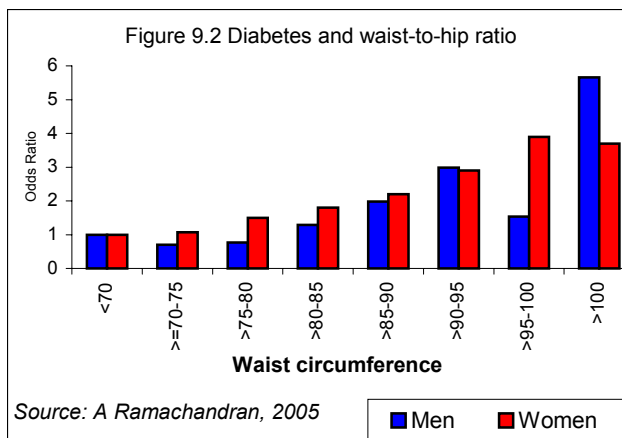
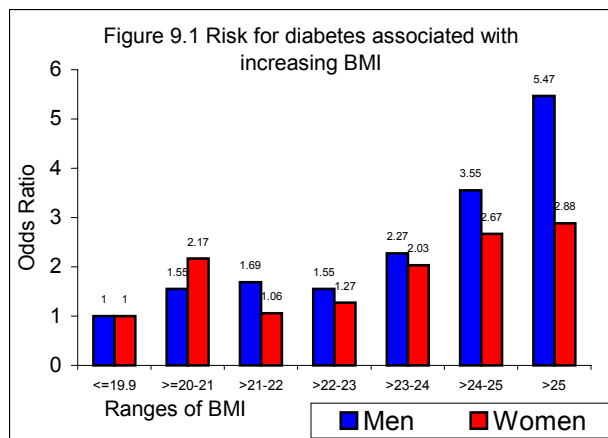
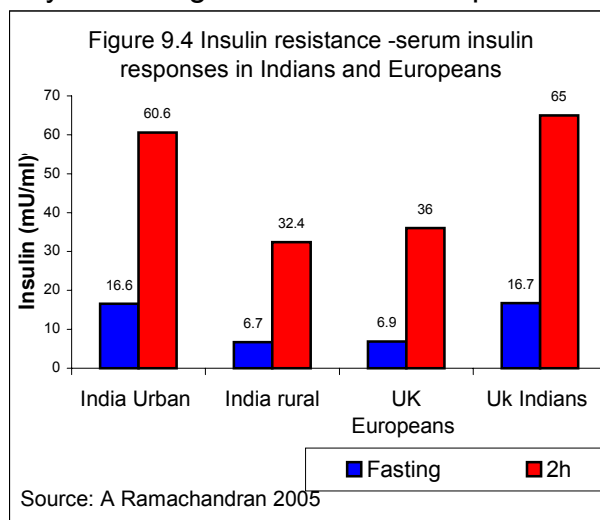
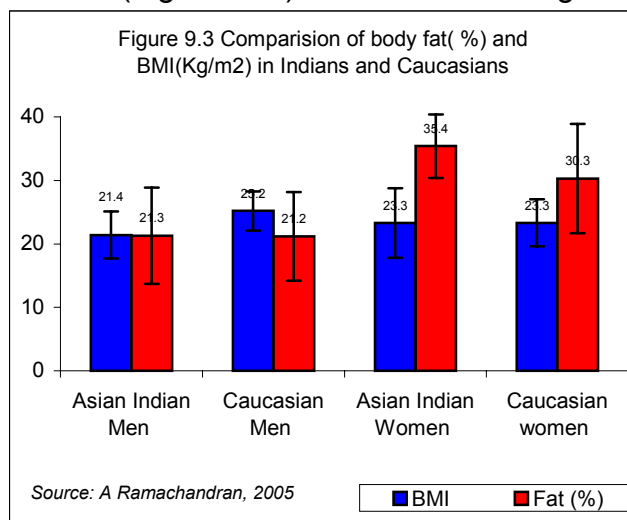


9. Over nutrition NCD linkages

9.1 Linkages between over nutrition and diabetes



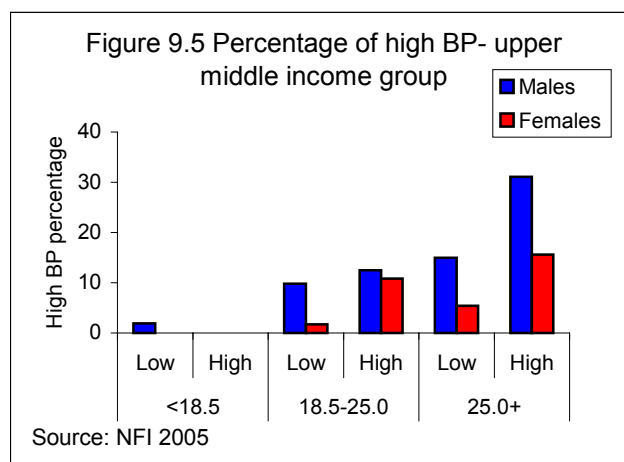
Studies from Chennai ([Ramachandran A, 2005](#)) have shown that with increasing BMI there is increase in risk of diabetes both in men and women. There is a steep increase in risk of diabetes when BMI increase beyond 23 (Figure 9.1). There was a progressive increase in prevalence of diabetes with increasing waist-hip-ratio both in men and women (Figure 9.2). Indians have higher body fat for given BMI as compared to



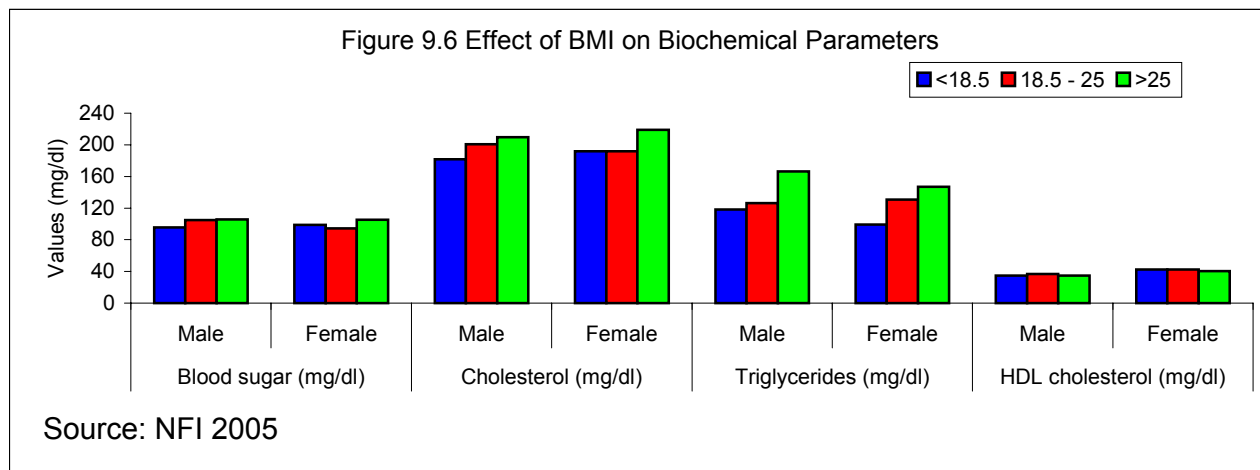
Caucasians (Figure 9.3). Association between abdominal obesity and the metabolic syndrome of hypertension, dyslipidemia, insulin resistance and diabetes have been well documented. Comparison of insulin resistance and insulin response between Indians and UK citizens showed that both fasting and 2 hour insulin levels are lower in Indians in rural areas and Europeans in UK; urban Indians and Indians residing UK have substantially higher fasting and 2 hour insulin levels indicating insulin resistance (Figure 9.4). Data from urban affluent population show that prevalence of insulin resistance is high not only in adults but also in children and young adults REF ([Yagnik CS, 1998](#)).

9.2. Linkages between over-nutrition and hypertension

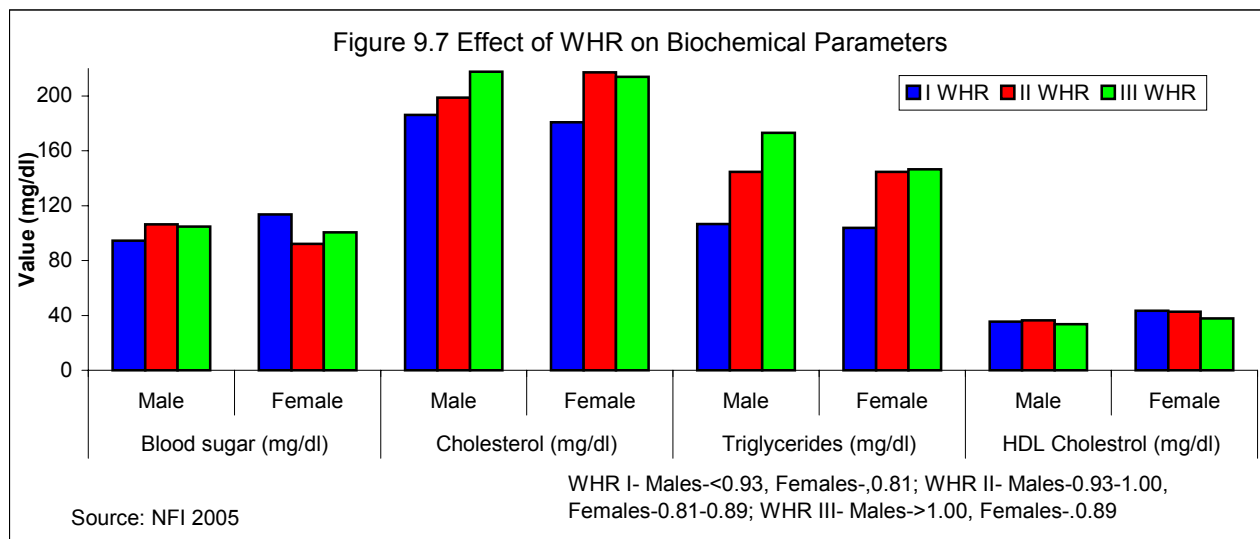
Nutrition Foundation of India carried out studies exploring relationship between over nutrition and cardiovascular diseases in - persons belonging to different income groups working in a Government Institution ([Nutrition Foundation of India, 2004](#)). There were a larger proportion of subjects having higher WHR (50.3percent) compared with the population with BMI>25 (30.8percent). The higher the BMI and WHR, the higher were the prevalence rates of hypertension both in men and women. The prevalence of high blood pressure in the normal and overweight subjects was higher when WHR was high. Overweight/obese subjects of both sexes with abdominal adiposity had higher systolic and diastolic blood pressure as compared to those without abdominal obesity (Figure 9.5).



Serum cholesterol and triglycerides in men were significantly higher in subjects with BMI>25. There was a positive trend of increase in blood sugar with increasing values of BMI both in men and women. Serum cholesterol and triglycerides increased significantly with increasing BMI and WHR both in men and women. A similar trend was seen in the ratio of total cholesterol and HDL cholesterol (Figure 9.6). Cholesterol levels greater

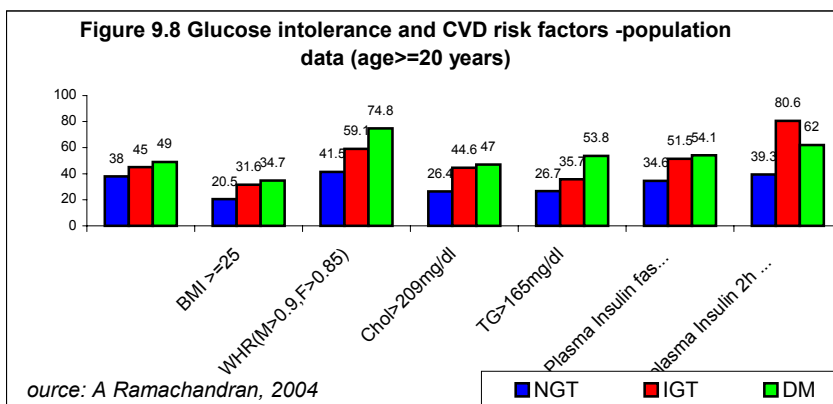


than 180 mg percent and blood sugar levels of 140 mg percent were mostly seen in subjects with high BMI, and those with greater WHR (Figure 9.7).



9.3. Linkages between obesity, diabetes and cardiovascular diseases

Indians have higher body fat for any BMI as compared to Caucasians. The susceptibility of the urban Indians to central adiposity has been highlighted by all studies. All studies in India have shown that central obesity was more strongly associated with glucose intolerance than generalized obesity. A cluster of risk factors has been demonstrated to be associated with central obesity. These include glucose intolerance, obesity, hyperinsulinemia, hypertriglyceridaemia, and hypertension, all-important risk factors for ischaemic heart disease. Recent studies comparing body fat topography in migrant Asian subjects with those of white Caucasians have also reported a higher waist-hip ratio with hyperglycemia, elevated plasma insulin concentrations, altered blood lipids and increased risk of coronary heart disease in Indians.



Indians are at higher risk of metabolic syndrome with Type 2 diabetes, dyslipidemia, hypertension and cardiovascular disease for example at BMI $>$ 25 the Cardio vascular risk is least if the person has normal glucose tolerance and highest if he has diabetes (Figure 9.8) ([Ramachandran et al., 2004](#)). Risk of glucose intolerance, insulin resistance and hypertension increases with age, BMI. Waist-to-hip ratio, blood cholesterol ($>$ 209mg/dl) and triglyceride level ($>$ 165 mg/dl).

Comparison of newly diagnosed NIDDM patients in KEM hospital, Pune compared with migrant Indian and white Caucasian NIDDM patients in UKPDS ([Yagnik CS, 1998](#)) showed that

- At diagnosis diabetic patients in India are about a decade younger (20percent < 35 years, and 50percent <40 years of age).
- Obesity (using body mass index, as criterion) is less common, but central obesity (increased waist-hip ratio, WHR) is a very striking feature in Indian patients. Highest glucose concentration was found in subjects who were thin but centrally obese.
- Hypercholesterolemia is uncommon (5percent), but plasma triglycerides and non-esterified fatty acids (NEFA) are significantly elevated in both IGT and diabetic Indian patients, compared to those with normal glucose tolerance (NGT).
- Both IGT and diabetic patients show fasting hyperinsulinaemia compared to NGT subjects but post-glucose plasma immunoreactive insulin (IRI) concentrations are diminished in diabetic patients. Plasma IRI concentrations show an inverted U-shaped distribution in relation to plasma glucose concentration suggesting that insulin resistance and compensatory hyperinsulinaemia precede diabetes. Even NGT Indians are substantially more hyperinsulinaemic and insulin resistant than white Caucasians.

In Indians the cardio vascular risk factors (obesity, central obesity, hypertension, high plasma triglycerides and elevated NEFAs) are increased not only in diabetic patients but also in those with IGT, a stage, which precedes diabetes by many years. Electrocardiographic changes suggestive of CHD were associated with older age, higher blood pressure, higher plasma triglycerides and Immuno Reactive Insulin (IRI) concentrations. Cardio-vascular risk factors were all related to plasma insulin levels and can be thought of as occurring as a part of the complex metabolic profile called the 'insulin resistance syndrome', metabolic syndrome or Syndrome X.

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