



TO ASSESS THE ROLE OF FIBER RICH DIETS IN MANAGEMENT OF BODY MASS INDEX AND WAIST CIRCUMFERENCE OF HUMAN TYPE II DIABETES MELLITUS

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ABSTRACT

Type II Diabetes mellitus is a long term metabolic disorder that is characterized by high blood sugar, insulin resistance, and relative lack of insulin. Diet plays very important role in the management of Diabetes mellitus. Calories in the form of complex carbohydrate and fiber have multiple benefits in this disease. Since obesity adds more complication in this disease so this study is designed to assess the effects of fiber in management of health status including BMI and waist circumference in human Type II Diabetes Mellitus. Under this study three diets viz. control diet (no fiber), low fiber diet (5 gm fiber), high fiber diet (10 gm fiber) were given to Control group, Experimental group 1, Experimental group 2 respectively. Data were recorded after three months supplementation and statistically analyzed. It was concluded that fiber is an influential component in the management of BMI but not showed any significant impact on waist circumference.

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INTRODUCTION

Diabetes mellitus type II (also known as type 2 diabetes) is a long term metabolic disorder that is characterized by high blood sugar, insulin resistance, and relative lack of insulin. Common symptoms include increased thirst, frequent urination, and unexplained weight loss. Symptoms may also include increased hunger, feeling tired, and sores that do not heal. Often symptoms come on slowly. Long-term complications from high blood sugar include heart disease, strokes, diabetic retinopathy which can result in blindness, kidney failure, and poor blood flow in the limbs which may lead to amputations. The sudden onset of hyperosmolar hyperglycemic state may occur however, ketoacidosis is uncommon (https://en.wikipedia.org/wiki/Diabetes_mellitus_type_2). Type II diabetes primarily occurs as a result of obesity and lack of exercise. Some people are more genetically at risk than others. Waist circumference provides a measurement criteria for Diabetes mellitus.

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A waist circumference of 102 centimeters (40 inches) or more in men, or 88 centimeters (35 inches) or more in women, is associated with health problems such as type II diabetes, heart disease and high blood pressure (www.diabetes.ca/diabetes-and-you/healthylivingresources/.../waistcircumference) Along with that Body mass index (BMI) also gives the idea about the prevalence of disease. Obese persons are more prone to be diabetic in compare to normal weight person. Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) are two pre diabetic conditions associated with insulin resistance. In these conditions, the blood glucose concentration is above the normal range. Subjects with IGT and/or IFG are at substantially higher risk of developing diabetes and cardiovascular disease than those with normal glucose tolerance (<http://www.faqs.org/nutrition/Diab-Em/Diabetes-mellitus.html>). Type II diabetes makes up about 90% of cases of Diabetes, with the other 10% due primarily to type I diabetes mellitus and gestational diabetes. In type I diabetes mellitus there is an absolute lack of insulin, due to an autoimmune induced breakdown of the islet cells in the pancreas. Diagnosis of diabetes is by blood tests such as fasting plasma glucose, oral glucose tolerance test, or A1C (1).

Treatment for Diabetes involves following a regimen of diet, exercise, self-monitoring of blood glucose, and taking medication or insulin injections. Diet plays very important role in the management of Diabetes mellitus. The number of calories needed to maintain weight depends upon person's age, sex, height, and weight and activity level. 45 - 65% of total daily calories should be provided by carbohydrates. The type and amount of carbohydrates both are important. Best choices are vegetables, fruits, beans, and whole grains. These foods are also high in fiber. Carbohydrate intake can be monitored by diabetic person either through carbohydrate counting or meal planning exchange lists. 25 - 35% of daily calories should be provided by fats. Monounsaturated and omega-3 polyunsaturated fats are the best types. 12 - 20% of daily calories should be fulfilled by protein. Fish, soy, and poultry are better protein choices than red meat. Weight reduction is advised if BMI is 25 - 29 (overweight) or higher (obese) (<http://www.umm.edu/health/medical/reports/article/diabetes-diet> (accessed)).

Fiber

Dietary fiber is a plant-based nutrient that is sometimes called roughage or bulk. It is a type of carbohydrate but, unlike other carbohydrate, it cannot be broken down into digestible sugar molecules. Therefore, fiber passes through the intestinal tract relatively intact. However, on its journey, fiber does a lot of work. Fiber is important to digestion and regularity, weight management, blood sugar regulation, cholesterol maintenance and more,. It has also been linked to longevity and decreasing the risk of cancer (Internet:www.livescience.com). Epidemiologic studies suggest that dietary fiber intake is linked with the prevention of weight gain and is inversely associated with BMI and waist circumference (<http://www.todaysdietitian.com/newarchives/021115p14.shtml>). Two types of fibers are Insoluble and soluble fibers. Cellulose, hemicellulose and lignin are some insoluble Fibers. Stool is made soft and bulky by this kind of fibers, which is then easily passed through bowel and thus constipation is prevented. On the other hand Gums and pectins are known as soluble fibers. It is showed by the different studies that cholesterol level may be reduced with the help of soluble fiber in the blood. Digestion is also slowed down by soluble fiber and the sudden release of energy is delayed, especially from carbohydrates into the bloodstream. This means that blood sugar levels are more stable, which is good for people with diabetes (<http://en.wikipedia.org/wiki/Dietary-fiber>).

Requirement of fiber

According to current Canadian guidelines, at least 26 grams of fiber - ideally 26 to 35 grams should be consumed daily by healthy adults. At present average 4.5 to 11 grams only are taken by a Canadian in a day. Ideally 25 to 50 grams per day should be consumed by people with diabetes (<http://www.diabetes.ca/diabetes-and-you/health-living-resources/diet-nutrition/fiber>). According to National Academy of Sciences, US, the average American's daily intake of fiber is about 5 to 14 grams per day. The current recommendations are to achieve an adequate intake (AI) of fiber based on one's gender and age (<http://en.wikipedia.org/wiki/Dietary-fiber>). According to the British Nutrition Foundation it is advised that 18g fiber a day should be aimed by healthy adults

(<http://en.wikipedia.org/wiki/Dietary-fiber>). There have been no studies on evaluating the dietary fiber requirements in Indians. It was investigated by the data from diets of the Western part of the country that the dietary fiber content is about 30-40 gm/day. The intake was being increased with increasing level of energy intake, 39 gm -47 gm/day in young men. The fiber intake is lower in women (15-30 gm/day) and is much less in tribal population (15-19 gm/day). It was also showed by another report from North India that the average total fiber intake per day is about 52 gm. More data needs to be generated in the Indian context to understand the phenomenon of health transition (<http://icmr.nic.in/RDA-2010.pdf>).

Oats

Oats is the one super food that can easily fit itself to suit our needs. Protein-packed, full of fiber and low on fat, oats are designed to boost energy levels and help lead a healthy lifestyle. They are not only good for the stomach but are interestingly super filling, satisfying and versatile. Oats contain a wide range of nutrients like fiber, vitamin E, essential fatty acids, etc. which make them top the healthy food charts. Oats are rich in soluble fibers (known as beta glucan) which help in lowering cholesterol levels. These soluble fibers help increase intestinal transit time and reduce glucose absorption. Oats is a low calorie food which slows digestion and makes you feel full longer. Cholecystokinin, a hunger-fighting hormone, is increased with the oatmeal compound beta-glucan. It Supports weight loss. Oats are also a rich source of magnesium, which is key to enzyme function and energy production and helps prevent heart attacks and strokes by relaxing blood vessels (Amazing Benefits of Oats, ?).

Table 1. Amount of nutrients per serving of one cup (156.0 gm) of oats (12)

Calories	607 Kcal
Total fat	10.8 gm
Saturated fat	1.9 gm
Poly unsaturated fat	4.0 gm
Mono saturated fat	3.4 gm
Cholesterol	0 mg
Sodium	3 mg
Total Carbohydrate	103.4 gm
Dietary Fiber	16.5 gm
Protein	26.3 gm

METHODOLOGY

In this study, the sample was selected from Type II Diabetic population of Diabetic camp, centre for translational research, Jiwaji University, Gwalior by probability random sampling method. The samples included male and female subjects in the age group of 35 to 65 years. For the purpose of study, subjects were divided into following three groups:

- Control group (diabetic subjects without fiber diet)
- Experimental group 1(diabetic subjects with low fiber diet 5 gm)
- Experimental group 2 (diabetic subjects with high fiber diet 10 gm)
- Subjects were chosen randomly from various areas of greater Gwalior city.

Size and Classification of Sample

100 diabetic subjects were randomly chosen irrespective of sex, age (35-65), occupation, income, religion etc. Out of these, 50 were assigned as control group and other 50 as Experimental group 1. The same 50 subjects, assigned as Experimental group 1, were then assigned as Experimental group 2 (after three months of intervention). A self made interview schedule was applied to collect the information from the subjects. This schedule was prepared considering all the possible aspects related to study. Subject's BMI, waist circumference and blood pressure were estimated by standardized equipments before and after administration.

Formulation of Different Test Diets

In order to carry out the study in a systematic manner, it was planned to formulate three test diets. First of which would contain no fiber, the second would have low fiber while the third one would have high fiber.

Formulation of Control Diet

Firstly rice flakes and bengal gram were roasted separately. Bengal gram was dehusked and then rice flakes and bengal gram were mixed. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of bengal gram and rice flakes. At last salt was added to this in required amount. All the ingredients were mixed properly. Three different diets were prepared as per table.

Table 2. Amount of ingredients for formulation of control diet

Ingredients	P1	P2	P3
Rice flakes (gm)	40	50	60
Bengal gram(gm)	30	20	10
Oil (ml)	5	5	5

The amounts of ingredients for formulation of control diet were taken as per the above table. No fiber source was used. The ingredients were processed as per the formulation procedure mentioned earlier.

Formulation of Test diet I

Firstly rice flakes and oats were roasted separately. Rice flakes and oats were mixed. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of oats and rice flakes. At last salt was added to this in required amount. All the ingredients were mixed properly. Here also three different diets were also prepared as per the ingredients.

Table 3. Amount of ingredients for formulation of Test diet 1

Ingredients	P4	P5	P6
Oats (gms)	25	50	-
Wheat bran (gms)	6	-	15
Rice flakes (gms)	40	20	50
Oil (ml)	3	3	3

The amounts of ingredients for formulation of Test diet 1 were taken as per the above table.

Oats and wheat bran were used here as a fiber source. The ingredients were processed as per the procedure mentioned earlier.

Formulation of Test diet II

Firstly oats and coriander seeds were roasted separately. The coriander seeds were crushed and then oats and coriander seeds were mixed together. After that measured amount of oil was taken, heated up to desired temperature and then spices were added into oil. This oil was mixed into mixture of oats and coriander seeds. At last salt was added to this in required amount. All the ingredients were mixed properly. The amounts of ingredients for formulation of Test diet II were taken as per the above table. Oats and wheat bran were used here as a fiber source. The ingredients were processed as per the procedure mentioned earlier. On the basis of the sensory evaluation scores P1 (Control diet), P5 (Test diet I), P9 (Test diet II) were decided for Control group, Experimental group 1 and Experimental group 2 respectively.

Table 4. Amount of ingredients for formulation of Test diet II

Ingredients	P7	P8	P9
Oats (gms)	35	-	70
Rice flakes (gms)	25	50	-
Wheat bran (gms)	10	20	-
Coriander seeds (gms)	5	5	5
Oil (ml)	1	1	1

STATISTICAL ANALYSIS

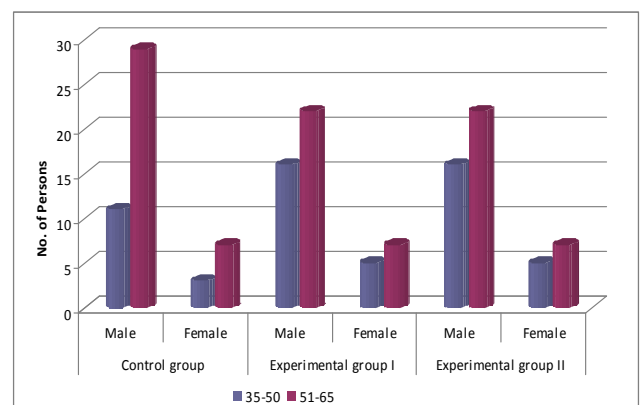
Percentage method was used for making simple comparison. For drawing significant conclusion, ANCOVA (software by SPSS 13.0) is a suitable analytical method, which was applied here.

RESULTS AND DISCUSSION

Some observations during the study have been tabulated below, and for quick and better understanding data have also been represented by bar diagrams.

Table 5. Distribution of subjects belonging to chosen three groups

Groups	Value Label	Number of subjects
Control group	No fiber	50
Experimental group 1	5 gm fiber (Test diet I)	50
Experimental group 2	10gm fiber (Test diet II)	50



Graph 1. Distribution of subjects according to age and Sex

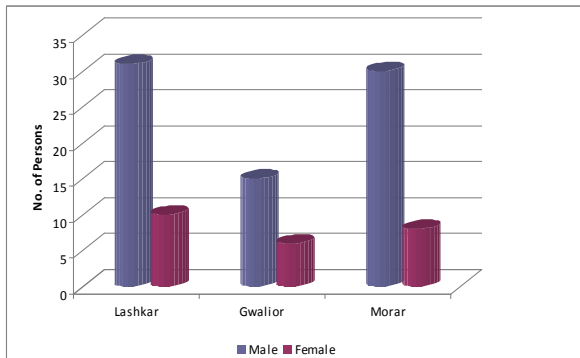
Table 6. Distribution of subjects according to age and Sex

S. No.	Age group	Control group				Experimental group 1				Experimental group 2			
		Male	Female	Total	%	Male	Female	Total	%	Male	Female	Total	%
1	35-50	11	3	14	28	16	5	21	42	16	5	21	42
2	51-65	29	7	36	72	22	7	29	58	22	7	29	58

Above table shows the distribution of subjects according to age and sex. 50 subjects each were included in three groups viz. control group, Experimental group 1 and Experimental group 2. In age group of 35-50yrs 28% subjects were in control group and 42% subjects were in Experimental group 1 and 2, respectively whereas in age group of 51-65 years 72% were in control group and 58% were in Experimental group 1 and 2 respectively.

Table 7. Demographic profile of the respondents

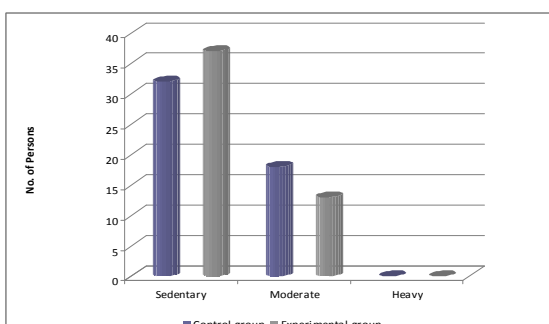
S. No.	Study Area	Distribution of subjects according to sex		
		Male	Female	Total
1	Lashkar	31	10	41
2	Gwalior	15	6	21
3	Morar	30	8	38
Total		76	24	100

**Graph 2. Demographic profile of the respondents**

Above table and graph shows the demographic profile of subjects (control and Experimental group 1, 2) under study. The study group comprised of 100 subjects. As the study area was greater Gwalior which is composed of three regions viz. Gwalior, Lashkar, Morar, among the total 100 subjects 31 male and 10 female from Lashkar, 15 male and 6 female from Gwalior and 30 male and 8 female were randomly chosen from Morar for the purpose of study.

Table 8. Distribution of subjects according to activity

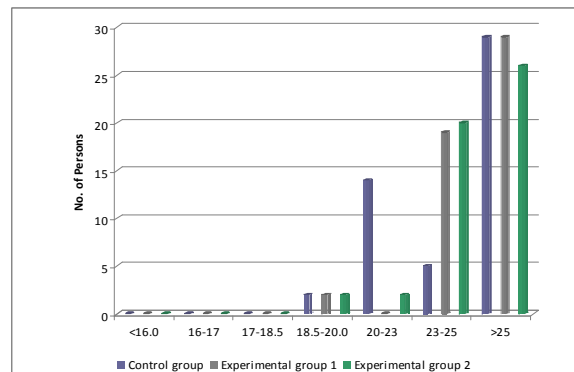
S.No.	Activity	Control group		Experimental group	
		No.	%	No.	%
1	Sedentary	32	64	37	74
2	Moderate	18	36	13	26
3	Heavy	0	0	0	0
Total		50	100	50	100

**Graph 3. Distribution of subjects according to activity**

As is evident in the above table majority of the subjects under study were sedentary active (control group 64% experimental group 74%). Remaining patients had moderate active. None of them undertook heavy activity.

Table 9. Distribution of subjects according to BMI (Before Intervention)

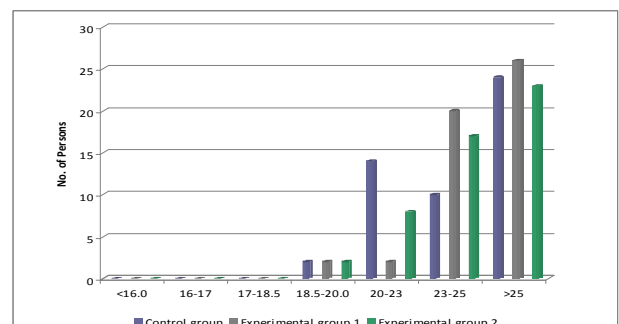
BMI ranges	Control group	Experimental group 1	Experimental group 2
<16.0	0	0	0
16-17	0	0	0
17-18.5	0	0	0
18.5-20.0	2	2	2
20-23	14	0	2
23-25	5	19	20
>25	29	29	26

**Graph 4. Distribution of subjects according to BMI (Before Intervention)**

Before supplementation most of the control group subjects were in the categories 20-23 and >25 and few were in 23-25. Among the total 100 subjects most of the test diet I group subjects and test diet II group subjects were in 23-25 and >25.

Table 10. Distribution of subjects according to BMI (After Intervention)

BMI ranges	Control group	Experimental group 1	Experimental group 2
<16.0	0	0	0
16-17	0	0	0
17-18.5	0	0	0
18.5-20.0	2	2	2
20-23	14	2	8
23-25	10	20	17
>25	24	26	23

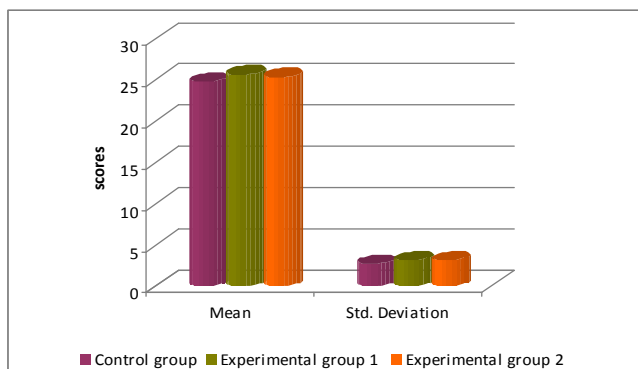
**Graph 5. Distribution of subjects according to BMI (After Intervention)**

After supplementation few control group subjects were shifted from >25 to 23-25. Few test diet I group subjects from >25 to 23-25 and 23-25 to 20-23. Better results were seen in context of test diet II. Number of subjects was increased in category of 20-23 in comparison of before supplementation. So we can say that fiber has weight reduction capacity.

Table 11.Table showing the descriptive statistics like Mean, Standard deviation of post scores of BMI (Body Mass Index) of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Group	Mean	Std. Deviation	N
Control group	24.7966	2.71887	50
Experimental group 1	25.6760	3.13412	50
Experimental group 2	25.3508	3.12857	50
	25.2745	3.00214	150

Std. Deviation: Standard Deviation



Graph 6.Table showing the descriptive statistics like Mean, Standard deviation of post scores of BMI (Body Mass Index) of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Table 12. Summary of one way ANCOVA of post scores of BMI (Body Mass Index) of subjects in three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Group	2.806	2	1.403	7.274	p < 0.05
Error	28.161	146	.193		
Total	97162.712	150			
Corrected Total	1342.912	149			

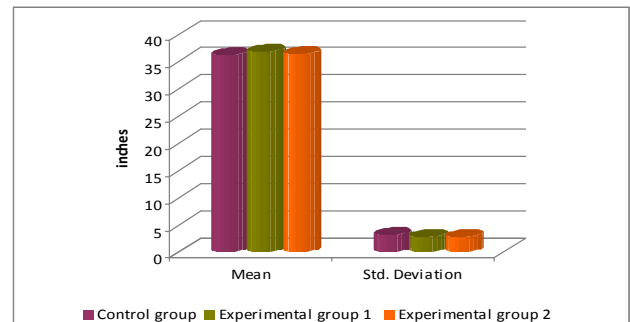
ANCOVA: Analysis of covariance F: Variance ratio
P: Probability Df: Degree of freedom

From the above table, it is evident that the F value for group being 7.274 is significant with df= 2/146. It indicates that the adjusted mean scores of BMI (Body Mass Index) of subjects under three conditions viz group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast, considering the baseline of BMI (Body Mass Index) as covariate, differ significantly. Thus the null hypothesis “There is no significant difference in the adjusted mean scores of BMI (Body Mass Index) when the subjects are not given fiber; when they are treated with test diet I (5g fiber in the breakfast) and when they are treated with test diet II (10 gm fiber in the breakfast)” is rejected. This evidently proves that oatmeal which is rich in fiber creates a substantial effect in reducing BMI (Body Mass Index) thereby reducing the weight of the subjects.

It is found that subjects of test diet I and II similarly have a lower BMI than the control group subjects.

Table 13.Table showing the descriptive statistics like Mean, Standard deviation of post scores of Waist Circumference (inches) of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Group	Mean	Std. Deviation	N
Control group	36.1652	3.10474	50
Experimental group 1	36.7860	2.80743	50
Experimental group 2	36.4080	2.78918	50
	36.4531	2.89586	150



Graph 7. showing the descriptive statistics like Mean, Standard deviation of post scores of Waist Circumference (inches) of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Table 14.Summary of one way ANCOVA of post scores of Waist Circumference of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast

Source	Type III Sum of Squares	df	Mean Square	F	Remark.
Group	1.825	2	.912	1.231	
Error	108.223	146	.741		p > 0.05
Total	200573.426	150			
Corrected Total	1249.515	149			

From the above table, it is evident that the F value for group being 1.231 is non significant with df= 2/146. It indicates that the adjusted mean scores of Waist Circumference of subjects under three conditions viz. group provided with no fiber; 5 gm fiber in the breakfast and 10 gm fiber in the breakfast, considering the baseline waist circumference as covariate, do not differ significantly. Thus the null hypothesis “There is no significant difference in the adjusted mean scores of waist circumference when the subjects are not given fiber; when they are treated with test diet I (5g fiber in the breakfast) and when they are treated with test diet II (10 gm fiber in the breakfast)” is accepted. This proves that oatmeal which is rich in fiber may not influence the waist circumference of the subjects. This also decides that intake of 5gm or 10gm of fiber all alone cannot influence the waist circumference. There are many other factors which aid fat reduction from waist other than fiber intake like exercise routine, good amount of protein intake and so on.

Conclusion

Diabetes mellitus is more prevalent in obese peoples. This study was designed to assess the therapeutic importance of dietary fiber in the management of BMI and waist circumference.

Through this study an attempt has been made to optimize the amount of fiber that should be incorporated in one's diet. The diabetic subjects were provided with test diets comprising of different quantities of fiber or no fiber at all. After the continuous consumption of test diets by all three groups (one control and two experimental) the mean scores of BMI of the subjects showed that fiber content of the diet creates a substantial effect in normalizing the BMI of subjects. It was concluded that fiber has influential effect on BMI whereas the other anthropometric measurement like waist circumference showed that there was not any significant impact of these two concentration of fibers diet.

Suggestions

In modern times, Type II Diabetes is mainly caused due to life style disorders, so this is a prime responsibility of a diabetic person that life style modification must be carried out by the patients as they become aware about it. Life style modification means;

- Turn sedentary active life to moderate active life style
- Regular monitoring of sugar level
- Estimation of lipid levels at regular intervals
- Diet consciousness (high fiber, high protein and low saturated fat)
- Stress relieving exercises
- Routine checkup
- Anthropometric measurements
- Monitoring of blood pressure
- Proper medication

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Coi Certificate

Certified that author Shweta Choudhary has not any conflict of interest regarding the relation of manuscript with any of the companies, patents or any other organization.

Authors' Contribution Certificate

It is certified that all the parts/sections of the manuscript has been only contributed by the author and that the work undertaken with human subjects was in accordance with norms of the ethical committee of the institution. No funding from any source.

Abbreviation list

BMI: Body mass index
ANCOVA: Analysis of covariance
A1C: Glycosylated hemoglobin
Df: Degree of freedom
F: Variance ratio
P: Probability
Std. Deviation: Standard Deviation

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