat percentages in older Chinese people, except in the obese.

Casas et al. (2001) used a prospective cross-sectional design to examine total
and regional body composition in Hispanic women (primarily of Mexican descent)
and white women of similar socio-economic status (SES). The results of their study
provided experimental support for the concept that among healthy women, Hispanic
ethnicity may be associated with modestly elevated total adiposity and lower total free fat mass (FFM). These whole-body differences appeared to be primarily the result of body-composition differences in the trunk region. These findings may have important implications for disease prevention and maintenance of functional capacity with advancing age in Hispanic women.

At relatively low BMI and WHR, Singaporean adults experience elevated levels of risks (absolute and relative) for cardiovascular risk factors. These findings, in addition to earlier reported high percentage body fat among Singaporeans at low levels of BMI, confirm the need to revise the WHO cut-off values for the various indices of obesity and fat distribution, viz BMI and WHR, in Singapore (Deurenberg-Yap et al., 2001).

Great dietary variety and high frequency of consumption of restaurant meals were predictors of body fatness equal in importance to low physical activity level (PAL). Dietary fat percentage and energy density were not significant predictors of body fatness, but energy density predicted within-subject variability in energy intake. These findings highlight the potential importance of dietary variety and frequency of consumption of restaurant meals in influencing dietary intake and body fatness (Yao et al., 2003).

Goh et al. (2004) conducted a study on BMI and other anthropometric measures appropriate as indices of obesity among Asian population. BMIs adjusted for the local population have much improved sensitivity but are still plagued by high false-positive rates, especially for men. Overall, locally established BMI cutoff points are better indices for screening of obesity that any of the anthropometric indices studied. However, to better assist in efforts to combat the scourge of the increasing incidence of obesity, more precise indices for obesity need to be established.

Lee et al. (2005) concluded that weight changes were common, but most participants, including those who unintentionally lost weight, maintained their weight change or resolved their weight change in 6 months. Unintentional weight loss appears less likely to resolve than other weight changes.
A population-based study was conducted on physical activity and energy expenditure (PAEE) to predict changes in body composition among middle-aged healthy whites (Ekelund et al. 2005). The results underscore the importance of developing physical activity programs designed to prevent obesity in younger middle-aged adults who are likely to gain weight. In contrast, such programs may prevent weight loss and preserve FFM in older adults who are weight stable.

Obesity is defined as a condition of abnormal or excessive fat accumulation in the fat tissue of the body. The practical and clinical definition of obesity is based on the body mass index (BMI) (weight (kg)/height (m²)), or obesity is defined as a condition of excessive fat and is associated with a large number of life threatening disorders (WHO, 1998). Stunkard and Wadden (1993) defined obesity as an excessively high amount of fat or adipose tissue in relation to lean body mass. Overweight/obesity refers to increased body weight in relation to weight, when compared to the same standard of acceptable or desirable weight.

Obesity is increasing alarmingly throughout the world. WHO (1998) estimated that there are more than 250 million obese people world-wide, equivalent to 7% of the adult population. Recently WHO (2002) has collected data on obesity among adults from 84 countries around the world in 1999-2000. The results indicated that the global prevalence of obesity (BMI ≥ 30kg/m²) was 8.7%. The prevalence was lowest in the least developed countries and highest in the developed countries. The research results from different corners of the globe indicated that the problem of overweight/obesity has been showing an increasing trend not only in the developed countries but also among the developing countries including Asian countries (Florentino, 2002).

The WHO (1998) stated that the growth in the number of severely overweight adults is expected to be double that of under-weight during 1995-2025. Although obesity is the starting scene in India compared to western countries, nevertheless it needs to be tackled aggressively before it assumes serious epidemic properties. Obesity is increasing at an alarming rate throughout the world and has become a global problem. The World Health Organization (WHO) has declared overweight as one of the top 10 health risks in the world and one of the top five in developed nations (WHO, 2002).
Once considered a problem related to affluence, obesity is now fast growing in many developing countries and in poor neighbourhoods of the developed countries (WHO, IASO & IOTF, 2000; WHO, 2003). Even in countries like India, which are typically known for high prevalence of under nutrition, a significant proportion of overweight and obese people now coexist with those who are under nourished (Popkin, 2002).

In many developing countries including India with increasing urbanization, mechanization of jobs and transportation, availability of processed and fast foods, and dependence on television for leisure, people are fast adopting to less physically active lifestyles and consuming more “energy-dense, nutrient-poor” diets (Drewnowski and Popkin, 1997; Popkin, 1998; 2001; 2002; Popkin et. al., 2001; Bell, Ge and Popkin, 2002; WHO, 2003). Because of urbanization and modernization, our lives are becoming more sedentary and less physically active than before. Urbanization involves changes in occupation patterns, lifestyles, family structures and value systems. These changes have an impact on dietary practices and the levels of physical activity.

The prevalence of obesity is increasing in most populations of the world, irrespective of gender and age. A number of factors have been linked to obesity, including age, gender and socio-economic status with the advancement of science and technology in industrialized societies. The prevalence of this menace is low in higher socio-economic groups, but in developing countries this relationship is reversed (Sobol and Stunkard, 1989; Randrianjohany et al., 1993). This difference is attributed to the rapid transition in lifestyles in the process of urbanization, wherein, urban lifestyle has been linked with dramatic changes leading to increased consumption of high energy dense foods and increased leisure time physical activity.

In India also the prevalence of overweight and obesity has been showing an increasing trend among the Indian populations (Gopalan, 1998). The prevalence is higher in urban populations than in rural, however, a rise is seen in both the groups (Venkatramana and Chengal Reddy, 2002).

Epidemiological and population health promotion surveys usually take body mass index (BMI: body weight in (kg)/height in (m²) as a useful indicator for measuring overall obesity and also it is an indicator to measure chronic energy
deficiency (CED). The waist-hip-ratio (WHR) and waist circumference (WC) are being used to measure abdominal fat accumulation that is, the indicator of central obesity.

The Food and Agriculture Organization (FAO) since its inception focuses on under nutrition and hunger. But over the past decade FAO has recognized the growing obesity epidemic occurring not only in the developed world but also among all income and socio-economic groups of the developing world. Hence, FAO in consultation with International Dietary Energy Consultative Group (IDECG) has proposed the following classification for under/overweight and obesity (Table -1).

<table>
<thead>
<tr>
<th>BMI (kg/m²)</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 16.0</td>
<td>Category III Category of Under nutrition/CED</td>
</tr>
<tr>
<td>16.0-16.9</td>
<td>Category II Category of Under nutrition/CED</td>
</tr>
<tr>
<td>17.0-18.4</td>
<td>Category I Category of Under nutrition/CED</td>
</tr>
<tr>
<td>18.5-24.9</td>
<td>Normal</td>
</tr>
<tr>
<td>25.0-29.9</td>
<td>Category I obesity A Garrow’s risk-based category of obesity</td>
</tr>
<tr>
<td>30.0-39.9</td>
<td>Category II obesity A Garrow’s risk-based</td>
</tr>
</tbody>
</table>

The FAO and the World Health Organization (WHO) have collaborated and formed the cut-off points of BMI for underweight, overweight and obesity for the entire globe. The BMI cut-off points (Table-2) for adults recommended from the WHO (1998) consultation on obesity for Preventing and Managing the global epidemic were the first such cut-off points at the international level.
Table 2. Classification of adults according to BMI

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (CED)</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal range</td>
<td>18.5-24.9</td>
</tr>
<tr>
<td>Overweight</td>
<td></td>
</tr>
<tr>
<td>Pre-obese</td>
<td>25.0-29.9</td>
</tr>
<tr>
<td>Obese class I</td>
<td>30.0-34.9</td>
</tr>
<tr>
<td>Obese class II</td>
<td>35.0-39.9</td>
</tr>
<tr>
<td>Obese class III</td>
<td>≥40.0</td>
</tr>
</tbody>
</table>

CED = chronic energy deficiency

After this classification, a good number of works shown cut-offs for obesity. The Asian populations are 'lean' and 'small' and being multiethnic and multilingual, population variation is predominant in this region. While applying the possible BMI risk based cut-off points, the prevalence of overweight and obesity appeared to be lower than elsewhere in the world populations. But statistical inference regarding the obesity and related diseases are growing in the region. This phenomenon suggests the need for a separate cut-off points for Asia. Based on large sample surveys, Inoue (2002) for Japanese populations have redefined obesity as a BMI of 25 or more and Zhou (2002) for Chinese as a BMI of 24 and 28 as markers for overweight and obesity, respectively. Later the WHO Western Pacific Regional Office in collaboration with International Obesity Task Force (IOTF) has proposed the following classification (table 3) for the Asian people (Steering Committee, 2000).
Table 3. IOTF-proposed classification of BMI categories for Asia

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt; 18.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-22.9</td>
</tr>
<tr>
<td>At-risk of obesity</td>
<td>23.0-24.9</td>
</tr>
<tr>
<td>Obese I</td>
<td>25.0-29.9</td>
</tr>
<tr>
<td>Obese II</td>
<td>≥ 30.0</td>
</tr>
</tbody>
</table>

**Waist-hip-ratio (WHR) or waist circumference (WC) to assess abdominal obesity:**

The cut-off points of waist-hip-ratio for men was greater than 1.0 and for women it was greater than 0.85 (WHO, 1998). Men and women with WC values ≤102 and ≤ 88 cm, respectively, were considered to have a normal WC, whereas men and women with WC values > 102 and >88 cm, respectively, were considered to have a high WC (NCEP, 2001).

**Prevalence of obesity among the world populations**

Over the last two to three decades, overnutrition and obesity have been transformed from relatively minor public health issues that primarily affect the most affluent societies to a major threat to public health that is being increasingly seen throughout the world even in the developing parts of the globe. The plight of the most affected populations, like the US, has been well publicized. The emphasis is on recent surveys and time-trends and data have been selected that are based on representative population surveys with measured weight and height. Most attention is devoted to the affluent countries with established market economies (North America, Europe, Australia, New Zealand, and Japan) because the data quality and time span covered by it are reasonably comparable. Data on time-trends in the developing world and in countries undergoing an economic transition are given in elsewhere (Seidell and Rissanen, 2004).
In Europe, the most dramatic increase in obesity prevalence was observed in England, where the rates have more than doubled from 6 to 15% in men and from 8 to 16.5% in women since 1980 (Prescott-Clarke et al., 1997). The other European nations experience an increase up to 40%. Rates are highest in southern and eastern European countries. In European countries, prevalence of obesity range from 10 to 20% among men and 10 to 25% among women National Health and Medical Research Council (NHAMRC, 1997).

Few countries in the European Region reported obesity rates below 10%. Prevalence rates, particularly among women, rise to more than 20% in countries such as the United Kingdom, Germany, Finland and Greece. The most rapid increase is noted in England where obesity rates have risen three-fold from 1980 to 2001. with levels of morbid obesity (BMI > 40) also increasing three-fold among men and almost doubling among women during the 1990s (Health Survey for England, 2001. www.doh.gov.uk/).

High prevalence of overweight and obesity were observed in Finland (Lahti-Koski et al., 2000), wherein 81% of men and 73% of women in 55 to 64 years of age had a BMI ≥ 25 kg/m² in 1997. In Germany in 1994, 24% of men in 60 to 69 years of age and 31% of women in the same age group had a BMI ≥ 30 kg/m² (Hoffmeister et al., 1994). In France, in 1991, 64% of men and 50% of women ≥60 years of age were overweight or obese (Maillard et al., 1999). According to the health survey in England (combined data for 1991 and 1992) the percentages of men and women from 65 to 74 years of age with a BMI ≥25 kg/m² were 62% and 60%, respectively (Breeze et al., 1994). Higher prevalence was found in the south of Italy (Barbagallo et al., 2001), where 76% of men and 86% of women in 60 to 69 years of age had a BMI ≥25 kg/m². In Spain, a study of a representative sample of adult population (35 to 64 years) showed high prevalence of overweight and obesity in the 55- to 64-year age group, in both men (74.4%) and women (77.7%) (Banegas Banegas et al. 1993). Some other studies including one or more regions in Europe have shown high prevalence of both general and central obesity in elderly populations (Quiles and Vioque, 1996; Rodriguez et al., 2000; Ramon and Subira, 2001; Martínez-Ro et al., 2001; Pablos-Velas e et al., 2002). The prevalence of
overweight and obesity in men was 49% and 31.5% respectively, in a cross-sectional study carried out on the prevalence of overweight and obesity in elderly people (>60 years) in Spain in 2001 by Gutierrez - fisca et al. (2004). The corresponding percentages in women were 39.8% and 40.8%. The results indicate that the prevalence of obesity was higher in persons with no education than in those with third level of education (i.e. University), especially among women (40.8% vs 17.5%). The prevalence of central obesity was 48.4% in men and 78.4% in women. The study indicates that differences by educational level were seen in only women, in whom the prevalence of central obesity was 80.9% in those with no education and 59% in those with third-level education. The study clearly indicates that the prevalence of overweight and obesity in Spanish adult elderly population is very high.

The prevalence of obesity among Danish population was more than doubled between 1987 and 2001 in men from 5.6% to 11.8% and in women from 5.4% to 12.5% with the largest increase among the 16-29 years old subjects (Bendixen et al., 2004). The prevalence of overweight increased from 34 - 40% in men and 17 - 27% in women. The authors concluded that substantial increase in the prevalence and risk of obesity and overweight among Danish adults was seen. The authors observed that a dramatic increase of obesity is observed in younger adults. This study concluded that the serious health and psychological problems associated with obesity likely to emerge in Danish children and young adults.

Onat et al. (1996) reported that the prevalence of obesity in a Turkish adult population of 3687 inhabitants was 18.8% (9% for men and 28.5% for women) and the prevalence was 16% in Trabzon city, which is located in the Black Sea Region, but the population studied in that region was very small (n = 422). Satman et al. (1999) in a study performed from 1997 to 1998, reported that prevalence of obesity in adults (13,708 women and 11,080 men) in Turkey was 22.3% in both men and women and the prevalence rate in women (29.9%) was higher than in men (12.9%) and the prevalence in Trabzon city was 17.8%. In another study conducted by Erem et al. (2001) from 1996 to 1997, and reported that the prevalence of obesity in adults (n = 2646) in the central province of Trabzon city was 19.2% (27.4% for women and 10.7% for men). Murat et al. (2004) reported that the prevalence of obesity and
overweight in Turkey population was show that 21.7% of the males and 31.0% of the females have obesity and an additional 43.4% of the males and 28.8% of the females were over weighted. In Turkish population, the prevalence of obesity and associated risk factors were (Erem et al., 2004) observed that the overall prevalence of obesity was 23.5%. The prevalence of obesity was 29.4% in women and 16.5% in men. The combined prevalence of both overweight and obesity was 60.3%. The prevalence of abdominal obesity was 29.4% in total population. The prevalence of abdominal obesity was 38.9% among women and 18.1% among men. The prevalence of obesity increased with age, being highest in the 60 to 69-year old age group (40.8%) but lesser in the 70+ age group.

AFRICA:

Wide disparities in levels of obesity are found in this region with the highest rates in South Africa, where mean BMI values for men and women are 22.9 kg/m² and 27.1 kg/m² respectively, but levels of central obesity among women have been assessed at 42% (Puoane et al., 2002). The South Africa Health Review (2000) indicated obesity rates range from 8% among black men to 20% among white men, but among women the rates range from 20% for Indian/Asians to 30.5% for black women. In parts of sub-Saharan Africa, obesity often exists along side under-nutrition (Maire et al., 1992).

Pasquet et al. (2003) studied on the prevalence of overweight and obesity among urban adults living in Cameroon. Obesity and overweight associated with age in both sexes. The prevalence rates increased from 20-29 years and peaked at 40-49 years in men and at 50-59 years in women then declined. Women as a group were more overweight, and more obese than men. One woman in two was overweight, and one woman in five was obese where as one-third of men were overweight and only 5% were obese. Moreover obese subjects had a larger age adjusted WHR than their non-overweight counterparts.
UNITED STATES OF AMERICA:

The prevalence of obesity in USA is more or less closer to European populations. The prevalence is 20% in males and 25% in females (Flegal et al., 1998). In the case of Brazil obesity ranges from 3.1 to 5.9% among women and from 8.2 to 13.3% among men in the 14 years between 1975 and 1989 (Monteiro et al., 1995). Within certain subpopulations of the USA, rates are even more alarming. In the United States obesity affects one in three adults overall, more than double the rate of 20 years ago. Ethnic minorities, particularly women, are even more adversely affected with 40% of Mexican American women and 50% of black American women having a BMI above 30 kg/m² compared to 30.6% of white women. Extreme obesity rates, classified as morbid or very severe obesity of BMI>40, are as high as 15% among black American women (National Health and Nutrition Examination Survey (NHANES 1999-2000). Neighboring Canada experienced an increase of 150% in its overall adult obesity rate from 1985 to 1998 reaching 14.8%, but 40% of men and 25% of women fell into the pre-obese category (Katzmarzky et al., 2002).

The prevalence of overweight has been increasing over the past several decades. In the most recently published United States data (1999 to 2002), 65% of adults are overweight (BMI 25 to 30 kg/m²), 30% of the total population are obese (BMI 30 to 40 kg/m²), and 5% have a BMI of 40 kg/m² or higher (Health United States, 2004; Hedley et al., 2004). The prevalence of obesity has also risen in some minority populations, with the highest rates found in some Native American groups, Hispanics and African Americans, the lowest rates have been found in populations of Asian ancestry (Hedley et al., 2004; Knowler et al., 1999; Lethbridge and Vickerie, 2005; Paeratakul et al., 2002). Prevalence rates for obesity in the United States are also highest in populations with less education and lower income levels (Paeratakul et al., 2002). Internationally, obesity rates are generally lower than those in the United States (York et al., 2004). However, even in societies that traditionally had the lowest prevalence of overweight and obesity, the rates of weight gain are beginning to meet or exceed those of Western societies (Popkin et al., 2001).
The Third National Health and Nutrition Examination Survey conducted on overweight and obesity among men and women (NHANES III, 1960-1994) in the United States showed that 70% of men in 60 to 69 years of age and 64% of women in the same age group were overweight or obese (Flegal et al., 1998). The NHANES survey from 1999–2000 continuously showed that 38% of men and 42% of women in the above said age group were obese (Flegal et al., 2002).

Wilson et al. (2007) conducted a study on the prevalence of obesity among American Indian and Alaska Native (AI/AN) adults with diabetes and to examine the temporal trends for class I, II and III obesity in high risk group during 10 year period. The obesity was highly prevalent in this population in 2004 and it is observed that the prevalence of BMI for class I, 28.9%; class II, 20.4%; class III, 20.3%. The percentage of obese adults increased from 16.7% to 20.4% in class II and 11.5% to 20.3% in class III from 1995 through 2004, and the mean BMI increased from 32.1 kg/m² to 34.4 kg/m². The increase in BMI was greater in the younger age groups.

Macdonald et al. (1997) reported that the prevalence of obesity among Canada adult population was estimated to be 13% in men and 14% in women. Katzmarzyk et al. (2000) conducted a survey on familial risk of overweight and obesity in the Canadian population using the WHO/NIH criteria. The study indicated that the spouses and first-degree relatives of underweight individuals have a lower risk of overweight and obesity than the general population. There is significant familial risk of overweight and obesity in the Canadian population using the BMI as an indicator. Comparison of risks among spouses and first-degree relatives suggests that genetic factors may play a role in obesity at more extreme levels more so than in moderate obesity.

AUSTRALIA:

Australia’s obesity epidemic is threatening the lives of more than half of all Australians. Recent studies estimate that more than half of all Australian women (52%) and two-thirds of men (67%) are overweight or obese (www.health.nsw.gov.au-nsw Health). That is, all most 60% of the adult populations in Australia is overweight or obese (Cameron et al., 2003).
A Nation-wide survey was conducted in 1999/2000 by Dorner et al. (2004) on the prevalence of overweight and obesity in Austrian male and female farmers. The results indicate that 15.2% of the farmers were obese and 42.9% were overweight. The prevalence of overweight and obesity was high amongst 15-19 years old, and reached a second peak among the age groups 50-59 and 60-69 years old. The prevalence of overweight and obesity is very high among Austrian farmers, especially when compared to the general population.

ASIA:

The prevalence of overweight and obesity in adults based on available data, points to the severity of the problem in Asian continent. In Malaysia, the overall nation wide prevalence of overweight was reported to be about 17%, and that of obesity 4%. The Singapore 1998 National Health Survey reported a prevalence of 24.4% for overweight and 6% for obesity. Slightly lower prevalence of overweight and obesity was gathered from the Philippine National Nutrition Surveys of 20.2%. In a study of a small number of subjects in Asian countries, the prevalence of those with BMI ≥25.0 kg/m² was found to be more than 23% in five cities, namely, Beijing, Hong Kong, Kuala Lumpur, Manila and Bangkok. In China, national nutrition surveys showed that the prevalence of overweight and obesity in young adults increased from 9.7% to 14.9% in urban areas, and from 6.2% to 8.4% in rural areas from 1982 to 1992 (Siong, 2002).

Various Asian populations may be particularly susceptible to the health risks of central obesity, regardless of BMI (James et al., 2002). Consequently there is an increasing focus on measuring waist circumferences, which can predict individual risk more accurately than body mass index (Lean et al., 1996). However, Japanese experts have agreed independently to redefine the criteria for obesity as a disease, with a cut-off at BMI>25. Using this standard, adult obesity in Japan would average 20%, rising to 30% in men over 30 years old and women over 40 years old, representing a three to four-fold increase over the last 40 years (Japan Society for the Study of Obesity (JSSO), 2002; Kanazawa et al., 2002). China has adopted its own standards defining overweight at a BMI of 24 or more, and obesity a BMI of 28 or more, while abdominal obesity is defined by a waist circumference of 85 cm in men and 80 cm in women (Zhou et al., 2002).
In Thailand, among adults (BMI > 25 kg/m²) in the 1991 National Health Examination Survey showed that 20.7% of males and 25.1% of females are overweight (IOTF, 2000). In Malaysia, Ismail et al. (1995) reported a prevalence among adults in urban areas in 1991–94 was 28.7% in males and 25.8% in females, and in Japan, the prevalence in adults with BMI ≥ 25 kg/m² in 1990–94 was 26.2% in males and 23.1% in females (Yoshiike et al., 1998). Chee et al. (2004) conducted a cross-sectional study on overweight among women workers in electronic factories in Peninsular Malaysia. Overweight was significantly raised for married women in relation to unmarried women. The factors significantly associated with overweight were age, marital status, education, income, and working in rotating shifts. The overall prevalence of overweight was 37.4%, the prevalence of overweight and mean BMI for younger age groups were similar to Malay women in the country wide. But the older age groups in this study had higher overweight.

In Vietnam, the prevalence of overweight and obesity was less than 2% in 1992–93, but double in the urban areas compared to the rural areas (Gillespie et al., 2001). In the Peoples’ Republic of China, which is in the later stage of socio-economic transition, the prevalence as shown in their 1992 National Nutrition Survey (NNS) (IOTF, 2000) was showed that 14.9% in the urban areas and 8.4% in the rural areas. In Indonesia, the prevalence of overweight in adults in 1993 was 21.5% in the urban areas and 7.5% in the rural areas. A cross-sectional survey was conducted on the prevalence and risk factors of overweight and obesity in a nationally representative sample of 15,540 Chinese adults in 2000-2001 (Reynolds et al., 2007). Body weight, height, and waist circumference were measured. The results showed that prevalence of overweight and obesity were 24.1% and 2.8% in men and 26.1% and 5.0% in women, respectively. The prevalence of central obesity was 16.1% in men and 37.6% in women. The prevalence of overweight, obesity, and central obesity were higher among residents in northern China compared with their counterparts in southern China and among those in urban areas compared with those in rural areas. Lifestyle factors were the most important risk factors to explain the differences in overweight and central obesity between northern and southern residents. Among women, lifestyle and diet were the most important risk factors to explain the differences between urban and rural residents, whereas socioeconomic status, lifestyle, and diet were all important among men. A study carried out on the
prevalence of obesity and the trends in obesity, mortality and morbidity in China (Wang et al., 2007). The results showed that between 1992 and 2002, the prevalence of overweight and obesity increased in all gender and age groups and in all geographic areas. Using the World Health Organization body mass index cut points, the combined prevalence of overweight and obesity increased from 14.6 to 21.8%. The Chinese obesity standard shows an increase from 20.0 to 29.9%. The annual increase rate was highest in men aged 18–44 years and women aged 45–59 years (approximately 1.6 and 1.0% points, respectively). In general, male subjects, urban residents, and high-income groups had a greater increase. With the increase in overweight and obesity, obesity and diet-related chronic diseases (e.g., hypertension, cardiovascular disease (CVD), and type 2-diabetes) also increased over the past decade and became more important preventable cause of death.

Abdulrahman et al. (1997) conducted a community–based National epidemiological household survey on overweight and obesity and the role of socio-demographic variables in Saudi Arabian adult population. The results showed that the prevalence of overweight was 33.1% for males and 29.4% for females. The prevalence of obesity was 22.1% for total population but it was 17.8% in males and 26.6% in females. The prevalence of obesity was higher in females than males, lower in subjects living in rural areas with traditional lifestyles than those in more urbanized environments, and increased with increasing age. The prevalence of overweight or obesity in persons 55 to 65 years of age was 74% in men and 88% in women among urban Palestinian population (Abdul-Rahim et al., 2001).

Shafique et al. (2007) conducted a study on under and overweight among rural, urban poor women living in Bangladesh. The results showed that the prevalence of chronic energy deficiency (CED) continuous to be major nutritional problem among Bangladeshi women (38.8% in rural, 29.7% in urban poor) between 2000–2004, 9.1% of urban poor and 4.1% of rural women were overweight. In addition, 9.8% of urban poor and 5.5% of rural women were found to be at risk of overweight. The risk of being overweight was higher among women who were older and of higher socioeconomic status. Rural women with at least 14 years of education had a 8.1% fold increased risk of being overweight compared with non-educated women.
Sotoudeh et al. (2005) calculated obesity in Iranian population on the basis of body mass index (BMI) and observed more than 19% of adolescents were overweight or at risk of it and 66.8% of adult females were overweight or obese. Frequency of central obesity (waist to hip ratio (WHR)) was 35.7% in all females. The mean BMI was significantly higher in married women and in women with less than 8 years of formal education.

In another study on the Iranian population (Hajian-Tilaki and Heidari, 2007), the overall prevalence rates of obesity and overweight were 18.8% and 34.8%, respectively. The overall prevalence rates of central obesity was 28.3%. The rate of obesity in women was higher than men. In both genders, particularly in the women, the rates of obesity were raised by increasing age. There was an inverse relation between the risk of obesity and marriage age, the high level of education, severe occupational activity and the level of exercise.

INDIA:

The prevalence of obesity is increasing rapidly in northern Indian states. The National family health survey (NFHS2, 1998-99) reported 5.8% of women with BMI ≥30 and 17.7% overweight women with BMI between 25-30 in urban India (Agrawal, 2002). A community-based epidemiological survey of coronary heart disease and its risk factors was carried out over the period 1984-87 on a random sample of adults aged 25-64 years, adults living in Delhi (Gopinath et al. 1994). Obesity was found to be more common in female subjects (21.3% in male and 33.4% in female). Obesity was more frequent in male subjects with lower physical activity compared to those doing heavier physical activity (29.3 vs 17.5%). In 1994, Indian Council of Medical Research (ICMR) task force carried out a study involving more than 5000 individuals (3050 urban residents and 2487 rural residents) reported 43% prevalence of overweight/obesity in urban Delhi and 12% in rural Haryana. Wander et al. (1994) conducted an epidemiology study on coronary heart disease in rural populations of Punjab in a total of 1100 individuals (623 males and 477 females) and the overall prevalence of overweight/obesity was observed to be 17%.

Chadha et al. (1997) reported a prevalence of overweight/obesity in the urban and rural Delhi areas was 27% and 10%, respectively. In another study conducted by the Nutrition foundation of India in urban Delhi revealed that the
prevalence of overweight/obesity among the middle class increased from low to high income groups, showing that about 32.2% of males and 50.0% of females in the high income group suffered from overweight (Gopalan et al., 1998). A series of studies were carried out by Gupta et al. (1995, 2002, and 2004) from Jaipur, during 1994, 2001 and 2003 and reported a rising trend of the prevalence of overweight / obesity of 20%, 36%, and 62%, respectively.

World Health Organization (2001-2003) has conducted a Sentinel Surveillance Systems survey for cardiovascular disease (CVD) in Indian Industrial Populations involving ten centers from different parts of the country. The populations included industrial employees and their family members aged 10-69 years. The overall prevalence of overweight/obesity from 10 regions of the country using the criteria (BMI ≥ 25) in the age group 20-69 was 31%. Dibrugarh in Assam had the lowest prevalence (0.5%) while Hyderabad in Andhra Pradesh had the highest (50%). The north Indian populations in Delhi, Lucknow in Uttar Pradesh and Ludhiana in Punjab had the prevalence of 41%, 37% and 15%, respectively. Central Indian populations in Nagpur and Pune in Maharashtra had the prevalence of 20% and 36% respectively. South Indian populations from Bangalore in Karnataka, Trivandrum in Kerala and Coimbatore in Tamil Nadu had a prevalence of 47%, 38% and 27% respectively. Among Industrial population in the Bharat Electronics Limited (BEL), Delhi, (Prabhakaran et al., 2005) reported that the prevalence of overweight/obesity was 35% among males. The prevalence of overweight/obesity had risen from 35% to 41% over a period of five years in BEL.

The urban cities in the country are facing high prevalence of obesity. In 2000, a multi centric study (Snehalatha et al., 2003) involving seven urban cities (Chennai, Bangalore, Hyderabad, Mumbai, Kolkata and New Delhi) in India among the age group of 20-40 and ≥ 40 age group showed a prevalence of overweight/obesity was 31% in men and 38% in women respectively (sample size: 5288 men; 5928 women). Similarly, Shukla et al. (2002) conducted a large study in Mumbai in the year 1994 and reported a prevalence of overweight/obesity was 26% among 35 age group.

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Some studies addressed the gradients of obesity among slum/non-slum groups. ICMR Task force study (1994) among dwellers of urban slum in Delhi showed a prevalence of overweight/obesity was 20%, as compared to urban and rural prevalence of 48% and 12% respectively whereas, Misra et al. (2001) reported 25% prevalence of obesity in the slums of Delhi.

Sidhu and Tatlar (2002) carried out a cross-sectional study on the prevalence of overweight and obesity among adult urban females of Punjab. The results showed that the prevalence of overweight and obesity was 20.0% and 25.3% respectively. It is apparent from this study that nearly half of the females belonging to upper middle class in Punjab are currently overweight/obese.

The prevalence of overweight and obesity is highest in the northern states of Delhi and Punjab, where, about one in three women are overweight and obese. followed by Goa and Kerala, where, about one in five are overweight or obese. The prevalence of overweight and obesity is much lower in the economically less developed states of India (Agrawal et al., 2004). Priyanka and Aarti (2007) reported the prevalence of overweight and obesity among urban college girls of Rajasthan (aged 18-24) and found that the prevalence of overweight and obesity was 5.6% and 4.4%, respectively.

Among the south Indian populations, the prevalence of overweight/obesity was 27% during 1989 (Ramachandran et al., 1992) in urban Chennai and it was 2% in rural Tamil Nadu. Subsequent studies from urban Chennai reported that the prevalence of overweight/obesity in the year 1995 and 2000 was 23% and 30%, respectively (Ramachandran et al., 1997, 2001). In the rural areas of Tamil Nadu the prevalence of overweight/obesity rose sharply from 2% in 1989 to 17% in 2003 (Ramachandran et al., 2004). Kutty et al. (1993) carried out a study in rural Kerala during 1991 using the criteria (BMI>27) and the prevalence was found to be 5.8%. Later studies in Kerala reported 49% of prevalence of overweight among 30-64 age group in 1998 (Kutty et al., 2002) and 41% among 40-60 age group during 2000 (Zachariah et al., 2003). A higher prevalence (54%) of overweight/obesity (criteria: BMI>22.25) was recorded among elderly populations (age group: ≥60) during 2000 (WHO, 2001). Visweswara Rao et al. (1995) reported that the prevalence of
overweight among adults in urban colonies of Hyderabad was 21.8% in males and 27.4% in females, while the prevalence of obesity was 2.1% and 8.9%, respectively.

Few studies were carried out on different socio economic groups in south India. In urban Chennai, Mohan et al. (2001) reported 20% prevalence of overweight/obesity among men and women aged 20 years and above who belong to the low socio economic group (based on household income, occupation and dietary pattern) while, the middle socio economic groups had a higher prevalence (35%) during 1996-97. A study conducted in the urban areas of Chennai in the age group of ≥40 during 2000 (Ramachandran et al., 2002) reported a higher prevalence of 33% among low income group (monthly income < Rs 30000/annum and 44% prevalence among high-income group (monthly income ≥Rs 60000/annum). The earlier studies among the caste populations of Andhra Pradesh showed that the prevalence of obesity was more among the affluent communities. The prevalence was 20% in Reddis and 18% in Kammans (Venkatramana and Chengal Reddy, 1999). The prevalence was lower in middle (Kaikala with 12%) and low income caste populations (Mala with 9%) (Venkatramana et al., 2005). The prevalence of obesity was more among the affluent communities compared to poor caste populations of Andhra Pradesh (Nirmala Reddy, 1998).

ASSOCIATION OF BMI, WHR AND WAIST CIRCUMFERENCE WITH LIPID AND LIPOPROTEIN LEVELS:

Several studies were carried out to understand the association of BMI, WHR and Waist Circumference with CHD risk factors. Some of the studies are mentioned below.

In seven European and two American populations (Valdez et al., 1993) WHR was important in explaining the association with cholesterol and HDL cholesterol. The BMI and WHR were showed significant association with CHD risk factors in black (Tyroler et al., 1975; Folsom et al., 1989; and Lackland et al., 1992) and white populations (Hartz et al., 1984; Larson et al., 1984; White et al., 1986 and Despres et al., 1990). The BMI of the women of Thailand showed significant association with TC and HDL cholesterol, while WHR had a significant association with HDL cholesterol only (Leelahagul et al., 1995). Lean et al. (1998) showed that
men with a large waist circumference (>102 cm) may develop several disorders including shortness of breath, hypercholesterolemia, hypertension and difficulty with the basic activities of daily life.

In a study among men of Andhra Pradesh (Venkatramana and Reddy, 2002) the BMI and waist circumference were significantly associated with many CHD risk factors. The abdominal obesity measured through WHR showed a significant association with blood pressure but not with lipid levels in rural men of Rajasthan State (Guptha and Majundar, 1994). In another study, the BMI significantly influenced the lipid levels but not the WHR of men and women of Andhra Pradesh State (Reddy et al., 1998).

A study was conducted by Maksvytis and Stakišaitis (2004) to analyze the impact of overweight on lipid and apolipoprotein profiles in healthy women in Klaipėda Seamen’s Hospital, Lithuania. The total cholesterol and triglycerides levels were similar in the healthy and the overweight women groups respectively. The concentrations of high-density lipoprotein cholesterol was significantly higher in the normal weight women compared to the overweight women respectively.

The foregone literature explained that the body composition measures and more particularly obesity is more useful in assessing the risk factors for noncommunicable diseases. Though many studies were conducted on northern Indian populations, studies among the general populations of south India are still lacking. As recommended by WHO (1998) population based studies are necessary to understand the risk factors and compare them with other populations of the world. It is in this background an attempt is made on body composition measured through anthropometry and overweight/obesity among the three endogamous populations, the Reddy, the Golla and the Madiga with the following aims and objectives.

1. To examine the different components of body composition and their variation among three populations;
2. To assess the prevalence of obesity among three endogamous populations;
3. To understand the association of BMI groups with nutritional status and physical activity among the studied populations;

4. To estimate the lipid and lipoprotein levels among the Reddy and the Madiga populations and

5. To examine the association of lipid and lipoprotein levels with obesity (overall and abdominal).