DISCUSSION

Diabetes and hypertension are lifestyle-related non-communicable diseases. Diabetes is accompanied by severe oxidative stress (especially lipid peroxidation) due to increased oxygen free radical production. Oxidative stress in part results into hyperglycaemia, but it may also precede and accelerate the development of over all type 2 diabetes and then of diabetic complications (90).

The damage done to bio molecules by reactive oxygen species (free radicals) is kept in check by a complex network of antioxidant defense and repair systems synthesized within the human body and some are obtained from the diet (49).

Vitamin E and ascorbic acid are collectively responsible for protecting cells from pro-oxidant molecules, especially free radicals (91).

Hyperinsulinemia causes endothelial dysfunction, endogenous angiotensin II production and activates sympathetic nervous system. 50 % of the patients with primary hypertension have insulin resistance, whereas hyperinsulinemia is rarely seen in secondary hypertension.

The present study was undertaken among the diabetic and hypertensive patients, to study the effect of antioxidants (Vitamin E and C) and tulsi powder on their serum lipid profile and blood sugar.
GENERAL PROFILE OF THE PATIENTS

The profile of the patients viz: age, sex, marital status, family type and size, education, eating habits and activity pattern are discussed below:

AGE

The results from this study indicated that the prevalence of hypertension and diabetes were highest in age group of 41-50 years respectively. Our observations that the severity of these diseases increasing with the advancing age, is consistent with earlier studies in Ibaden-Nigeria (17), Bursa-Turkey (18), Benin-Nigeria (92) and Rajahmundry-India (19). Okoduwa’s (16) study also indicated that prevalence of hypertension and diabetes is highest in age group 60-69 and 50-59 years (16). This observation is also similar to the findings of other researchers that say, hypertension which co-exist with type 2 diabetes in about 40% at age 45 rises to 60% at the age of 75 years. On this basis someone diagnosed with type 2 diabetes in middle age (40-60 years) stands to lose as much as 10 years of their life expectancy (20).

The risk of death among individuals with DM is almost twice that of individuals without diabetes of similar age. For patients diagnosed before the age of 40 years, the average reduction in life expectancy is 12 years for men and 19 years for women (21).
Ghafoorunisa (22), and Christopher (93), also supports that with advancing age, the incidence of CHD increases.

**SEX (GENDER)**

The gender difference in the patients suffering from hypertension and diabetes in the present study shows that the number of female patients were more than male patients.

But data given in study done by Kannel and Crouse indicated that compared to men prevalence of hypercholesterolemia is lower among women (94, 95). Ghafforunisa also supported that male gender is predominantly affected more than the females, although the prevalence appears to be similar after menopause in both the genders (22).

The menopause related increase in blood pressure has been attributed to a variety of factors, including estrogen withdrawal effect, weight gain and overproduction of pituitary hormones. During the fifth decade, the prevalence of hypertension in women exceeds that of men, it is due to the decline in endogenous estrogen production, after 40 years of age; which leads to an increase in vascular stiffness of the great arteries in combination with atherosclerotic changes in vessel wall.
MARITAL STATUS

The marital status of patients taken in the present study is very high as 95% of the patients were married, rest 5% are widowed or single. This information could be of use as social and psychological factors play an important role in predisposing a person to diabetes & heart problem. Married persons however, showed a positive relationship with these diseases.

Some studies showed that the gender and marital status interaction variable were only significant in the diabetes or hypertension model, not others. One cannot conclude that marital status is a real contributing factor on having these diseases (96).

Pankaj et al found significant association between marital status and hypertension (23).

Contrary to this, Sharma et al could not find any association between marital status and hypertension among adult population of rural area by J & K. (24).

FAMILY SIZE AND TYPE OF FAMILY

Most of the married patients were from joint families (52.81%) and the rest came from nuclear families (47.19%). 37.51% patients had five to seven members and 33.43% had four or less than four members in their family and rest had eight or more family members.
This information could be of use, as social and psychological factors play an important role in predisposing a person to diabetes and heart problems. Increased family size has got a positive association with hypertension and diabetes. The difference was found to be highly significant in a study done by Kannan et al (97). There were no such observations made in the earlier studies.

**EDUCATION**

Majority of the subjects were from primary group (28.75%) & illiterate group (22.18%). An inverse relationship between the subject’s own education and serum total and LDL cholesterol concentration, smoking and body mass index was found by Leino et al (98).

Generally, both diseases are common among males, the aged and unmarried and those who are less educated and earn less are also at higher risk (99).

**DIETARY HABITS AND HABITS RELATED TO SMOKING AND DRINKING.**

As seen in this study 56.87% of the total patients were strictly vegetarian, while 48.12% were vegetarian & non-vegetarian. Consumption of animal foods particularly red meats and egg yolk, which are rich sources of saturated fats and cholesterol could be the reason for elevated cholesterol
level. Restriction of meat consumption and chicken can significantly lower blood pressure, serum total cholesterol and LDL cholesterol (100).

Both smoking and drinking are prominent risk factors for CHD. From total patients 54.37% were non-smokers, 17.8% were smokers and alcoholics, 13.8% were only alcoholics; while 14.1% were only Tobacco chewers.

Smoking induces a blood pressure increase response. After smoking a cigarette, the peripheral blood pressure returns to normal within 15 minutes but pressure in the aorta remains high. Also, the large artery stiffness indices are higher in smokers as compared to that of non-smokers.

Here, it is worth mentioning that alcohol should be taken in moderation as light to moderate alcohol consumption reduces the risk of cardiovascular and total mortality risk and it is favorable related to HDL-Cholesterol (101). But obese hypertensive patients should limit their intake of alcohol to no more than two drinks a day: alcohol adds calories to the diet and in itself it can raise blood pressure (102).

Kannan et.al found in his study that the hypertensives, smoking and tobacco chewers had important risk factor for the association of hypertension and the difference was statistically significant compared to nonsmokers and non tobacco chewers. Among the alcoholics, 4 (5.06%) were normotensives, followed by 34 (43.03%) who were pre hypertensives and remaining
41(51.8%) were found to have higher prevalence of hypertension. Statistical analysis was found to be significant indicating that alcohol is one of the risk factors in association with hypertension compared to non-alcoholics (97).

Studies done by Benovitz Neal L (103) observed that sodium absorption was higher (107mmol/day) among persons who smoked cigarettes and chewed tobacco as compared to non-tobacco users. This increased sodium absorption in the body due to tobacco use, has got some role in association with hypertension.

Fried-man (104) also reported that excessive alcohol intake is related to development of hypertension.

**OCCUPATION, TYPE OF WORK AND DAILY ACTIVITY**

Maximum patients (78.75%) were housewives or engaged in office job or business and belonged to a sedentary activity category. Most of the female patients were housewives and belonged to sedentary or moderate activity category, as they were not carrying out most of the household chores; like sweeping, washing etc.

Study, done by Singh et al (28), states that low physical activity had been thought to be related with coronary artery disease and obesity. The occupational status has been found to have association with hypertension in
the present study. Those who were in professional group had lesser prevalence rate as compared to other category of occupation. On the contrary, Padmavati and Gupta (105) at Delhi, Gosh & Joshi et al (106) at Shimla found that hypertension was more common in professional group as compared to unskilled and semiskilled groups, but Mill et al (107) did not find any significant association between occupational status and hypertension. Probably, the level of occupation may materially affect physical activity and other aspect of life in relation to hypertension.

**CLINICAL PROFILE OF THE PATIENTS**

Data on the clinical profile of the patients were also gathered to find out the extent and severity of the coronary heart disease in patients.

**FAMILY HISTORY AND DURATION OF HYPERCHOLESTEROLEMIA**

Cultural, environmental genetic factors along with nutrition, physical activity, smoking, physical exercise may also have a pronounced influence on the concentration of lipids and lipoproteins (108).

As rightly said, genetic factors or family history, does play a prominent role in the etiology of diabetes and hypertension. In the present study, 52.5% had
a positive family history and their blood relations were also suffering from related diseases. However, rest (47.5%) doesn’t reported any established family history, so in these cases, environmental factors might be playing, some significant role.

Half of the patients included in the study were known cases of diabetes and hypertension for quite some time. 62.5% of the patients were diagnosed during the last one to five years back and 26.56% had been diagnosed more than five to ten years back, while rest were suffering from both diseases from more than ten years back.

It is to be concluded that blood relatives tend to have many of the same genes that can predispose a person to hypertension, heart disease or stroke.

**HYPERTENSION AND DEGREE OF OBESITY (BMI)**

Weight gain increases the incidence of hypertension. According to the Framingham study, 70% of hypertension in men and 61% of that in women were directly attributable to increase in weight. Every 4.5 Kg (10 pounds) gain in weight was associated with 4.5 mmHg increase in systolic blood pressure. Adults with BMI>40 had 6.38 times more odds ratio for hypertension.

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\text{BMI} > 25 = \text{Over weight}
\]
BMI > 30 = Obese

BMI > 40 = Massively Obese

Also, in meta analysis of 11 weight reduction trials, it was shown that SBP and DBP reduced by 1.6 mm Hg and 1 mm Hg respectively per Kg of weight loss. According to the Normative Aging Study, a small amount of weight loss (in subjects with increased abdominal girth) could lead to a dramatic lowering of blood pressure (109).

The rate at which BMI increases in childhood is associated with the risk of coronary heart disease (CHD) as an adult. On average, adults who had a coronary event had been small at birth and thin at two years of age and thereafter put on weight rapidly. This pattern of growth during childhood was associated with insulin resistance in later life. The risk of coronary events was more strongly related to the tempo of childhood gain in BMI than to the BMI attained at any other particular age (110).

According to the JNC criteria 7 (84), present data indicates that only 254 (79.37%) patients were suffering from hypertension and it was absent in 66 (20.63 %) patients. From 254 hypertensive; 147 were only mild hypertensive, 65 had moderate hypertension and only 42 were suffering from severe hypertension.
From 320 patients, only 148 (46.25%) were non-obese, 120 (37.50%) were found to be having grade-I obesity, 51 (15.93%) patients fall in grade II and only 01 (0.31%) patient seen to be suffering from grade-IV obesity.

Both hypertension and obesity have been found to have a strong association with CHD. Largely, as a result of the metabolic consequences of adiposity, there is an increased risk of CHD in both sexes. (Kannel, 94). Mac Mahon et al (111) concluded that usual DBP is positively related to the risk of stroke and of CHD, not only among those individuals who might be considered “hypertensive” but also among those who would usually be considered “normotensives”.

As, the higher BMI in these diseases could be attributed to increased calorie intake which leads to overweight as observed in the hypertensive / diabetic hypertensive groups. This may be due to sedentary life style, resulting from decreased exercises as the individuals increase in age (30).

**PULS RATE AND BLOOD PRESSURE**

Pulse Rate or Heart Rate is the number of times heart beats/minute. With aging the changes in the rate and regularity of pulse can change and may signify a heart condition or other condition that needs attention. In experimental and control groups the HR values shows no significant relation, on comparing the mean values of both groups.
Hypertension is a very common problem in elderly population. It is defined as SBP > 140 mm Hg or DBP > 90 mm Hg or both. The profile of hypertension is altered by age and other physiological and pathological conditions. Systolic hypertension becomes more prevalent with age; whereas DBP is relatively constant from 50-80 years of age and may fall thereafter. The average DBP is higher in men than women from the age 50-60 years. SBP rises more steeply in women with aging.

Dr. Kshirsagar and colleagues concluded that pre hypertensive levels of blood pressure are clearly associated with a significant increase in the risk of cardiovascular diseases (112).

Pulse pressure is the best predictor of cardiovascular mortality according to the results of a prospective cohort study reported in the Journal of Internal Medicine. Blood pressure measurements were significant long term predictors of CVD death and despite the high correlation of pulse pressure with SPB; Pulse pressure predominates in predicting cardio-vascular death in middle aged men. Normal Pulse Pressure is 30-50 mm Hg. More than 50 mm Hg is abnormal (84).

Dyslipidaemia, in DM is associated with atherosclerosis and higher risk of coronary vascular disease. High Triglycerides level and low HDL levels may be stronger risk factors for coronary artery disease in diabetic patients than in non-diabetic patients.
Detection and treatment of dyslipidaemia is one method of preventing the coronary vascular diseases associated with diabetes.

**COMPARISON OF EFFECT OF ANTIOXIDANTS (VITAMIN E&C) on Pulse Rate and B.P.**

Many studies have shown that oxidative stress through free radical generation plays a role in the onset of diabetes and hypertension. The deleterious effect of these free radicals can be prevented by antioxidants (vitamin E & C) as they neutralizes the free radicals.

The antioxidant supplementation given to the patients shows a remarkable improvement in their different basal and blood parameters. These findings corroborate with the observations of Okey et al (57), who had studied the effect of vitamin E & C on different basal parameters in diabetic and hypertensive patients, and the same was supported by the reports of others also (50, 58, 59).

The PR and BP SBP, DBP, PP and MAP of diabetic and hypertensive patients in group II, shows significant reduction (improvement) after supplementation of the patients with vitamin E & C. It shows that the antioxidants (vitamin E & C) plays an excellent role in protecting the cells from oxidative damage and thus shows blood pressure lowering effects.
A recent study investigating the effect of vitamin E & C on development of hypertension in pregnancy failed to show any benefit of antioxidants in hypertension (113).

In contrast, smaller clinical studies which were well controlled and which investigated effects of antioxidants on B.P. have demonstrated significant beneficial effects (114,115).

**BLOOD SUGAR (FASTING AND POST-PRANDIAL)**

As oxidative stress is increased in diabetes, several studies shows decreased basal vitamin E & C serum levels in diabetic patients.

Vitamin C helps to lower blood sugar by helping insulin to penetrate the cells in the body, as insulin booster. Vitamin E also helps insulin to work better in the body and it also prevents heart diseases.

In our study; on comparing the mean values of FBS and PPBS of group II patients in pre and post supplementation phases respectively; shows a very significant reduction (P<0.001) in FBS and PPBS values.

Findings, in our study are in accordance with the other studies also (7,42,47,58,59).
**LIPID PROFILE**

There were no significant differences were found in mean values of Triglycerides, HDL & VLDL levels between pre and post supplementation phase values of group II was found. But mean values of Total Cholesterol, LDL, TC/HDL and LDL/HDL were found to be highly significant in the same group in similar conditions.

Results shows that Vitamin E & C in addition to normal diet and treatment schedule may help in improving plasma glucose and lipid profile in patients with type 2 diabetes mellitus and hypertension.

Findings in our study were in accordance with the results of Afkhami A M et al (42), vitamin E is a well-known peroxyl scavenger, which is to breaks the chain reaction of lipid peroxidation and prevents oxidation of LDL in the cell membrane (116). Vitamin C, a water-soluble antioxidant, acts as an important factor in lipid regulation, increases HDL levels and protects against LDL oxidation, thus reduces the risk of cardiovascular disease (42).

**EFFECT OF TULSI ON BASAL PARAMETERS (PR & BP)**

Tulsi is a powerful anti stress agent, besides other effects it also balances SBP & DBP and it also regulates blood sugar & lowers cholesterol level also.
Singh et al (117) have shown that Ocimum Sanctum possesses blood pressure lowering property. In the present study also, the results regarding PR and BP (SBP, DBP, MAP & PP) values were also very promising.

On comparing the mean values of group III patients of pre supplementation & post supplementation phases, they shows a remarkable decrease in PR & BP parameters (P<0.001).

Tulsi may also be an effective complementary treatment for hypertension. As tulsi contains a powerful anti-oxidant component called Eugenol, Which protects the heart by keeping one’s blood pressure under control and also lowers the cholesterol levels.

**ON BLOOD SUGAR (FASTING AND POST PRANDIAL)**

In experimental group III, the mean blood glucose value of fasting & post prandial after 45 days supplementation with tulsi leaf extract was reduced from 130.79 to 119.19 and from 240.65 to 218.21 respectively. It confirms the fact that tulsi leaf extract has hypoglycemic effect.

The anti-diabetic properties of Ocimum Sanctum have been evaluated in experimental models and on humans also (64,65).
Studies done by Chopra D. (66) also shows that the holy basil have substantial blood sugar lowering effects, similar to standard oral diabetic medications.

One small study showed it to reduce blood glucose levels in type 2 diabetics when combined with hypoglycemic drugs. (118). Same study showed significant reduction in total cholesterol levels with tulsi. Another study shows that its beneficial effects on blood glucose level is due to its antioxidant properties (119).

**ON LIPID PROFILE ESTIMATIONS**

In the present study the administration of Tulsi extract over a period of 45 days to diabetic and hypertensive patients lead to a reduction in Total Cholesterol, Triglycerides, LDL, VLDL, & TC/HDL being accompanied by no change in HDL & LDL/HDL.

Rai et al (71), observed that eugenol oil present in tulsi leaf, causes inhibition of lipid peroxidation. Similar observations were also reported by Eshhart Halim and his co-workers (79).

Administration of fresh leaves of Ocimum Sanctum (Tulsi) mixed as 1 g and 2 g in 100g of diet given for four weeks, brought about significant changes in the lipid profile of normal albino rabbits. This resulted in significant
lowering in serum total cholesterol, triglyceride, phospholipids and LDL-cholesterol levels and significant increase in the HDL-cholesterol and total faecal-sterol contents (68).

Gupta et al also demonstrated the hypolipidaemic and antioxidant activity of Ocimum Sanctum; stated that lipid lowering effect may be due to eugenol constituent present in oil extract which either increases catabolism or interfere with absorption of cholesterol. The antioxidant effect of Ocimum Sanctum seed oil may be related to its hypercholesterolemic property (69).

**COMBINED EFFECT OF TULSI & ANTIOXIDANT ON PR &BP**

Tulsi & antioxidants shows additive effect due to their chemical constituents & shows remarkable antihypertensive effect on SBP, DBP & PR.

In the present study group IV were given combined supplements (tulsi and vitamin E & C) for 45 days. In post supplementation phase, parameters shows highly significant reduction in PR (85.75 to 82.6), SBP (154.6 to 147.08) DBP (93.52 to 90.15) Pulse pressure (61.07 to 56.93) & MAP(113.88 to 109.13).
ON BLOOD SUGAR (FASTING AND POST PRANDIAL)

Vitamin E & C are less potent than O.S. But when both are given in combination showed remarkable hypoglycaemic effect. This is consistant with the data already published by Hussain et al & Sarkar et al (79,70). Study done by Agrawal et al, indicates that the holy basil leaves may be beneficial for blood sugar reduction in a Randomized placebo-controlled, single blind trial of holy basil leaves in patients with noninsulin-dependent diabetes mellitus (120).

They study, the effects of treatment with holy basil leaves on fasting and post prandial blood glucose and serum cholesterol levels in humans. Results indicated a significant decrease in fasting and postprandial blood glucose levels during treatment with holy basil leaves compared to during treatment with placebo leaves. Fasting blood glucose fell by 21 mg/dl and mean total cholesterol levels showed mild reduction during basil treatment period (76).

Our study also shows a reduction in fasting and post prandial blood sugar.

Hyperglycemia leads to increased protein glycosylation, which is an important source of free radicals. Tulsi and antioxidants proves to be helpful in reducing the levels of free radicals.
ON LIPID PROFILE

The mean total cholesterol level in the experimental group IV prior to the supplementation was 201.91 mg/dl. After 45 days of tulsi and vitamin E & C supplementation its level dropped to an average of 180.06 mg/dl, showing a statistically significant values (P<0.001). Mean triglycerides, LDL & VLDL levels also shows strongly significant relation (P<0.001) between the pre and post supplementation values.

These findings are similar with the findings of R.P. Agrawal et al, who recorded a significant fall in serum total cholesterol, TG, LDL & VLDL in tulsi treated groups. Hypolipidemic effect seems to be additive when combined treatment with Ocimum Sanctum & Vitamin E were given (121).

No study was found showing the results of Tulsi & vitamin E & C collectively.

However, there was no significant change in serum HDL levels were reported. Rai et al has similar supportive findings (77).
In the present study, we observed that patients suffering from diabetes & hypertension taking 45 days supplementation (group II,III &IV), on comparison with those who are not taking any supplementation (group I), on applying one way ANOVA, the three experimental groups showed a very significant difference in almost all the parameters.

Pulse rate shows very promising results on comparison between different groups except in between group 3 & 4. SBP and DBP shows most significant relation between group 1 & 3 only. Pulse pressure also gives significant results with only group 3 & 4; while MAP shows not significant results in between all the groups on inter group comparison. (P<0.001)

No significant difference was found between the groups on applying one way ANOVA in Blood Sugar (Fasting and PP), Total Cholesterol and Serum Triglycerides.

HDL shows significant results in between group 1Vs 3, 1Vs 4, 2 Vs 3 and 2 Vs 4; but the results are not significant in between group 1 & 2 and group 3 & 4.

LDL shows promising results in between group 3 & 4 only. While VLDL shows significant results with group 1 & 3, 1 & 4 and 2 & 4 only.
TC/HDL results are significant with groups 1& 4 and 2 & 4 only. On the other hand LDL/ HDL shows significant results with groups 1&4, 2 &4 and 3& 4 on intergroup ANOVA comparison.

It is evident from the results that antioxidants taken on a regular basis can bring about significant decrease in the level of Hypertension, Blood Sugar and Lipid Profile, as compared to those who are not taking antioxidants regularly.

As Vitamin E & C and Tulsi (O.S.) possesses their greatest potential in the area of stress relief and relaxation. And in the fast pace world in which we live, these findings may prove to be extremely significant and useful.

Tulsi powder exerts more potent hyper cholesterolemic and hypo triglyceridemic effects in human subjects as compared to Vitamin E & C given separately (comparison between group II and III). But when both Vitamin E & C and Tulsi powder were given together, they exert most potent effect on hypertension & Cholesterol levels. They also lowers LDL Cholesterol but whether it plays a role in increasing HDL-Cholesterol and decreasing Blood Sugar significantly is yet to be established.

From the above discussion and the talks about the beneficial effects of antioxidants (vitamin E & C ) and Tulsi powder as claimed by various research workers, we can say in nutshell that taking both or either is an
effective way to prevent and combat the damaging effects of everyday stressors related diseases.