# LIFESTYLE MODIFICATIONS ON CONTROL OF DIABETES MELLITUS

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## ABSTRACT

Lifestyle related risk factors play an important role in the development of type 2 diabetes mellitus. This is evident from increasing incidence of various secondary complications in diabetics. Some of these risk factors like dietary choices, smoking, alcohol consumption, overweight and sedentary lifestyle are modifiable. Studies have shown that these factors, if effectively controlled, can lead to reduction in the risk of developing further complications. Thus the present study was undertaken to assess the effectiveness of community based nutrition counselling and education programme on behavioural risk factors, weight and serum biochemical parameters, for arresting and/or delaying of secondary complications in diabetic subjects. A total of 60 diabetic subjects were enrolled for the study and divided randomly into control and experimental groups, consisting of 30 subjects each. The control group was given no education intervention, whereas for the experimental group, nutrition health education was given at baseline and the subjects were followed up every three months, for one year. The nutrition health awareness programme included individual counselling and its impact was assessed using both, anthropometric and biochemical parameters.

Results of the study showed a significant reduction in fasting blood sugar (FBS), triglycerides (TG), total cholesterol (TC) and its fractions viz. LDLC and VLDL-C, after the intervention. Also subjects who included some kind of exercise in their daily routine, showed a decrease in their weight, accompanied by an altered lipid profile towards the favourable side. However, in the control group, no such changes were seen. The dietary data of the subjects revealed significant reduction in the total fat intake, as compared to the baseline. With regard to the control group, the dietary habits remained nearly the same. Thus community based health education programme, if effectively conducted, will result in the better control of diabetes, and thereby help in arresting or delaying the secondary complications of diabetes.

**KEY WORDS :** Diabetes mellitus; Nutrition health education; Lifestyle intervention.

## INTRODUCTION

Patients with type 2 diabetes mellitus have a two to three fold increase in incidence of diseases related to atherogenesis (1). Life style related risk factors are associated with the development and progression of type 2 diabetes. Risk factors like dietary choices, smoking, alcohol consumption, overweight or obesity and sedentary life style, are modifiable. Studies have shown that these factors, if effectively controlled, can lead to reduction in risk of developing further complications (2-4).

Community based health education programmes, directed to bring about dietary changes to reduce blood total cholesterol (TC), have shown that changes in the diet can reduce TC by 10-15% (5). The chief determinants of TC concentrations are dietary intake of saturated fats, poly-unsaturated fatty acids and cholesterol (6). TC concentrations are also affected by specific dietary supplements such as fibre, garlic and fish oils (7-9). Diets that lower cholesterol concentrations may modify some or all of these factors.

Individual dietary counselling, usually delivered through primary care, has been proposed as a method of achieving population goals for reducing cardiovascular diseases (CVD) (10). A major concern in case of diabetic patients with respect to CVD risk management is care of the patient with multiple risk factors for coronary artery disease (CAD). It has been shown that with the exception of obesity, risk factors rarely occur singly (11). Multiple risk factors often act synergistically, causing a geometric increase in overall CVD risk. It is therefore particularly important that recognition and management of multiple risk factors, should be a primary goal in comprehensive preventive care.

Effective, low cost, community oriented programmes, that simultaneously target multiple risk factors, have in fact been developed (12). The North Karelia project, Finland study and Stanford five city project, are among the few community based interyention trails, which emphasised the role of nutrition counselling and health education programme in reducing or modifying the risk factors (2-4). As risk reduction requires changes in a given individuals life style, community action and ready access to support services, can lead to significantly

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changes in behaviour. Similarly, family support can greatly enhance patient compliance with lifestyle changes and/or pharmacologic therapy, leading to greater changes in targeted risk factors. There is also a need to educate family members regarding the importance of risk reduction and they should be encouraged to support patients in their efforts.

However, with regard to the Indian population, the literature available in this context, is very sparse. Moreover, the level of awareness among Indian population regarding the benefits of a healthy diet and good food habits is also very low. Diet being the cornerstone in the treatment of diabetes mellitus, a need is felt to bring about awareness among diabetic patients, regarding the deleterious effects of an unhealthy diet (high intake of fat, sugar and salt), sedentary life style and general habits such as smoking and alcohol consumption.

It is generally observed, that diabetic patients have many wrong beliefs, regarding various foods and this sometimes proves to be harmful. This may unknowingly result in high intake of calories, leading to wide fluctuations of blood glucose levels. The main goal in the treatment of diabetes mellitus is to avoid both hypoglycemia as well as hyperglycemia. This calls for providing diabetic subjects with knowledge regarding different low fat, high fibre recipes and various means through which they would be able to modify the normal diet with a new variety of foods and at the same time also have good control over their blood glucose and TC levels.

Keeping in mind the above considerations, the present study was undertaken with the following objectives :

1. To increase patients' awareness regarding the risk factors associated with CAD.

2. To provide patients' with nutrition knowledge in context of a balanced, healthy diet.

3. To promote the lowering of blood glucose and TC levels.

4. To increase patients' confidence in their ability to make dietary changes.

5. To enhance patients' skills needed for longterm adherence to a blood glucose and cholesterol lowering, eating patterns.

## METHODS AND MATERIALS

A total of 60 adult, male, diabetic subjects, from the Gujarat Refinery Hospital, Baroda, were enrolled for this study and .were randomly divided into two groups, experimental and control, consisting of thirty subjects each.

### Patient Inclusion Criteria

1. Screening by the physician during the 24-month recruitment period from February '98 to February '99

2. No prior/present insulin treatment and on hypoglycemic drugs

3. No pre-existing CAD

4. Willingness to participate in the study

### Assessment Procedure

A baseline questionnaire, including standard questions, was used to collect general information regarding smoking, use of exercise to lose weight and medical history of the subjects.

### Serum Lipids

At the baseline and at one year follow up, estimation of various biochemical parameters was done by collecting overnight fasting (12 hour) blood sample and analyzing the serum for various parameters like fasting blood sugar (FBS), triglycerides (TG), total cholesterol (TC), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C). The analysis of all these parameters was done using enzymatic kits supplied by Glaxo India Ltd. (13-16). Very low density lipoprotein cholesterol (VLDL-C) was calculated by subtracting the sum of HDL-C and LDL-C from TC.

### Body Habitus

Weight and height were assessed using a bathroom scale and measuring rod respectively. Body mass index (measured as $kg/m^2$) was calculated using weight and height measurements.

### Dietary Intake

Dietary information of the subjects was collected at baseline and after one year follow-up, with the help of 24-hour dietary recall method and a food frequency questionaire. The nutrient intake of the subjects was calculated using the nutritive value of Indian foods (18).

## Intervention

At baseline. the subjects in the experimental group, were asked to attend a group session of 45 minutes. These subjects were then followed up at an interval of three months, for a period of one year, which included individual counselling. This format allowed for group interaction concerning dietary change and discussion of individual goals. The nutrition health awareness (NHA) programme provided nutrition education and emphasized on practical skills for reducing intakes of total fat, saturated fats, ready to eat foods, smoking and inclusion of some kind of exercise.

Because family support is important in achieving and maintaining behavioural change, spouses were encouraged to attend all the sessions At the end of the follow up period, once again the dietary history and anthropometric measures were recorded and the biochemical analysis of all the parameters was repeated. The nutrition counselling algorithms were as presented in Table 1.

## Data Analysis

As this investigation was focussed on behavioural changes in response to nutrition health awareness intervention, the data was analysed using a paired 't' test to compare the values obtained at baseline, and after intervention. Unpaired 't' test was used to compare the results between the subjects belonging to experimental and control groups.

**Table 1 : Nutrition Health Awareness Programme**

Group Session :

- Collection of fasting blood sample and analysis of biochemical parameters
- Collecting information regarding the dietary intake of the subjects
- Imparting education regarding diabetes mellitus, its causes and symptoms.
- Information regarding dietary management of diabetes mellitus
- Ways of modifying normal diet in case of diabetes

Individual Session:

- Review patient's typical eating patterns
- Develop personal goals for dietary changes
- Determine strategies for coping with expected changes
- Increasing the intake of dietary fibre
- Modifying the recipes and planning meals

**Individual Follow Up Session (One Year) :**

- Assessing the progress in meeting dietary goals
- Recording the anthropometric measurements, diet history and repeating the biochemical estimations.
- Discussing self management skills and plan for the future

## RESULTS

The clinical profile of the subjects is given in Table 2. As seen from the table, the post intervention data in case of the experimental group, revealed significant reduction in BMI and WHR, as compared to the baseline and the control group. Moreover, a significant increase in weight was observed in subjects belonging to the control group. This difference between the two groups can be attributed to the fact that most of the subjects (n=17) in the experimental group, included some kind of exercise in their daily routine, during and after the intervention programme.

**Table 2 : Clinical Profile of the Male Diabetic Subjects**

| Variable | | Experimental | Control | 't' Value |
|---|---|---|---|---|
| n | | 30 | 30 | |
| Age (Years) | | 42±2 | 44±2 | |
| Height (metres) | | 1.66±.06 | 1.63±.07 | |
| Weight (Kg) | Pre | 70±10.3 | 69±12.5 | 0.33 |
| | Post | 68+11.3 | 74+14.3 | 1.79 |
| | 't' value | 1 .2 | 2.05** | |
| BMI ($Kg/m^2$) | Pre | 26.0+3.9 | 26.4+4.2 | 0.38 |
| | Post | 24.9+3.1 | 27.1+3.2 | 2.31** |
| | 't' value | 2.06** | 2.01 | |
| WHR | Pre | 0.97+0.04 | 0.95+0.07 | 1.42 |
| | Post | 0.93+0.04 | 0.96+0.06 | 2.3** |
| | 't'value | 2.1** | 1.9 | |

**Significant at $p<0.05$

Table 3 depicts the fasting blood glucose (FBG) and lipid profile values of the diabetic subjects, prior to, and after intervention. As can be seen, significant reduction in FBG, TG, TC and its fractions (LDL-C and VLDL-C), was observed in the experimental group, as compared to the baseline and the control group. However, in the control group. no such

changes in the lipid parameters and FBG were observed after intervention.

**Table 3 : FBG and Lipid Profile of Diabetic Male Subjects (Mean±SD mg/dl)**

| Variable | | Experimental | Control | 't'Values |
|---|---|---|---|---|
| n | | 30 | 30 | |
| FBS | Pre | 183±43.3 | 185±47.4 | 0.16 |
| | Post | 175±40.4 | 183±44.9 | 0.71 |
| | 't' value | 2:33** | 1 .97 | |
| TC | Pre | 210±32.3 | 212±35.2 | 0.33 |
| | Post | 193±32.0 | 211±34.1 | 2.09** |
| | 't' value | 2.29** | 0.29 | |
| HDL-C | Pre | 38±8.0 | 37±7.9 | 0.48 |
| | Post | 39±7.5 | 35±8.2 | 1.96 |
| | 't'value | 1.99** | 2.02 | |
| LDL-C | Pre | 143±30.2 | 145±28.2 | 0.26 |
| | Post | 127±29.0 | 143±29.3 | 2.12** |
| | 't'value | 2.09** | 2.01 | |
| VLDL-C | Pre | 28.34±4.5 | 32±3.5 | 3.88* |
| | Post | 27.84±4.6 | 31±3.5 | 3.80* |
| | 't'value | 2.17** | 1.98 | |
| TG | Pre | 141±22.4 | 143±20.0 | 0.36 |
| | Post | 138±22,8 | 150±24.1 | 1.96 |
| | 't'value | 2.17** | 2.09 | |
| L/H | Pre | 3.82±1 .0 | 4.48±1.1 | 2.44** |
| | Post | 3.52±0.9 | 5.07±1 .0 | 6.10* |
| | 't'value | 2.85*** | 2.05** | |
| TC/L | Pre | 1.48±0.1 | 1.40±0.2 | 2.22** |
| | Post | 1.56±0.1 | 1.40±0.1 | 5.00* |
| | 't'value | 2.76** | 1.0 | |
| TC/H | Pre | 5.58±1.2 | 6.29±1.2 | 2.44** |
| | Post | 4.98±1.1 | 7.10±1.1 | 7.31 |
| | 't'value | 2.12** | 2.1** | |

*Significant at p<0.001 **Significant at p<0.05 ***Significant at p<0.01

With respect to the dietary data of the subjects (Table 4), it was found that the intake of total calories was reduced significantly in the experimental group after intervention, as compared to the baseline and the control group. The total calories coming from carbohydrates and proteins increased significantly, whereas those coming from fats showed a reduction after NHA intervention, in case of the experimental group as compared to the baseline (carbohydrates 48.6% vs. 44.9%, proteins 13.9% vs. 10.5% and fats 38.3% Vs. 44.4%). The intake of saturated fats also showed a significant reduction in the experimental group, as compared to the control group (Table 5). A significant increase in the intake of dietary fibre and vitamin C was also observed in the experimental group, which can be attributed to the increase in intake of fruits and vegetables.

**Table 4 : Nutrient Intake of Diabetic Male Subjects (Mean±SD)**

| Nutrients | | Experimental | Control | 't' Value |
|---|---|---|---|---|
| Energy (Kcal) | Pre | 2278±265 | 2294±273 | 0.22 |
| | Post | 2034±213 | 2334±295 | 4.47* |
| | 't'value | 3.81* . | 2.01 | |
| Carbohydrate(g) | Pre | 274.3±34.2 | 320.0±40.6 | 4.67* |
| | Post | 291.4±35.7 | 297.0±41.1 | 0.49 |
| | 't' value | 2.05** | 3.70* | |
| Protein (g) | Pre | 67.6±6.4 | 58.3±9.3 | 4.51* |
| | Post | 62.3±6.8 | 59.8±8.1 | 1.26 |
| | 't'value | 2.81*** | 2.03 | |
| Fats (g) | Pre | 93.1±27.3 | 88.6±30.2 | 0.60 |
| | Post | 74:2+26.0 | 98.6+28.8 | 3.42** |
| | 't'value | 3.99* | 2.21** | |
| Fibre (g) | Pre | 8.0±3.6 | 7.9±4.1 | 0.03 |
| | Post | 15.4±4.5 | 7.1±5.0 | 2.67** |
| | 't'value | 2.08** | 0.99 | |
| Iron (mg) | Pre | 16.0±7.8 | 15.1±9.9 | 0.37 |
| | Post | 14.7±7.0 | 14.6±8.1 | 0.03 |
| | 't'value | 1.97 | 1.82 | |
| Sodium (mg) | Pre | 183.1±27.0 | 198.7±965.9 | 2.06** |
| | Post | 144.8±20.4 | 291.9±23.6 | 8.22** |
| | 't'value | 3.68* | 2.01 | |
| Potassium (mg) | Pre | 1906.2±765.8 | 2075.2±965.9 | 1.11 |
| | Post | 1895.9±172.8 | 2018.8±535 | 1.13 |
| | 't'value | 0.98 | 2.32** | |
| Carotene (µg) | Pre | 2741.8±1764.9 | 1237.8±684.9 | 4.32* |
| | Post | 2695.9±1272.4 | 1039.4±510.3 | 4.88* |
| | 't'value | 2.02 | 3.21**' | |
| Vitamin C (mg) | Pre | 67.4±14.6 | 70.0±15.8 | 0.67 |
| | Post | 78.4±12.7 | 71.1±13.9 | 2.09** |
| | 't'value | 3.02*** | 1.89 | |

**Significant at p<0.001 **Significant at p<0.05 ***Significant at p<0.01*

**Table 5 : Consumption of Calories derived from Carbohydrates, Fats and Protein as well as of Saturated, Unsaturated and Invisible fats, Before and After Intervention in Control and Study groups. (All values in percentages).**

| | Control | | Study | |
|---|---|---|---|---|
| | Before | After | Before | After |
| Carbohydrates | 48 | 55 | 44.99 | 48.6 |
| Fats | 39 | 34 | 44.4 | 38.3 |
| Protein | 13 | 11 | 10.5 | 13.9 |
| Saturated Fat | 47 | 47 | 41 | 39.0 |
| Unsaturated fat | 30 | 28 | 32 | 32.0 |
| Invisible oil | 23 | 25 | 27 | 29.0 |

As intake of fats has been found. to alter the lipid profile, the data was also analysed in relation to the fat intake of the subjects (Table 6).

**Table 6 : Fasting Blood Glucose and Lipid Profile in the Subjects with Variable Fat Intake (Mean + SD, mgldl)**

| Variable | Pre≥120g | Post≤90g | 't' Value | Pre≥80g | Post≤60g | 't' Value | 't' Value 120vs 80g | 't' Value 90 vs 60g |
|---|---|---|---|---|---|---|---|---|
| N | 13 | 17 | | 5 | 6 | | | |
| FBG | 162±5.3 | 155±42.6 | 3.01** | 158±39.3 | 149±42.2 | 4.01*** | 0.17 | 0.3 |
| TC | 237±3.3 | 222±34.3 | 3.41*** | 193±29.2 | 202±37.4 | 1 .81 | 0.86 | 0.59 |
| HDL-C | 35±8.5 | 38±11.4 | 2.26** | 44±9.3 | 46±14..3 | 2.08** | 0.59 | 0.38 |
| LDL-C | 217±3.6 | 150±42.3 | 3.81* | 138±35.7 | 121±50.3 | 3.22*** | 3.76*** | 0.88 |
| VLDL-C | 35±15.4 | 34±17.4 | 1.99 | 23±13.8 | 28±12.3 | 0.96 | 0.11 | 0.77 |
| TG | 1756±5.2 | 170±49.5 | 2.10** | 169±5 | 141±56.4 | 3.41*** | 0.17 | |

* Significant at p<0.001 ** Significant at p<0.05 *** Significant at p<0.01

It was found that subjects consuming > 120 g of dietary fats per day, prior to the intervention, had significantly higher values of FBS, TG, TC and LDL-C, as compared to their post intervention data, when they consumed ≤ 90 g of fat per day. With the exception of TC, which showed no change, similar trends were also found in subjects consuming > 80 g of fats per day prior to the intervention, as compared to their post- intervention values of < 60 g of fats per day. An interesting observation here was that subjects taking 90 g and 60 g of fats per day had significantly higher levels of HDL-C, as compared to those taking ≥ 120 g and ≥ 80 g of fats per day prior to the intervention (38 and 46 mg/dl vs. 35 and 44 mg/dl respectively).

Body Mass Index (BMI) is a commonly used measure to detect the level of obesity. Since lipid levels are affected by larger body surface area, the data was also analysed in relation to BMI of the subjects (Table 7). As can be seen, out of a total of 30 subjects, 7 of them had a BMI ≥ 30 $Kg/m^2$ whereas 23 of them had BMI between the range of 25-29.9 $Kg/m^2$. This indicated that all the subjects were either in the category of overweight or obese. However in the experimental group, the post intervention data revealed significant reduction in levels of FBG, TC and TG. Amongst the two categories, subjects having BMI in the range of 25-29.9 $Kg/m^2$ had significantly lower levels of LDL-C, VLDL-C and TG and the atherogenic indices, (that is, TC/HDL and LDL/HDL ratios) as cornpared to those with BMI>30 Kg/mz, after intervention.

**Table 7 : FBG and Lipid Profile of Diabetic Male Subjects in Relation to BMI (Mean ± SD, mg/dl)**

| VARIABLE | BMI 25-29.9 $Kg/m^2$ | | | BMI>30 $Kg/m^2$ | | | 't' VALUE | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | 't' Value | Pre | Post | 't' Value | Pre | Post |
| n | 23 | 19 | | 7 | 5 | | | |
| FBG | 168±5.2 | 161±42.4 | 2.10** | 173±48.1 | 171±46.43 | 2.00 | 0.24 | 0.44 |
| TC | 198±3 | 193±23 | 3.1 1 *** | 220±30 | 217±32 | 1 .99 | 1 .89 | 1.83 |
| HDL-C | 39±9.4 | 40±8.2 | 2.00 | 30±11.2 | 32±13.4 | 2.03 | 0.23 | 1.60 |
| LDL-C | 130±29.5 | 128±30.2 | 2.01 | 138±32.4 | 135±31.4 | 2.15** | 1.04 | 0.44 |
| VLDL-C | 39±8.3 | 37±7.4 | 1 .05 | 52±10.6 | 50±12.9 | 2.10** | 3.36*** | 2.81 ** |
| TG | 195±32.2 | 178±36.3 | 3.21 *** | 260±42.8 | 250±47.5 | 3.11 *** | 4.30* | 3.54*** |
| TC/H | 5.1±1.07 | 4.8±1.09 | 0.94 | 7.3±1.54 | 6.7±1.28 | 0.91 | 4.31* | 3.27*** |
| L/H | 3.33±0.93 | 3.2±0.97 | 0.98 | 4.6±1.23 | 4.2±1.52 | 0.94 | 3.02*** | 1.78 |
| TC/L | 1.52±0.14 | 1.50±0.15 | 0.99 | 1.59±0.97 | 1.60±0.14 | 0.98 | 0.35 | 1.42 |

**Significant at p<0.001 ** Significant at p<0.05 *** Significant at p<0.01*

Exercise is known to have a beneficial effect on the body, as it increases the HDL-C levels, which is a cardio-protective factor. When the data was analysed in relation to the exercise pattern of the subjects, it was found that the number of subjects doing exercise increased from 12 to 17 after intervention, and the lipid profile of the subjects doing exercise also showed a favourable trend as depicted in Table 8, where FBS, TG, TC and its fractions, show significant decrease, with an increase in the HDL-C levels. In case of subjects not doing exercise, an increase in the FBS, TC and LDL-C values was found after intervention. This indicates that for a better control of blood glucose and total cholesterol in diabetics, along with a balanced, healthy diet, a good, regular, exercise regime is also necessary non-smokers, both prior to and after intervention.

Table 10 gives the life style modifications brought about by the subjects after intervention. As can be seen, after NHA intervention, there was a significant reduction in the total number of smokers as well as in the number of cigarettes smoked by them per day. There was also a reduction in the intake of total fats, with a significant increase in the intake of fruits and vegetables.

**Table 8 : FBG and Lipid Profile of Diabetic Male Subjects Based on the Exercise Pattern (Mean ± SD, mg/dl)**

| Variable | Doing | | | Not Doing | | | 't' Value Doing Vs. Not Doing | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post | 't' Value | Pre | Post | 't' Value | Pre | Post |
| n | 12 | 17 | | 18 | 13 | | | |
| FBG | 153±39.3 | 145±41.1 | 2.09** | 168+50.0 | 172±48.2 | 2.06** | 0.8 | 1.68 |
| TC | 218±30.2 | 206±35.2 | 3.65*** | 221+28.5 | 225±51.3 | 2.76*** | 0.25 | 1.26 |
| HDL-C | 35±10.2 | 41±12.3 | 3.71* | 37+9.2 | 35±10.1 | 2.02 | 0.51 | 1.45 |
| LDL-C | 149±32.2 | 141±33.6 | 2.79*** | 155+29.6 | 161±33.6 | 2.81*** | 0.48 | 1.64 |
| VLDL-C | 34±6.5 | 24±9.9 | 3.73* | 29±12.2 | 29±12.2 | 0.36 | 1.2 | 1.2 |
| TG | 172±40.9 | 1.59±52.1 | 4.01* | 1.81±49.6 | 1.81±49.6 | 1 .99 | 0.4 | 1.42 |

**Significant at p<0.001 ** Significant at p<0.05 *** Significant at p<0.01*

**Table 9 : Lipid Profile of Diabetic Subjects in Relation to the Smoking Habit (Mean + SD, mg/dl)**

| Variable | Smokers | | | Non Smokers | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre | Post 't' | Value | Pre | Post | 't' Value | Pre | Post |
| n | 22 | 18 | | 8 | 12 | | | |
| TC | 212±12.3 | 207±10.5 | 2.12** | 203±15.2 | 195±11.1 | 2.32** | 3.89* | 3.0*** |
| HDL-C | 29±5.12 | 30±3.2 | 2.03 | 30±2.2 | 32±6.5 | 2.06** | 1.26 | 1.14 |
| LDL-C | 139±12.8 | 134±15.1 | 2.06** | 135±9.2 | 131±11.6 | 3.01*** | 2.31** | 0.58 |
| VLDL-C | 45±12.1 | 42±10.5 | 2.05** | 38±13.3 | 32±12.4 | 3.28*** | 2.18** | 2.38** |
| TG | 225±16.7 | 210±14.1 | 3.69* | 212±12.2 | 190±10.6 | 3.71* | 7.84* | 4.19* |
| TC/H | 7.3±1.67 | 6.9±1.15 | 1.98 | 6.7±2.34 | 6.09±1.14 | 2.02 | 1.04 | 1.92 |
| L/H | 4.7±2.32 | 4.5±1.97 | 0.99 | 4.5±2.32 | 4.0+0.97 | 1.99 | 0.31 | 0.83 |

**Significant at p<0.001 ** Significant at p<0.05 ** Significant at p<0.01*

As smoking is one of the factors which affects the lipid levels adversely, we also analysed the lipid profile of the subjects in relation to their smoking habits (Table 9). It was found that after intervention, there was an increase in the number of non-smokers and a significant decrease in all the lipid parameters was found in both the groups. When the data of smokers versus non-smokers was compared, it was found that the smokers had significantly higher values of TC, LDL-C, VLDL-C and TG, as compared to

**Table 10:Life Style Modifications brought about by the Subjects**

| Variables Intervention | Pre Intervention | Post |
|---|---|---|
| Smokers | 22 | 18 |
| Number of cigarettes per day | 10-15 | 9-12 |
| Total fat intake (g/d) | 180-130 | 60-90 |
| Not doing exercise | 27 | 22 |
| BMI 25-29.9 ($Kg/m^2$) | 23 | 19 |
| BMI > 30 (Kg/m2) | 7 | 5 |
| Intake of vegetables (g/day) | 100-120 | 200-300 |
| Intake of fruits (g/day) | 170-210 | 200-250 |

## Discussion

Cardiovascular disease remains one of the major causes of morbidity and premature mortality, not only in developed countries, but all over the world (12), and therefore a need is felt to reduce this toll of ill health and death through population directed preventive measures. Community based, low-cost, nutrition education programmes have been found to be effective in many studies targeted at lowering the various risk factors for CVD. As diabetics have higher chances than the normal subjects of suffering from coronary artery disease, risk reduction should be one of the most important components of the diabetes treatment plan.

The results of this study indicate significant reduction in BMI, WHR and biochemical parameters like FBG, TG, TC, LDL-C and VLDL-C, with a nonsignificant increase in the levels of HDL-C, in the experimental group after intervention, as compared to the baseline and the control group. This could be attributed to the fact that the programme was designed to help the patients to make dietary changes by teaching them various ways of modifying their diet, along with emphasising the importance of exercise and benefits of avoiding smoking.

Changes can be related to the total "dose" of intervention or factors inherent to the dynamics of the group sessions. With regards to "dose", the findings of our study are consistent with data reported by McGehee et al (19) which showed a significant (19) ($p<0.05$) relationship between FBG, serum TC, TG, LDL-C and VLDL-C concentration and the time spent with the diabetic patient during individual counselling. Concerning group dynamics, multiple factors inherent to the group session included not only nutrition education, but also sharing of ideas in the context of facilitated discussions, verbal interaction and development of practical skills for achieving dietary goals by including various low fat, high fibre recipes in their diet. Further research is warranted to systematically evaluate the education, social and emotional aspects of the group session, that may have contributed to successful dietary treatment in these diabetics.

The dietary data indicated significant reduction in percent calories coming from fat as well as an increase in the intake of dietary fibre in case of the experimental group, as compared to baseline and the control groups. Fibre is an important component of the diet. Insoluble fibre promotes regular bowel movements, whereas soluble fibre helps to lower cholesterol. The long-term effects of fibre are demonstratred in a study wherein 20g of fibre per day (pectin and guar gum), resulted in a 9% reduction in the LDL-C level after one year of supplementation. However, HDL-C did not show any change (20). In our investigation, the intake of vegetables and fruits had significantly increased in the experimental group after intervention, with the resultant increase in intake of fibre and vitamin C, which could be the reason for reduction in TC and FBG. When the lipid profile was studied in relation to fat intake of the subjects, it was found that the major dietary risk factor in case of diabetic subjects was the total fat intake, which was greater than twice the RDA for fat. The post intervention data revealed significant reduction in fat intake, with an altered lipid profile towards the favourable side. This could be attributed to the fact that the intake of total calories coming from fat decreased and those coming from carbohydrates increased, with an increase in the intake of dietary fibre, fruits and vegetables.

Lipid profile, when studied in relation to exercise, indicated significant reduction in FBG, TC and TG levels with a non-significant increase in HDLC levels. This could be attributed to the fact that most of the subjects had included some kind of exercise in their daily routine, which ranged from brisk walking to a jogging schedule of 30 minutes.

Regular exercise has generally been recommended as an important component for the treatment of all the patients with diabetes. Most excess morbidity and mortality in type 2 diabetes patients is attributed to CAD, strokes and peripheral vascular diseases, resulting from accelerated atherosclerosis (21). Epidemiological evidence suggests that regular exercise and physical fitness in adult life are associated with decrease in prevalence of CAD in the general population (22,23). Although no direct evidence is available for patients with type 2 diabetes, effects of regular exercise on known risk factors for CAD, suggests a beneficial effect. Risk factors that may improve include plasma lipoprotein levels, hyperinsulinemia and hyperglycaemia (24).

With regards to BMI, it was observed that lipid profile and FBS varied significantly with increasing BMI. The TC, TG, LDL-C and VLDL-C values were significantly higher in subjects with BMI≥30 $Kg/m^2$ as compared to those having BMI in the range of 25-29.9 $Kg/m^2$. Studies have shown that increase in BMI is one of the major risk factors in the development of CVD (26,27). Our results are in line with this finding, as subjects having a BMI≥30 $Kg/m^2$ also s,howed significantly higher values of FBG, TC and its fractions. However, after

intervention there was a decrease in BMI, with the lipid profile also showing a decreasing trend.

Table 9 depicts the lipid profile of diabetic subjects in relation to smoking. It was found that the levels of TC and its fractions significantly reduced in both the smokers and non-smokers after intervention. In case of smokers, the reduction can be attributed to the fact that at baseline all the subjects were active smokers (cigarettes≥10 per day). However, post intervention data revealed decrease in number of cigarettes smoked (10-15 vs 9-12 per day). Several studies have shown lower HDL-C levels among smokers compared to non-smokers (25). In our study also, similar ~esults were found. However after intervention, lipid profile showed a favourable trend in both the categories.

Many community based nutrition health education (NHE) programmes targeted at reducing life style related risk factors have been successfully carried out and all have shown that NHE can be effectively used to bring about changes in the lifestyle of the population (2-4,27). The results of our investigation are in consonance with the earlier studies. Thus, it can be concluded that this investigation provides convincing data, demonstrating the effectiveness of NHA intervention programme, in the care of patients with diabetes.

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