Fat storage was at some part of our evolution was a protective mechanism, for survival during frequent famine causing non-availability of adequate nutritional supply. In today’s world, where food is plenty and majority of the world’s population overeats regularly, fat storage leads to obesity related disorders. Obesity is a chronic disease, prevalent globally among the affluent and sedentary subjects and affects the young and the old equally. It has been considered as a key risk factor for many chronic and non-communicable diseases, such as diabetes.

Obesity is recognized as a major health problem in both developed and developing countries. In India, obesity is emerging as an important health problem, paradoxically co-existing with significant under nutrition prevailing in different sections of the population. The major health consequences associated with overweight and obesity are type 2 diabetes, coronary heart diseases (CHD), hypertension, gall bladder disease, certain types of cancer, dyslipidaemia and insulin resistance.

There have been sufficient data showing an almost linear relationship between body mass index (BMI) and death. The risk increases proportionately with the duration of obesity. BMI is a simple measurement of overall adiposity. It is now recognized that rather than the degree of obesity, the distribution of body fat is a more important determinant of several disorders.

A positive association between overweight and obesity and risk of type 2 diabetes has been established repeatedly in many cross-sectional and prospective studies. It was shown that the risk conferred by obesity for developing diabetes was higher by over 40 times in obese women compared to those who remained slim; and the risk would be reduced significantly with weight loss. The association of obesity with type 2 diabetes is complex and compounded by many heterogenous factors. Obesity not only is a risk factor for development of diabetes, but also complicates the management of the disease.

Asian Indians generally have lower BMI than many other races but the association of BMI with glucose intolerance is as strong as in any other population. Recent studies have established lower limits for ideal BMI for Asian populations. It was shown for urban Indian population that at a BMI of > 23 kg/m² the risk for diabetes was significant for both genders. Therefore the healthy BMI for an Indian is definitely below 23 kg/m². This has been confirmed by studies from other parts of India and in migrant Indians, and also from other Asian populations. According to the World Health Organization (WHO) recommendations a BMI of 18.5-22 kg/m² has been considered as healthy for Asian populations.

Dietary factors and physical activity strongly influence the energy balance and therefore are the major modifiable factors influencing weight gain. The threshold for the risk associations with metabolic disorders show wide racial differences. There is a strong association of body weight with insulin resistance; higher BMI is associated with hyperinsulinaemia and insulin resistance. Insulin resistance is one of the major aetiological factors for diabetes and the risk association of obesity with diabetes is greatly mediated through insulin resistance.

Many Asian races show a tendency for fat deposition in the abdominal area which is known as central adiposity. Hyperinsulinaemia and insulin resistance are closely associated with central adiposity. Visceral fat increases the risk of diabetes and hyperlipidaemia by favouring insulin resistance. By measuring the visceral and subcutaneous abdominal fat areas in nondiabetic south Indians, we
had shown that insulin resistance was associated with subcutaneous fat thereby indicating that the subcutaneous fat was not innocuous\textsuperscript{10}.

Increased risk posed by intra-abdominal fat for diabetes and other metabolic diseases could be related to higher fat cell number in the abdominal adipose tissue, higher blood flow, increased receptors for cortisol and testosterone and greater catecholamine-induced lipolysis when compared with the subcutaneous adipose tissue\textsuperscript{11}. In addition, there is a marked increase in flux of non esterified fatty acids to the liver in abdominally obese subjects. There is sufficient evidence to show that abdominal obesity causes insulin resistance and it is a key component of the metabolic syndrome. Racial susceptibility to insulin resistance and metabolic syndrome has been demonstrated and Indians are highly susceptible to both\textsuperscript{12}.

A comparative study of the non diabetic Asian Indians and Mexican Americans demonstrated that although the former had a much lower BMI than the Mexican Americans, they had upper body adiposity [measured as waist to hip ratio (WHR)] comparable to that of Mexican Americans\textsuperscript{13}. The existence of high insulin resistance despite a lower BMI could be explained by the upper body adiposity present in the Asian Indians.

A cluster of risk factors co-exists with central obesity including glucose intolerance, obesity, hyperinsulinaemia, hypertriglyceridaemia and hypertension, all of these are important risk factors for CHD. Studies in migrant Asians comparing body fat topography with that in Caucasians have confirmed similar findings\textsuperscript{8,9,14}. Mc Keigue \textit{et al}\textsuperscript{14} reported that in Asian Indians every 0.04 unit increase in WHR was associated with 4-fold increase in diabetes (20 % in Asians, 5 % in Europeans), 2-fold higher post-glucose insulin levels (41 µU/ml in Asians vs 19 µU/ml in Europeans) and significantly higher triglycerides and low high density lipoprotein (HDL).

Insulin resistance, a characteristic feature of Asian Indians is worsened by minor increment in weight\textsuperscript{12}. Both nutritional factors and physical activity levels influence the biological action of insulin directly and also through their effect on body weight. Because central adiposity is an important risk indicator of diabetes and insulin resistance, the cut-off values for waist circumference and WHR were also determined. The cut-off values for normal waist circumference were 85 and 80 cm and for WHR 0.89 and 0.81 in men and women respectively\textsuperscript{6}. Use of waist circumference as an index of upper body adiposity appeared to be more sensitive than WHR as the former showed an interaction with general adiposity at lower levels of BMI. Therefore, use of waist circumference as an index of central adiposity is recommended.

We observed a significantly lower BMI in the rural than in the urban population, but both the groups had similar WHR\textsuperscript{15}. This probably indicated a racial tendency in the population for preferential abdominal deposition of fat. A more recent study\textsuperscript{16} showed that life style transition occurring in the rural population had significant influence on the prevalence of obesity and glucose intolerance. Prevalence of diabetes had increased from 2.2 to 6.3 per cent in a period of 14 yr. Important risk factors associated with this increase were lack of physical activity and increased upper body adiposity.

It has also been noted that for a given BMI Asian Indians have higher fat percentage compared with Caucasian subjects\textsuperscript{8,9}. Higher insulin resistance and increased risk of diabetes may be partly attributed to this feature.

There is also an increasing prevalence of type 2 diabetes among children in India and in other countries which to has been attributed to the epidemic of obesity among children\textsuperscript{1}. Prevalence of overweight was 17.8 per cent in boys and 15.8 per cent in girls aged 14-19 yr in urban southern India\textsuperscript{17}. A strong association of overweight with lack of physical inactivity and higher socioeconomic background was evident.

Urbanization is occurring rapidly in the Indian subcontinent. Life style changes involving major deviations in diet pattern, decreased physical activity due to improved transportation and availability of
energy-saving devices and high level of mental stress are associated with modernization. Weight gain and decreased energy expenditure contribute further to the existing insulin inertia.

Obesity is a modifiable disorder. There is evidence from many prospective studies that weight reduction by lifestyle modifications including dietary changes and regular physical activity reduces the risk of diabetes in high risk groups\textsuperscript{18}. Implementation of preventive measures from early childhood will have far reaching benefits as even the prevalence of other obesity related disorders could decline.

A. Ramachandran  
Diabetes Research Centre  
M.V. Hospital for Diabetes & WHO Collaborating Centre for Research, Education & Training in Diabetes  
4 Main Road, Royapuram  
Chennai 600013, India  
e-mail: ramachandran@vsnl.com  

References  


