SUMMARY & CONCLUSIONS

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The burden of chronic diseases is rapidly increasing worldwide. It has been calculated that, in 2001, chronic diseases contributed approximately 60 % of the 56.5 million total reported deaths in the world and approximately 46 % of the global burden of disease (WHO 2002). The proportion of the burden of non-communicable disease is expected to increase to 57% by 2020 Almost half of the total chronic disease deaths are attributable to cardiovascular diseases· obesity and diabetes are also showing worrying trends, not only because they already affect a large proportion of the population, but also because they have started to appear early in life

The chronic disease problem is far from being limited to the developed regions of the world Contrary to widely held beliefs, developing countries are increasingly suffering from high levels of public health problems of chronic diseases It is clear that the earlier view of these chronic diseases as "diseases of affluence" is increasingly a misnomer, as they rapidly emerge both in poorer countries and into the poorer population groups of richer countries The evolution is taking place at an accelerating rate, with the transition occurring at a faster rate in developing countries than in the industrialized regions of the world, which experienced a more gradual evolution into the past century (Popkin 2002). This rapid rate of change, together with the increasing burden of disease, is creating a major public health threat, which demands immediate and effective action

Apart from the classical risk factors, some ethnic populations have special risk factors, for example, people of Asian origin have a high risk even at "normal" total cholesterol concentrations Hence, it becomes prudent to study the risk factors for the specific population where prevention efforts are to be made for these diseases Thus, the present study, in addition to mapping the prevalence of chronic degenerative diseases and studying the metabolic profile of the subjects the risk factor analysis of the of the subjects suffering from various chronic degenerative diseases was also assessed

We enrolled 1025 subjects from the Indian Oil Corporation (Gujarat Refinery), Vadodara. The anthropometric measurement, medical history, dietary intake data as well as the information regarding general habits of the subjects were collected The assessment of the foods available from the industrial canteen was also carried out The fasting blood sample was drawn so as to measure a number of biochemical parameters

The mean age of the subjects was found to be 42 years, indicating that with respect to age they were at a higher risk to suffer from any kind of chronic degenerative disease Of the 1025 subjects enrolled, 63 1% were males and 36.9% were females. The mean Body Mass Index (BMI) was found to be 24.5 in case of males and 25 1 in the case of females, indicating that many of the subjects fall under the overweight category.

The educational profile of the subjects revealed that 33 9% of males had

studied up to high school, and 30.5% were diploma or graduates, and in the case of females 42 5%had studied up till high school and 26 3% were privileged to completed diploma or graduation Majority of the subjects (78.6%) had per capita income greater than 1000, indicating that they were above the economically disadvantaged category

In depth information regarding the food provided by the two industrial canteens was collected so as to get an idea regarding the consumption pattern of the employees in this set up The caloric value of the lunch or dinner was found to be approximately 1200 Kcal The snacks were mainly ready to eat ones in a packet size of 50g. These packets were given at a highly subsidized rate of 20-25 paise each Each employee could buy worth Rs 80 per month from this canteen by exchanging coupons Thus, the employee can purchase 400 packets in a month The average caloric content of the snacks was 291 kcal Protein, fat and carbohydrate content on an average were found to be 8.3g, 23.2g and 18 4g respectively Furthermore, the data revealed that the average monthy sale of snack packets irrespective of the food items was found to be very high, indicating the increased consumption of energy dense snacks from the canteen This is also evident from the dietary analysis, which reveals the fat energy ratio of the subjects was greater than 30%. Furthermore, the energy intake of the subjects highly correlated (r= 0.83) with fat as well as with carbohydrate (r=0 83). This shows that the energy dense foods might have been one of the plausible cause for the increased prevalence of obesity in the population This observation is in

line with research which has shown that diets rich in fat may lead to over consumption of energy and obesity because of its palatability, high energy density and metabolic efficiency (Li-Ching Lyu et al 1994)

The prevalence of chronic degenerative diseases which is increasing to epidemic proportions around the world, especially in the developing nations has probed us to find out the prevalence of these diseases in the developing countries and economies in transition In the present study the prevalence of CDD such as overweight, obesity, diabetes, hypertension and CHD was found to be 33%, 8%, 8%, 6% and 1% respectively Among all the chronic degenerative diseases the prevalence of overweight and obesity was found to be highest Even among the diabetic subjects (n=82) there were 44% subjects who were overweight and obese Similarly among the hypertensives there were 54% of the subjects who overweight and obese The increasing prevalence of chronic degenerative diseases in this study portrays that the morbidity of chronic degenerative diseases is on the rise in urban cities of India and it lays emphasis to study the risk factors associated with the same.

It is said that females have an advantage over men with respect to CDD. Women experience heart disease 10 years later than men, so the prevalence of coronary disease is lower in women throughout most of their lifetime (Veronique 2000). Similarly, with respect to lipid parameters also the females have an advantage. The assessment of lipid levels of male and female subjects showed that the male subjects had significantly higher levels of TC

(p<0 001), TG (p<0 001), VLDL-C (p<0 001), Non HDL-C (p<0 001) and TC/H (p<0.01) ratio respectively.

Another non-modifiable risk factor is age As the age advances the risk of suffering from any kind of CDD increases. The influence of age on the lipid parameters of males and females showed that the males who were above the age of 40 years had significantly higher levels of TC (p<0.01), LDL-C (p<0 001) and Non HDL-C (p<0.001) in comparison to those below the age of 40 years Similarly, the lipid parameters viz. TG (p<0.001), VLDL-C (p<0.001), LDL-C (p<0 001) and Non HDL-C (p<0 001) were found to be significantly raised among females who were above the age of 40 in comparison to those below the age of 40 years. This is in line with research which has shown that as the age advances the chances of aberrations in the lipid parameters increase (Kannel and Schatzkin 1983, Kritchevsky 1978)

The influence of habits of subjects such as smoking or chewing tobacco, and alcohol consumption of the individual increases the chances of giving rise to complications among those subjects who are diseased as well as well as among the normal subjects. The risk of death from CAD is up to six times higher in smokers than in non-smokers (Whig et al 1992, Davies et al 1985, Shah and Sadaria 2003). Similarly, excessive alcohol intake is a risk factor for CHD, hypertension and all other cardiovascular diseases Excess intake leads to increase the blood pressure because of increase in sympathetic nerve activity, which in turn increase cardiac output affecting the heart rate

(Malhotra and Patel, 2003) A positive correlation between alcohol consumption and the risk of mortality from stroke in men drinking excessive alcohol is also observed (Rimm et al 1996, Hart et al 1999) In the present study the relative risk of diseased subjects to develop complications with respect to smoking, tobacco chewing and alcohol consumption was found to be 1 6, 1 3 and 1 4 respectively This indicates that smokers, tobacco chewers and alcohol consumers who were suffering from any kind of chronic degenerative disease were more probable to develop complications related to the disease in comparison to normal subjects These results thus indicate that the general habits of the subjects such as smoking or chewing tobacco and consumption of alcohol do play a role in worsening the disease profile of the subjects

Among the various etiological factors, elevated levels of the circulating lipids are of great importance The comparison of lipid levels among the normal and diseased subjects showed atherogenic dyslipidemia to be present in subjects suffering from various CDD such as overweight or obesity, diabetes, hypertension and CHD respectively Hyperglycemia was observed among the diabetics and the atherogenic lipids also showed a deteriorating trend This was in accordance with research that has shown two abnormalities characterizing lipoprotein metabolism in type 2 patients fasting and postprandial concentrations of TG-rich lipoproteins, especially VLDL-C are higher among people with diabetes (Mani et al 1986, Kannel 1985, Taskinen 1990, Howard 1987) The overweight and obese subjects who were clinically

normal but had abnormal BMI (BMI>=25) were also found to have detrimental levels of atherogenic lipids viz TC, TG, Non HDL-C, VLDL-C etc This is in accordance with studies which have shown that a BMI of above 25 increases the chances of dying early, mainly from heart disease or cancer, and that a BMI of 30 and above dramatically increases further these chances (Pi-Sunyer 1993, Higgins et al 1988)

Another chronic degenerative diseases in which hyperlipidemia has been observed is hypertension Various studies including the Framingham (Castelli and Anderson 1986) as well as the Multiple Risk Intervention Trial (National Institute of Health Report 1993) have shown that TC levels are high in hypertensive subjects In addition to cholesterol, recent studies also show that hypertriglyceridemia is an important cardiac risk factor (Assman et al 1996) Various Indian studies have also shown that TC and LDL-C were higher amongst hypertensive subjects in comparison to normotensive subjects (Joglekar and Nanivadekar, 1996, Latheef etal 1998, Mani and Gujarathi 2002) In the present study the hypertensive subjects had significantly higher levels of atherogenic lipids in comparison to the normals Dyslipidemia was also noticed with respect to TC, TG and VLDL-C of CHD subjects A significant relationship has been demonstrated between hypercholesterolemia and CAD in the western world In the Indian studies a similar trend is observed, but the occurance of myocardial infarction is seen at lower levels of TC This indicates that among the Indian subjects the occurance of CHD is at a lower level of TC than that observed among the Western world. The results

of the present study are in accordance with the literature and revealed the occurance of CHD at lower levels of serum total cholesterol.

Research has shown that Non HDL-C is considered to be a better indicator than LDL-C as it reflects a combined risk of all lipoprotein changes observed in various CDD (Havel and Rapaport 1995, Frost and Havel 1998, Garg and Grundy 1990, Executive Summary of the NCEP 2001). In the present study the Non HDL-C and LDL-C were found to be significantly raised between the overweight or obese, diabetic and hypertensive subjects. In case of CHD subjects it was observed that the LDL-C was not significantly increased when compared with normal subjects, however, the Non HDL-C was found to be significantly higher, thus suggesting that the Non HDL-C might be a better predictor than LDL-C

The relationship between obesity and type 2 diabetes is well established Numerous studies have shown that overweight and obese individuals are at an increased risk of developing diabetes (Lew and Finkel 1979, Albu and Pi-Sunyer 1999, Jung 1997) In the present study also out of the total 82 diabetics 44 % were found to be overweight and obese, thus implying that overweight and obesity may be one of the causative factors to make them diabetics.

Furthermore, obesity also carries a penalty of the development of hypertension. A study carried out by Kodali (1997) found that hypertensives

had significantly higher body weight, body fat, BMI and WHR as compared to controls in both men and women Out of the total hypertensive subjects 54 % were overweight or obese, thus validating the role of obesity in the development of hypertension

There is a marked deterioration with respect to atherogenic lipids in the case of overweight and obese diabetics who had clinically proven risk of being affected with any one of the metabolic disorders This observation indicate that the presence of one of the CDD along with the increased body mass index are of greater significance in aggravating the degenerative condition With no proven clinical records the subjects with increased BMI, classified either as overweight or obese also exhibit dyslipidemia as compared to normal subjects

The most common form of primary hyperlipidemia results from the interaction of multiple genes with diet, body weight, exercise habits and endocrine factors, and are often termed multifactorial hyperlipidemias. In this study the population was segregated into hypercholesterolemic, hypertriglyceridemic and hyperlipidemic subjects respectively Among the male and female subjects of the hyperlipidemic group, significantly higher levels of atherogenic lipids were observed This observation is similar to various studies which have shown that hyperlipidemia is a risk factor for CVD (Syvanne and Taskinen 1997, Kannel 1985) When the comparison of the diabetic, hypertensive and CHD males was done with the dyslipidaemic males, little difference was

noticed in the atherogenic lipids This shows that hyperlipidemic subjects are at a higher risk of developing cardiovascular disease

Obesity as mentioned earlier is associated with detrimental changes in the lipid profile. Body mass index, a tool to measure the degree of obesity is found to bring about alteration in the lipid profile As BMI increases TG and LDL-C levels increase, while HDL-C levels decrease (Austin and Selby 1995) The comparison of lipid profile among normal and overweight or obese subjects (who were clinically normal) was thought worthwhile to analyse in order to study the lipid levels as one moves from a lower to higher BMI In the present study significant rise in the atherogenic lipid levels was noticed with an increase in the BMI. This once again emphasizes the fact that overweight and obesity do carry a penalty for the occurance of atherogenic dyslipidemia, which in turn is a risk factor for other CDD

Apart from the total body weight, the distribution of fat is also equally important to be considered as a risk factor for various CDD Abdominal or android fat distribution in the central or upper body - has been found in both cross-sectional and longitudinal studies to be significantly more risky for health than gluteal femoral or lower body or gynoid obesity (Higgins 1998, Garrison and Kannel 1993, Despres et al 2001, Bray et al 1992, Lemieux 1996). Men with higher waist circumference / waist to hip ratio exhibited a significant rise in atherogenic lipids, whereas in the case of females, the prominent presence of atherogenic lipids were noticed only when the waist

circumference was found to be elevated The analysis of atherogenic lipid parameters viz. TC, TG, VLDL-C and Non HDL-C were found to be significantly raised among the males having higher waist hip ratio However, they did not show a significant rise with an increase in the waist hip ratio of the females. When the lipid levels were analysed with respect to the waist circumference of the subjects, significant increments in the atherogenic lipids were observed among the male and female subjects having a higher waist circumference. These results suggest that in the study population waist circumference was found to have more prominent effect on the lipid parameters in comparison to the waist hip ratio These results are in accordance with the WHO (1998) and the National Heart Lung and Blood Institute (NHLBI) recommendations, suggesting the use of body mass index and waist circumference for classifying abnormalities in body weight and body fat distribution.

When the linear regression analysis was done, there was a good correlation between BMI and WC in all subjects (males r=0 88, females r=0 77), but he relationship was found to be poor when BMI was compared with waist hip ratio (males r=0.47, females r =0.02) The presence of a larger waist along with an increased hip measurement, the waist hip ratio is not significantly raised Thus bringing down the correlation coefficient to almost zero in the case of females when BMI was compared with waist hip ratio. Hence, absolute waist measurement instead of WHR is considered a good parameter. Katzmarzyh et al in 1999 also advocated WC to be a good

indicator of body fatness as WHR ratio may have a fallacy especially among Indian women Taylor et al 1999 showed BMI and WC to provide simple yet sensitive methods for the estimation of total and central adiposity Hence the use of both the methods, in combination help in establishing the degree of overweight and obesity

In addition to the comparison of lipid profile between various groups with respect to their disease profile, the analysis of relative risk of the subjects (Normals Vs Diseased) in relation to the lipid profile was also done so as to study the risk of various atherogenic lipid parameters It was observed that among the overweight, obese, hypertensive and CHD subjects TC was found to be the highly dependable risk factor in comparison to other lipid parameters viz TG, Non HDL-C and LDL-C Thus indicating that the contribution of TC for taking a person into clinically uncontrolled state was more then the other lipid parameters However, among the diabetics TG (RR=4.4) was the more dependable risk factor followed by TC, LDL-C and Non HDL-C respectively. This suggests that in comparison to normals, diabetics were more at a higher risk to show aberrations in TG followed by TC, LDL-C and Non HDL-C. This observation is in line with data which shows that in type 2 diabetes patients the abnormality that characterizes lipoprotein metabolism is the fasting and post prandial triglyceride rich lipoproteins (Kannel 1985, Taskinen 1999, Howard 1987 and Syvanne et al 1994).

Recent studies indicate that the use of additional biochemical markers such

as apolipoproteins (Apo A1 and Apo B) to be better indicators for the assessment of coronary risk It is said that higher levels of Apo B may indicate increased risk of cardiovascular disease even when the total LDL-C is not high (Walldius et al 2001) The Apo B levels of the overweight or obese subjects were found to be higher than the normals. The comparison of the Apo B levels among the diabetic and normal subjects showed that they were found to be significantly higher among the diabetics Similarly, the hypertensive subjects also showed higher levels of Apo B in comparison to the normal subjects The ratio of Apo A1 / Apo B show a decreasing trend among the dyslipidemic, overweight or obese, diabetic and hypertensive subjects thus indicating their being at a greater risk of developing CVD as the ratio is considered to be a sensitive index for predicting the risk

The evidence that antioxidants may play a role in the prevalence of atherogenesis has been increasing rapidly in recent years (Salonen et al 1991, Esterbauer et al 1992, Steinberg 1992) They have also suggested that variations in serum antioxidant levels may explain the cross-cultural differences in the incidence of ischemic heart disease better than the classic risk factors such as raised serum cholesterol, high blood pressure and smoking (Luoma et al 1995) In the present study the total antioxidant activity of the normal subjects (1.81 ± 0 20 μmoles/l) was significantly higher than the overweight or obese (1 65 ± 0.17μmoles/l), diabetic (1.63 ± 0.15μmoles/l) and hypertensive (1 64 ± 0 17μmoles/l) subjects. These results strengthen the fact that low levels of antioxidants may play a role in the development of

ischemic heart disease

Thus, from the results of the present study it can be summarized and concluded that

- The energy dense food provided by the industrial canteen at highly subsidized rates would have been the plausible cause of increased prevalence obesity along with sedentary lifestyle in this study population

- The general habits of the people such as cigarette smoking, tobacco chewing and alcohol consumption do have a role to play in worsening the metabolic profile of the individuals.

- Aberrations in the lipid levels are seen as one develops chronic degenerative diseases. Thus portraying that atherogenic dyslipidemia is the hallmark of all these chronic degenerative diseases

- As one moves from a lower to higher BMI, the risk of suffering from various CDD increases and that obesity is emerging as the root cause of all the complications, thus it is aptly said that obesity is the mother of CDD.

- The apolipoproteins and the total antioxidant activity showed an adverse trend in the subjects suffering from various CDD thus suggesting that they can be used as an additional tool for mapping the risk of developing cardiovascular disease.