

## JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH

How to cite this article:

MALHOTRA V, SINGH S, SHARMA S B, GUPTA P, PRASAD A , PRASAD A, TANDON O P, MADHU SV, JAI GANGA R .The Status Of NIDDM Patients After Yoga Asanas: Assessment Of Important Parameters. Journal of Clinical and Diagnostic Research [serial online] 2010 June [cited: 2010 June 30]; 4:2652-2667.

Available from

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## ORIGINAL ARTICLE

### The Status Of NIDDM Patients After Yoga Asanas: Assessment Of Important Parameters

MALHOTRA V\*, SINGH S\*, SHARMA S B\*\*, GUPTA P\*, PRASAD A\*\*\*, TANDON O P\*, MADHU SV\*\*\*\*, JAI GANGA R\*\*\*\*\*

#### ABSTRACT

Fifty six patients of Type 2 Diabetes Mellitus (NIDDM), with a history of diabetes of 0 - 10 years, in the age group of 30 - 60 years, were selected. The diagnoses of Type 2 Diabetes Mellitus (NIDDM) patients were done according to the WHO criteria Technical Report Series. Subjects suffering from cardiac, renal and proliferative retinal complications were excluded from the study. The yoga asanas regime included the Suryanamskar Tadasan, Konasan, Padmasan Pranayam, Paschimottansan Ardhamatsyendrasan, Shavasana, Pawanmuktasana, Sarpasana and Shavasana. The subjects were called to the cardio-respiratory laboratory in the morning and were given training by the Yoga expert. The Yoga exercises were performed for 30-40 minutes every day for 40 days. The subjects were on a recommended diet and oral hypoglycaemic drugs. Basal blood glucose, serum insulin, lipid profile, body mass index, malondialdehyde levels (MDA) as an index of lipid peroxidation, cardiac function, p300 and the nerve conduction velocity of the median nerve was measured and repeated after 40 days of the Yogic regime. Another group of 50 Type 2 diabetes subjects of comparable age and severity, called as the control group, were kept on prescribed medication and light physical exercises like walking. Their basal and post 40 days parameters were recorded for comparison.

There was a reduction in the weight and even in the distribution of fat in the body space, as shown by a significant decrease in the waist to hip ratio in NIDDM patients on *Yoga asanas*. There was a significant fall in the fasting blood glucose levels. The one hour postprandial blood glucose level also decreased after 40 days of *Yoga asanas*, the subjects developed a sense of wellbeing within 10 days and there was a lowering of the dosage of the oral anti-diabetic drug (s). There was a significant reduction in total cholesterol also. There was a noticeable decrease in triglyceride levels, LDL and VLDL cholesterol, MDA levels and GHb. Improvement of nerve conduction velocity and pulmonary and cardiovascular function occurred, thus indicating a shift to the parasympathetic dominance. The subjects were also more aware and restful.

*Yoga asanas* in *mild to moderate* NIDDM cases, which were used in addition to normal medical therapy, would give benefit to the patient and improve the status of diabetics in terms of the use of less medicine, improvement of physical well being, improvement of mental alertness and activity and leading a complication free life. Consequently, it is suggested that *Yoga asanas* and *pranayama* may be used as an adjunct to reduce Diabetes Mellitus.

Key Words: Yoga, NIDDM

\*, Department of Physiology, \*\* Biochemistry,  
\*\*\* Neurology, \*\*\*\* Medicine, \*\*\*\*\* Student.

University College of Medical Sciences,  
Institute of Human Behaviour and Allied  
Sciences, Delhi.

Corresponding Author: MALHOTRA V,  
Department of Physiology, Vinayaka Missions  
Medical College, Salem. Email:  
dr\_varun@yahoo.com

## Introduction

The prevalence of Type 2 diabetes is increasing the world over. This trend is being found, both in the developed and in the developing countries.

Diabetes Mellitus is a slowly progressive disease, affecting most of the systems in the body and perpetually deteriorating their normal function. However, specific *Yoga asanas* along with prescribed meditation and diet help in arresting the progress of further complications of the disease and perhaps in slowing it down.

Further studies are required in this direction to substantiate scientific studies. Our study evaluated the status of NIDDM patients before and after 40 days of yoga asanas by the assessment of some important parameters.

## Materials And Methods

The study of the assessment of anthropometric, biochemical and cardio-pulmonary parameters before and after 40 days of *Yogic* exercises by NIDDM patients was conducted in the Departments of Physiology, Biochemistry and Medicine, University College of Medical Sciences and Guru Tegh Bahadur Hospital, Delhi and Institute of Human Behavior of Allied Sciences, Delhi.

## Selection Of Subjects.

Fifty six patients of Type 2 Diabetes Mellitus (NIDDM), with a history of diabetes of 0 – 10 years, in the age group of 30 – 60 years, were selected. The diagnoses of Type 2 Diabetes Mellitus (NIDDM) patients were done according to the WHO criteria Technical Report Series. The diagnostic details are given in the review of literature.

Patients selected from the Endocrine Metabolic Clinic, Department of Medicine, Guru Tegh Bahadur Hospital were informed about the thesis project. A written, duly signed consent was taken from the subjects according to the ethical principles of the Indian Council of Medical Research, New Delhi, India. No conscious effort was made to especially pick-on persons related to meditation. Once selected, the subjects were not excluded from various *Yoga asanas*, investigations and measurements, except when the desired co-operation required for the testing procedures was not forthcoming.

## Screening

Subjects with nephropathy, retinopathy (proliferative) and coronary artery disease were excluded from the study. Nephropathy was excluded by a negative dipstick test for proteins in the urine. The subjects were subjected to a baseline ophthalmological fundus examination. A baseline complete electrocardiogram was done in every patient to rule out any coronary artery disease. In addition, the treating physician clinically diagnosed and approved them for the study. The subjects were on a recommended diet and oral hypoglycaemic drugs. Routine laboratory tests were done before and after the *Yoga asanas*. All subjects had a complete physical examination and the clinical assessment was recorded in the proforma as per its format in Annexure 1. The relevant parameters were recorded at the beginning (i.e. baseline values) and after forty days of *Yoga asanas* for the *Yoga* group ( $n_1$ ). Similarly, these parameters were recorded for the control group ( $n_2$ ) in the beginning (i.e. baseline values) and after forty days.

The recorded parameters were compared and statistically analysed and conclusions were drawn therefrom. All *Yogic asanas* were conducted under the guidance and supervision of a *Yogic* expert. A qualified doctor was also present during the exercises, so as to attend to the patients as and when required.

## II. Methodology

The patients were divided into two separate groups. Group I NIDDM, the *Yoga* group patients were put through various *Yogic asanas* for 40 days, together with diet plus traditional diabetic medicines. ( $n_1 = 26$ ). They acted as their own controls.

Group II NIDDM, the control group patients, were retained on diet plus normal walking exercises etc. plus normal medical therapy only. ( $n_2 = 38$ ). The controls were matched with respect to age, sex, body mass index, socio-economical status and glycaemic base line parameters. The grouping of patients provided vital data for effective comparison, statistical analysis and inferences. The patients performed *Yoga asanas* for 40 – 60 minutes per day for 40 days under the supervision and guidance of a *Yoga* expert. The various *asanas* and *pranayamas* along with their duration are tabulated in [Table/Fig 1].

### Yoga Group

26 NIDDM subjects in the *Yoga* group ( $n_1$ ) were kept on a prescribed diet and oral anti-diabetic medicines and they performed specific *Yoga asanas* for 40 days under the guidance of a *Yoga* expert [Table/Fig 1]. The important parameters before the commencement of the *Yoga* exercises (baseline values) and after the *Yoga* were recorded. The observations and results are enumerated in the succeeding paragraphs.

[Table/Fig 1]

NAME AND DURATION OF VARIOUS ASANAS INCLUDED IN YOGIC EXERCISES		
S.No.	NAME	DURATION
1.	Surya Namaskar – 1	3 – 7 nams of each, the pose being maintained for ten seconds adding one tum each, every fortnight
2.	Surya Namaskar – 2	3 – 7 nams of each, the pose being maintained for ten seconds adding one tum each, every fortnight
3.	Tadasana	½ minute to one minute for adding ½ minute per week
4.	Trikona-asana	½ minute to one minute for each side, adding ½ minute per week
5.	Sukhasana	½ minute to one minute, adding ½ minute per week
6.	Padmasana	½ minute to one minute, adding ½ minute per week
7.	Bhastrika Pranayama	5 – 15 minutes per day
8.	Pashimottasana	½ minute to one minute for each side, adding ½ minute per week
9.	Ardhmatsyendrasana	½ minute to one minute for each side, adding ½ minute per week
10.	Vajrasana	½ minute to one minute, adding ½ minute per week
11.	Pawanmuktasana	½ minute to one minute for each side, adding ½ minute per week
12.	Naukasana	3 – 7 nams of each, the pose being maintained for ten seconds adding one tum each, every fortnight
13.	Bhujangasana	3 – 7 nams of each, the pose being maintained for ten seconds adding one tum each, every fortnight
14.	Dhanurasana	3 – 7 nams of each, the pose being maintained for ten seconds adding one tum each, every fortnight
15.	Shavasana	2 – 10 minutes, adding 2 minutes per week

### Anthropometric Parameters

Height (Ht.) remained same at  $152.4 \pm 0.9$  cm. There were decreases in the parameters

of Weight (Wt.) from  $62.94 \pm 2.4$  kg to  $62.17 \pm 2.2$  kg, Waist Hip Ratio (WHR) of 14 subjects from  $0.93 \pm 0.1$  to  $0.88 \pm 0.1$ , Body Surface Area (BSA) from  $45.06 \pm 0.8$   $m^2$  to  $44.83 \pm 0.8$   $m^2$  and Body Mass Index (BMI) from  $26.81 \pm 0.9$  kg /  $m^2$  to  $26.49 \pm 0.9$  kg /  $m^2$ . The Lean Body Mass (LBM) increased from  $66.53 \pm 2.5$  kg to  $66.69 \pm 2.4$  kg. The result of WHR was significant at a p value of 0.005. The remaining results were insignificant.

### Plasma Glucose

There was a decrease in the fasting blood glucose (FBG) from  $208.3 \pm 20.0$  in mg / dl to  $171.7 \pm 19.5$  in mg / dl, which was significant at a p value of 0.001. Postprandial Blood Glucose (PPG) after one hour also decreased from  $295.3 \pm 22.0$  in mg / dl to  $269.7 \pm 19.9$  in mg / dl at a p value of 0.059.

### Serum Lipid Profile

There was a decrease in the values of Cholesterol (CHOL) from  $222.8 \pm 10.2$  mg / dl to  $207.9 \pm 8.6$  mg / dl, Low Density Lipoprotein Cholesterol (LDL – C) from  $144.8 \pm 8.6$  mg / dl to  $140.7 \pm 7.9$  mg / dl and Very Low Density Lipoprotein Cholesterol (VLDL – C) from  $37.4 \pm 4.6$  mg / dl to  $32.1 \pm 3.4$  mg / dl. The CHOL results were significant at a p-value of 0.003. Serum Triglyceride (TG) levels decreased from  $168.5 \pm 15.5$  mg / dl to  $146.3 \pm 13.5$  mg / dl, which was significant at a p value of 0.001. There was almost no effect in High Density Lipoprotein Cholesterol (HDL – C) levels from  $43.8 \pm 2.6$  mg / dl to  $40.7 \pm 1.9$  mg / dl, which was insignificant at a p value > 0.05. Other Biochemical Parameters Like Fasting Serum Malondialdehyde (MDA) Levels Of The 26 NIDDM Subjects And Plasma Glycosylated Haemoglobin (Ghb) Values Of 15 NIDDM Subjects

There was a decrease of serum MDA levels from  $6.7 \pm 0.7$  nmol/ml to  $3.4 \pm 0.5$  nmol / ml, which was significant at a p value of 0.000. There was a decrease of glycosylated

haemoglobin from  $9.98 \pm 0.5 \%$  to  $9.82 \pm 0.7 \%$ .

### Serum Insulin Levels

Serum insulin levels increased from  $13.9 \pm 4.9 \mu\text{IU} / \text{ml}$  to  $19.7 \pm 4.8 \mu\text{IU} / \text{ml}$  in four **NIDDM** subjects with a Body Mass Index (BMI)  $< 25$  at a p value of 0.079. It decreased from  $36.1 \pm 11.3 \mu\text{IU} / \text{ml}$  to  $11.0 \pm 2.0 \mu\text{IU} / \text{ml}$  in seven **NIDDM** subjects with a Body Mass Index  $> 25$ , within the normal range.

**Cardiac parameters** There was a decrease in Diastolic Blood Pressure (DBP) from  $86.7 \pm 2.5 \text{ mm of Hg}$  to  $75.5 \pm 2.1 \text{ mm of Hg}$ , which was significant at a p value of 0.000. There were decreases in Systolic Blood Pressure (SBP) from  $142.0 \pm 3.9 \text{ mm of Hg}$  to  $126.0 \pm 3.2 \text{ mm of Hg}$ , which was significant at a p value of 0.000 and in Pulse Rate (PR) from  $86.45 \pm 2.0 \text{ pulse} / \text{min}$  to  $77.65 \pm 2.5 \text{ pulse} / \text{min}$ , which was significant at a p value of 0.001. The corrected QT interval (QTc) decreased from  $0.42 \pm 0.0$  to  $0.40 \pm 0.0$ .

### Pulmonary Function Values

There were increases amongst 22 **NIDDM** subjects in Slow Vital Capacity (SVC) from  $2.11 \pm 0.1 \text{ lt}$  to  $2.21 \pm 0.1 \text{ lt}$  and Forced Vital Capacity (FVC) from  $2.14 \pm 0.1 \text{ lt} / \text{sec}$  to  $2.20 \pm 0.1 \text{ lt} / \text{sec}$  and Maximal Voluntary Ventilation (MVV) from  $55.19 \pm 4.7$  to  $57.48 \pm 4.0 \text{ lt} / \text{sec}$  amongst 20 subjects. Forced Expiratory Volume (FEV1) increased from  $1.83 \pm 0.1 \text{ lt} / \text{sec}$  to  $1.93 \pm 0.1 \text{ lt} / \text{sec}$ , which was significant at a p value of 0.003. There were increases in the FEV1/ FVC RATIO in 20 subjects from  $0.84 \pm 0.0$  to  $0.86 \pm 0.0$  and in the Peak Expiratory flow rate (PEFR) from  $3.7 \pm 0.3 \text{ lt} / \text{sec}$  to  $4.4 \pm 0.6 \text{ lt} / \text{sec}$  among 20 subjects. These changes were insignificant.

### Nerve Conduction Parameters

The distal amplitude of the right hand (RWA) decreased from  $6.73 \pm 0.5 \text{ mV}$  to  $6.55 \pm 0.5 \text{ mV}$ . The distal amplitude of the

left hand (LWA) increased from  $7.02 \pm 0.4 \text{ mV}$  to  $7.78 \pm 0.6 \text{ mV}$ . The proximal amplitude of the right hand (REA) decreased from  $6.65 \pm 0.5 \text{ mV}$  to  $6.22 \pm 0.4 \text{ mV}$ . The proximal amplitude of the left hand (LEA) decreased from  $6.90 \pm 0.4 \text{ mV}$  to  $6.66 \pm 0.4 \text{ mV}$ . The proximal latency of the left hand (LEL) had practically no change from  $7.81 \pm 0.2 \text{ milli sec}$  to  $7.81 \pm 0.2 \text{ milli sec}$ . The proximal latency of the right hand (REL) decreased from  $7.48 \pm 0.4 \text{ milli sec}$  to  $7.30 \pm 0.3 \text{ milli sec}$ . The distal latency of the right hand (RWL) increased from  $4.02 \pm 0.1 \text{ milli sec}$  to  $4.26 \pm 0.3 \text{ milli sec}$ . The distal latency of the left hand (LWL) decreased from  $4.34 \pm 0.3 \text{ milli sec}$  to  $4.27 \pm 0.3 \text{ milli sec}$ . The left hand velocity (LV) increased from  $52.46 \pm 1.0 \text{ m} / \text{sec}$  to  $55.75 \pm 1.0 \text{ m} / \text{sec}$ , which was significant at a p value of 0.033. The right hand velocity (RV) increased from  $52.81 \pm 1.0 \text{ m} / \text{sec}$  to  $53.87 \pm 1.0 \text{ m} / \text{sec}$ .

### Control Group

In the control group, 36 **NIDDM** subjects were on diet, mild exercises like walking and medical therapy, as prescribed by the clinician. Various baseline and after 40 days parameters of the control group who were not on the *Yoga* regimes were recorded. The observations are results which are enumerated in the succeeding paragraphs.

### Anthropometric Parameters

Height (Ht.) decreased from  $152.4 \pm 1.1 \text{ cm}$  to  $149.5 \pm 3.1 \text{ cm}$  in 35 **NIDDM** patients. There were increases in the parameters of Weight (Wt.) from  $64.37 \pm 2.3 \text{ kg}$  to  $65.50 \pm 0.9 \text{ kg}$  in 27 **NIDDM** patients and Body Mass Index (BMI) from  $27.11 \pm 0.85 \text{ kg} / \text{m}^2$  to  $27.40 \pm 0.98 \text{ kg} / \text{m}^2$  in 14 **NIDDM** patients. There were increases in the Waist Hip Ratio (WHR) in 20 subjects from  $0.87 \pm 0.00$  to  $0.90 \pm 0.00$  and Body Surface Area (BSA) in 27 **NIDDM** subjects from  $45.45 \pm 0.9 \text{ m}^2$  to  $45.87 \pm 1.2 \text{ m}^2$ . The Lean Body Mass (LBM) of 27 **NIDDM** subjects decreased from  $47.74 \pm 1.15 \text{ kg}$  to  $42.55 \pm 0.8 \text{ kg}$ , which was significant at a p value of 0.000.

### Plasma Glucose Values

There was an increase in fasting blood glucose (FBG) levels from  $154.15 \pm 9.14 \text{ mg / dl}$  to  $160.38 \pm 11.11 \text{ mg / dl}$  in 26 subjects. There was decrease in postprandial blood glucose (PPG) levels from  $245.33 \pm 12.5 \text{ mg / dl}$  to  $243.11 \pm 13.6 \text{ mg / dl}$  in 24 subjects. The results are not significant.

### Fasting Serum Lipid Profile Values

There were decreases in the values of Cholesterol (CHOL) from  $202.27 \pm 8.72 \text{ mg / dl}$  to  $200.46 \pm 9.3 \text{ mg / dl}$  and Low Density Lipoprotein Cholesterol (LDL - C) from  $132.0 \pm 7.8 \text{ mg / dl}$  to  $126.62 \pm 7.6 \text{ mg / dl}$ . There was an increase in High Density Lipoprotein Cholesterol (HDL - C) levels from  $40.73 \pm 1.7 \text{ mg / dl}$  to  $43.54 \pm 2.1 \text{ mg / dl}$ . There were also increases in Very Low Density Lipoprotein Cholesterol (VLDL - V) levels from  $29.23 \pm 2.8 \text{ mg / dl}$  to  $30.15 \pm 2.4 \text{ mg / dl}$  and Triglyceride (TG) levels from  $133.08 \pm 8.1 \text{ mg / dl}$  to  $159.31 \pm 14.7 \text{ mg / dl}$ . These results were not significant, except for Triglyceride TG, which was significant at a p value of 0.050.

### Other Biochemical parameters

Fasting serum Malondialdehyde (MDA) levels of 9 **NIDDM** subjects and plasma Glycosylated Haemoglobin values (GHb) values of 20 **NIDDM** subjects are as follows: There was an increase in serum MDA levels from  $4.85 \pm 0.93 \text{ nmol/ml}$  to  $7.32 \pm 0.8 \text{ n mol / ml}$ . There was a decrease in glycosylated haemoglobin levels from  $8.62 \pm 0.26 \%$  to  $8.47 \pm 0.17 \%$ . The results were not significant.

### Fasting Serum Insulin Levels

The levels increased from  $13.06 \pm 2.3 \mu \text{ IU / ml}$  to  $14.03 \pm 2.5 \mu \text{ IU / ml}$ . The results were significant in four **NIDDM** subjects.

**Cardiac parameters** There was an increase in Diastolic Blood Pressure (DBP) from  $77.70 \pm 2.2 \text{ mm of Hg}$  to  $79.40 \pm 2.6 \text{ mm of Hg}$  in 20 subjects. There was a decrease in

Systolic Blood Pressure (SBP) from  $128.10 \pm 3.2 \text{ mm of Hg}$  to  $132.70 \pm 5.4 \text{ mm of Hg}$  in 20 subjects. There was an increase in Pulse Rate (PR) from  $80.00 \pm 2.7 \text{ pulse/min}$  to  $86.57 \pm 3.6 \text{ pulse / min}$  in 21 subjects, which was significant at a p value of 0.030. There was an increase in the Corrected QT interval (QTc) levels from  $0.40 \pm 0.4$  to  $0.42 \pm 0.0$  in 23 subjects.

### Pulmonary Function

There were decreases of Slow Vital Capacity (SVC) from  $2.12 \pm 0.1 \text{ lt}$  to  $2.01 \pm 0.1 \text{ lt}$  in 23 **NIDDM** subjects and in Forced Expiratory Volume (FEV1) from  $1.83 \pm 0.1 \text{ lt / sec}$  to  $1.66 \pm 0.1 \text{ lt / sec}$  and Forced Vital Capacity (FVC) from  $1.95 \pm 0.1 \text{ lt / sec}$  to  $1.89 \pm 0.1 \text{ lt / sec}$ , in 24 patients. The Peak Expiratory Flow Rate (PEFR) also reduced from  $3.83 \pm 0.3 \text{ lt / sec}$  to  $3.41 \pm 0.3 \text{ lt / sec}$  in 23 subjects, which was significant at a p value of 0.035. Besides, there were decreases in Maximal Voluntary Ventilation (MVV) from  $53.41 \pm 2.7 \text{ lt / min}$  to  $47.51 \pm 3.1 \text{ lt / min}$  in 22 subjects and FEV1/ FVC (RATIO) from  $0.96 \pm 0.1$  to  $0.88 \pm 0.0$  in 24 subjects.

### Nerve Conduction Parameters

The distal amplitude of the right hand (RWA) decreased from  $7.23 \pm 0.5 \text{ mV}$  to  $6.71 \pm 0.6 \text{ mV}$ . The distal amplitude of the left hand (LWA) decreased from  $7.06 \pm 0.6 \text{ mV}$  to  $6.19 \pm 0.5 \text{ mV}$ . The proximal amplitude of the right hand (REA) decreased from  $6.81 \pm 0.5 \text{ mV}$  to  $5.92 \pm 0.5 \text{ mV}$ , which was significant at a p value of 0.016. The proximal amplitude of the left hand (LEA) decreased from  $6.30 \pm 0.3 \text{ mV}$  to  $5.84 \pm 0.4 \text{ mV}$ . The proximal latency of the left hand (LEL) decreased  $7.66 \pm 0.2 \text{ milli sec}$  to  $7.59 \pm 0.2 \text{ milli sec}$ . The proximal latency of the right hand (REL) changed from  $7.84 \pm 0.3 \text{ milli sec}$  to  $7.84 \pm 0.2 \text{ milli sec}$ . The distal latency of the right hand (RWL) increased from  $4.09 \pm 0.1 \text{ milli sec}$  to  $4.12 \pm 0.1 \text{ milli sec}$ . The distal latency of the left hand (LWL) increased from  $3.74 \pm 0.1 \text{ milli sec}$  to  $4.02 \pm 0.2 \text{ milli sec}$ . The left hand velocity

(LV) decreased from  $54.53 \pm 1.0 \text{ m / sec}$  to  $53.31 \pm 1.3 \text{ m / sec}$ . The right hand velocity (RV) increased from  $53.75 \pm 1.0 \text{ m / sec}$  to  $54.03 \pm 0.8 \text{ m / sec}$ .

### Levene's Test For Equality Of Variances

The analysis of the recorded results by Levene's test showed that there was equality of variances in both groups. In both groups, there were significant decreases in the waist hip ratio at a p value of 0.019, in triglyceride levels at a p value of 0.030, in serum MDA levels at a p value of 0.000, in FEV<sub>1</sub> at a p value of 0.037, in QT<sub>C</sub> at a p value of 0.045 and in LV at a p value of 0.036. These analyses were statistically significant. The analyses of the other results by the said test were not significant.

### Discussion

The present study was conducted in mild to moderate cases of NIDDM. It was observed that there was a significant fall in the fasting and postprandial blood glucose, cholesterol and triglyceride levels. Besides, MDA and glycosylated haemoglobin levels also came down (tables 5.2, 5.3 and 5.4). Very few studies are available on the effect of *Yoga asanas* on different parameters in NIDDM patients. In fact, only B.K. Sahay [1] have conducted the studies and have shown the beneficial effects of *Yoga asanas* in NIDDM cases. The present study has however tried to cover various / important parameters to show the effect of a few specific *Yoga asanas* in Diabetes.

### The Effect Of Yoga Asanas On Anthropometric Parameters.

In the present study, there was a reduction in the weight and even in the distribution of fat in the body space, as shown by a significant decrease in the waist hip ratio in NIDDM patients on *Yoga asanas*. There was a noticeable decrease in body mass index and an increase in lean body mass [Table/Fig 2].

B.K. Sahay [1] have reported a significant decrease in lean body mass, with a significant change in the weight of normal healthy volunteers after *Yoga asanas*. *Yoga* helps in the reduction of fat from the waist, and causes a change from central obesity ('apple shape' or 'android') to peripheral obesity ('pear shape' or 'gynoid') due to a change in insulin resistance.

[Table/Fig 2]

ANTHROPOMETRIC PARAMETERS BEFORE AND AFTER 40 DAYS OF YOGA ASANAS					
S. No.	Parameters	n	Before Yoga	After Yoga	p Value
			Mean $\pm$ S. E.	Mean $\pm$ S. E.	
1.	Ht.	20	152.4 $\pm$ 0.9	152.4 $\pm$ 0.9	—
2.	Wt.	20	62.94 $\pm$ 2.4	62.17 $\pm$ 2.2	0.350 <sup>NS</sup>
3.	WHR	14	0.93 $\pm$ 0.1	0.88 $\pm$ 0.1	0.005*
4.	BMI	20	26.81 $\pm$ 0.9	26.49 $\pm$ 0.9	0.347 <sup>NS</sup>
5.	LBM	20	67.53 $\pm$ 2.5	66.69 $\pm$ 2.4	0.347 <sup>NS</sup>
6.	BSA	20	1.6 $\pm$ 0.0	1.59 $\pm$ 0.0	0.266 <sup>NS</sup>

  

*	: Significant at p value $\leq$ 0.05
NS	: Non Significant
Ht.	: Height in cm
Wt.	: Weight in kg
WHR	: Waist Hip Ratio
BMI	: Body Mass Index in $\text{kg} / \text{m}^2$
LBM	: Lean Body Mass in kg
BSA	: Body Surface Area in $\text{m}^2$

### The Effect Of Yoga Asanas On The Biochemical Profile.

#### Glucose

There was a significant fall in the fasting blood glucose levels. One hour postprandial blood glucose levels also decreased after 40 days of *Yoga asanas* [Table/Fig 3] and the subjects developed a sense of wellbeing within 10 days. There was a lowering of the dosage of the oral anti-diabetic drug (s). Data from some patients who discontinued *Yoga* practices for some time and restarted, showed poor control during the interval, with return to normal values after restarting the *Yoga* practices, which confirms "Cause and Effect Relationship between *Yoga asanas* and the Blood Glucose Levels". These findings are similar to those reported by [2], [3], [10]



[Table/Fig 3]

<b>FASTING AND POSTPRANDIAL PLASMA GLUCOSE BEFORE AND AFTER 40 DAYS OF YOGA ASANAS</b>				
S.No.	Parameters	Before Yoga	After Yoga	p Value
	n = 20	Mean $\pm$ S.E.	Mean $\pm$ S.E.	
1.	FBG	208.3 $\pm$ 20.0	171.7 $\pm$ 19.5	0.001**
2.	PPG	295.3 $\pm$ 22.0	269.7 $\pm$ 19.9	0.059 <sup>NS</sup>

\*\* : Significant at p value of 0.00  
 NS : Non Significant  
 FBG : Fasting Blood Glucose in mg / dl  
 PPG : Postprandial Blood Glucose in mg / dl  
 Note : Values are mean fasting plasma samples in mg / dl

### Lipid Profile:

In the present study, there was a significant reduction in total cholesterol. There was also a noticeable decrease in triglyceride, LDL and VLDL cholesterol levels. There was an improvement in glycaemic control in NIDDM patients who were associated with an improvement in serum lipid profile [Table/Fig 4]. Studies on the effect of *Yoga asanas* on lipid profile have been reported [1]. These have shown a significant decrease in free fatty acids and LDL and VLDL cholesterol levels with an increase in HDL cholesterol. Desai has also reported a significant reduction in serum lipase activity after *Yoga asanas* in Diabetics. This helps to maintain the normal concentration of circulating free fatty acids.

[Table/Fig 4]

<b>FASTING LIPID PROFILE BEFORE AND AFTER 40 DAYS OF YOGA ASANAS</b>				
<b>TABLE 5.3</b>				
S.No.	Parameters	Before Yoga	After Yoga	p Value
	n = 22	Mean $\pm$ S.E.	Mean $\pm$ S.E.	
1.	CHOL	222.8 $\pm$ 10.2	207.9 $\pm$ 8.6	0.003*
2.	TG	168.5 $\pm$ 15.5	146.3 $\pm$ 13.5	0.075 <sup>NS</sup>
3.	HDL – C	43.8 $\pm$ 2.6	40.7 $\pm$ 1.9	0.309 <sup>NS</sup>
4.	LDL – C	144.8 $\pm$ 8.6	140.7 $\pm$ 7.9	0.466 <sup>NS</sup>
5.	VLDL – C	37.4 $\pm$ 4.6	32.1 $\pm$ 3.4	0.059 <sup>NS</sup>

\* : Significant at p value  $\leq$  0.050  
 NS : Non-significant  
 CHOL : Cholesterol in mg / dl  
 TG : Triglyceride in mg / dl  
 HDL – C : High Density Lipoprotein Cholesterol in mg / dl  
 LDL – C : Low Density Lipoprotein Cholesterol in mg / dl  
 VLDL – C : Very Low Density Lipoprotein Cholesterol in mg / dl  
 NOTE : Values are for fasting serum samples are in mg / dl

In the present study, there was a significant fall in fasting malondialdehyde levels within 40 days of the *Yoga asanas*. This indicates that the level of lipid peroxidation / oxidative stress was reduced. The subjects felt better, were relieved of their stress and had improvement in their day to day performances. Studies regarding the effect of Yoga on oxidative stress in Type 2 diabetics are virtually not existent. In Diabetes Mellitus, there was increased oxidative stress because of the prolonged exposure to hyperglycaemia due to the improper utilisation of blood sugar by the tissues [3], [4]. This resulted in an increase in free radical production and insufficient antioxidants in the body. The increase in oxidative stress can be measured by estimating the status of malondialdehyde (MDA), a marker of lipid peroxidation. Yogic exercises require low amount of oxygen consumption and produce high oxygen tension in blood, leading to the postponement of fatigue (anaerobic threshold) [5].

### Glycosylated Haemoglobin

In the present study, there was a decrease in glycosylated haemoglobin in the NIDDM patients undergoing *Yoga* practice. Glycosylated haemoglobin is abnormally high in Diabetics with chronic hyperglycaemia and reflects their metabolic control. B.K. Sahay [1] have reported a decrease in glycosylated haemoglobin to normal levels after *Yoga asanas*, thus indicating a smooth and good control of Diabetes. Glycosylated haemoglobin did not show much change as the patients did *Yoga asanas* for 40 days only and it represented a three month control [Table/Fig 5].

### Oxidative Stress



[Table/Fig 5]

SERUM MDA & GLYCOSYLATED HEMOGLOBIN BEFORE AND AFTER 40 DAYS OF <i>YOGA ASANAS</i>					
S.No.	Parameters	n	Before Yoga	After Yoga	p Value
			Mean $\pm$ S.E.	Mean $\pm$ S.E.	
1.	MDA	26	6.7 $\pm$ 0.7	3.4 $\pm$ 0.5	0.000***
2.	GHb	15	9.98 $\pm$ 0.5	9.82 $\pm$ 0.7	0.863 <sup>NS</sup>

\*\*\* : Significant at p value of 0.000  
NS : Non Significant  
MDA : Malondialdehyde in  $n\text{ mol/ml}$   
GHb : Glycosylated Hemoglobin in percentage  
Note : Mean values of MDA are fasting serum samples in  $n\text{ mol/ml}$   
Mean values of GHb are fasting plasma samples in percentage

**Insulin Kinetics** Insulin levels increased with the increase in BMI (index of obesity). These levels decreased after 40 days of *Yoga asanas*. There was a reduction in insulin resistance with an improvement in insulin sensitivity. Thereby, it is inferred that *Yoga asanas* and *pranayamas* produce beneficial effects on insulin kinetics, prevent  $\beta$  cell exhaustion and thus avoid the development of insulin resistance (Syndrome X) in obese NIDDM. In normal weight NIDDM patients on *Yoga asanas*, insulin levels increased from a basal value, thus suggesting an increase in the secretion of serum insulin. The other changes included the normalisation of insulin levels, thus suggesting the beneficial effects of *Yoga asanas* in both obese and non-obese NIDDM patients. The mechanisms that contributed to the improvement of this status in both subgroups seemed to be variable. The improvement in insulin sensitivity was probably receptor mediated in obese NIDDM patients. However, future studies at receptor levels are needed to confirm this. Increase in insulin levels in non-obese diabetics need to be confirmed by further studies at the cellular gene level. Rughmini et al have postulated that *Yoga asanas* help in releasing stored insulin or in freeing bound insulin from the pancreas when pressure is applied on the abdomen. In the present study, serum insulin levels increased in non-obese NIDDM patients who were on *Yoga asanas* for 40 days. Thus, the normalisation of serum insulin helped NIDDM patients by directly increasing the utilisation and the metabolism of glucose in peripheral tissues, liver and adipose tissues

through its effect on enzymatic processes. [B.K. Sahay [1] have also shown a significant increase in insulin sensitivity and a decrease in insulin resistance by reporting a significant rise in the insulin receptors. Diabetic subjects have demonstrated a decrease in body fat percentage, increase in the lean body mass, normalisation of the insulin glucagon (I/G) ratios and up-regulation of insulin receptors. They have thus suggested a better utilisation of insulin and decreased peripheral resistance to insulin. B.K. Sahay [1] have also analysed the insulin / glucose ratio and have reported a significant fall in the fasting state in these patients, thus suggesting that *asanas* and *pranayamas* help in bringing about a near physiological response to stress in Diabetic patients. In their study, the increased fasting insulin concentrations have been found to correlate positively with the degree of obesity and with insulin resistance. [Table/Fig 6].

[Table/Fig 6]

PLASMA INSULIN BEFORE AND AFTER 40 DAYS OF <i>YOGA ASANAS</i>			
Before Yoga ( $\mu\text{U/ml}$ )		After Yoga ( $\mu\text{U/ml}$ )	
BMI < 25 n = 4	BMI > 25 n = 7	BMI < 25 n = 4	BMI > 25 n = 7
13.9 $\pm$ 4.9 <sub>a</sub>	36.1 $\pm$ 11.3 <sub>b</sub>	19.7 $\pm$ 4.8 <sub>a</sub>	11.0 $\pm$ 2.0 <sub>b</sub>

a : p value < 0.079  
b : p value < 0.614

The effect of *Yoga Asanas* on the Cardiovascular System In the present study, it was observed that there was a significant decrease in the heart rate, besides there being a decrease in systolic and diastolic blood pressure. QTc intervals were also seen to have decreased. The subjects felt relaxed too. These observations suggest that *Yoga* exercises shift the autonomic equilibrium to the parasympathetic side [B.K. Sahay [1] have shown reduction in both systolic and diastolic blood pressure in hypertensive subjects after two to three weeks of *Yoga* practice, with significant reduction in drug requirements The diastolic blood pressure was low in trained subjects, especially after

the *Yogic* exercises. This has been associated with a decrease in the sympathetic tone and consequently, a decreased peripheral resistance in trained subjects [6]. It has been established that certain *Yogis* can alter the patterns of their cardiovascular functions voluntarily [7],[8]. Changes of heart rate and respiration accompanying a *Yogic* subjective activity are intended to alter the state of mind alone [7]. There is rapid decrease of whole blood and red cell glycotoc rate during meditation [9]. There is a small but significant increase of cardiac output which is reported during Meditation (15%), coupled with a significant decline of renal and hepatic blood flow [7]. It seems that blood pressure changes due to meditation are mainly dependent on peripheral resistance. Blood pressure may not change acutely during Meditation [11]. It leads to an improvement in the vagal tone, as shown by a decrease in the voluntary control over heartbeat. [12]. The Heart rate adjusted QT interval (QTc) predicts mortality in Diabetic patients with coronary heart disease, along with nephropathy and autonomic neuropathy. It may be associated with an imbalance of the sympathetic nervous system [13]. In Diabetics, QT lengthening has been linked to an increased risk of unexpected deaths. [14]. Reduction of the P wave in ECG in a group practicing *Yoga asanas*, has also been noted [12]. Other types of voluntary control of the heart such as tachycardia, bradycardia, achieving T-wave amplitude more than that of the R-wave and atrial flutters, have also been recorded [12] [Table /Fig 7].

**[Table/Fig 7]**  
**CARDIAC PARAMETERS BEFORE AND AFTER 40 DAYS OF YOGA ASANAS**

S. No.	Parameters n = 20	Before Yoga Mean $\pm$ S.E.	After Yoga Mean $\pm$ S.E.	p Value
1.	DBP	86.7 $\pm$ 2.5	75.5 $\pm$ 2.1	<0.001
2.	SBP	142.0 $\pm$ 3.9	126.0 $\pm$ 3.2	<0.001
3.	Pulse Rate	86.45 $\pm$ 2.0	77.65 $\pm$ 2.5	<0.001
4.	QTc	0.42 $\pm$ 0.0	0.40 $\pm$ 0.0	0.246

DBP : Diastolic Blood Pressure in mm of Hg  
SBP : Systolic Blood Pressure in mm of Hg  
PR : Pulse Rate in pulse / min  
QTc : Corrected QT Interval

## The effect of *Yoga Asanas* on the Respiratory System and on Energy Metabolism.

In the present study, the regular practice of *Yogic asanas* in NIDDM Diabetics over a period of 40 days have been observed to lower the rate of respiration, increase FEV<sub>1</sub> / FVC, increase slow vital capacity and maximal voluntary ventilation, increase peak expiratory flow rate with a reduction in bronchial hyperactivity, increase the expansion of the chest and increase the vital capacity and the ability to hold the breath. These changes were not significant, as *pranayamas* were carried out for 40 days only, as their blood sugar did not decrease. [Table/Fig 7]

**[Table/Fig 8]**  
**EFFECT OF YOGA ON LUNG FUNCTION BEFORE AND AFTER 40 DAYS OF YOGA ASANAS**

S. No.	Parameters	n	Before Yoga Mean $\pm$ S.E.	After Yoga Mean $\pm$ S.E.	p Value
1.	SVC	22	2.11 $\pm$ 0.1	2.21 $\pm$ 0.1	0.156 <sup>NS</sup>
2.	FEV1	20	1.83 $\pm$ 0.1	1.93 $\pm$ 0.1	0.287 <sup>NS</sup>
3.	FVC	22	2.14 $\pm$ 0.1	2.20 $\pm$ 0.1	0.375 <sup>NS</sup>
4.	RATIO	20	0.84 $\pm$ 0.0	0.86 $\pm$ 0.0	0.521 <sup>NS</sup>
5.	PEFR	22	3.7 $\pm$ 0.3	4.4 $\pm$ 0.6	0.252 <sup>NS</sup>
6.	MVV	22	57.2 $\pm$ 4.7	55.8 $\pm$ 3.8	0.332 <sup>NS</sup>

NS : Non Significant  
SVC : Slow Vital Capacity in lt  
FEV1 : Forced Expiratory Volume in First Second in lt / sec  
FVC : Forced Vital Capacity in lt / sec  
RATIO : FEV1/FVC  
PEFR : Peak Expiratory Flow Rate in lt / sec  
MVV : Maximal Voluntary Ventilation in lt / min

## The effect of *Yoga Asanas* on Nerve Functions

In the present study, there was an increase in the left hand nerve conduction velocity. The distal amplitude in the diabetic subjects who were on *Yoga asanas* also increased. This was mainly due to decrease in blood sugar. The other reasons were proper utilisation of oxygen by the nerves, as measured by decrease in oxidative stress, a reduction of the weight and even distribution of fat in the body space, as shown by a decrease in the waist to hip ratio in these patients. The vibration sense as measured by a tuning fork was better appreciated and

the motor reflexes also improved. The latency decreased. Other parameters were insignificant because of intra observed variations such as the placement of electrodes, etc. Studies regarding the effect of *Yoga* on nerve conduction velocity in Type 2 Diabetics are virtually nonexistent. This study of this parameter is one of the firsts of its kind. It has been established that *Yogic* exercises reduce blood sugar [1] and serum lipid peroxide, thereby decreasing the toxicity of oxygen free radicals [15].It is therefore hypothesised, that the practice of *Yoga asanas* can decrease nerve injury and control or improve Diabetic neuropathy.

The effect of *Yoga Asanas* on the Central Nervous System.

The subjects felt better and were relieved of their stress and had improvement in their day to day performances. The subjects developed a sense of well being. *Yoga* relaxes, relieves stress and makes the patient feel good, alert, active and exhilarated by releasing opioids and altering adrenocortical activity that gives pleasurable sensations and keeps the body fit. Anand B.K., Chhina G.S., Baldev Singh. [16],[17] reported the dominance of alpha rhythm in the EEG activity of the persons who were trained in *Yoga*. The subjects were more aware and restful. The presence of alpha waves (8-13 Hz) and theta waves was not correlated with the numbers of the years of *Yoga* practice. *Yoga* enhances the physical threshold to withstand every adverse state of the body and to achieve a mental stamina to ignore the most painful physical sensations. Exercises lead to efficiency and perfection. A person, by the practice of *Yoga*, acquires the knowledge of human physiology and psychology and thus, is able to govern the physiological and psychological aspects of his life. [Table/Fig 9]

[Table/Fig 9]

NERVE CONDUCTION VELOCITY BEFORE AND AFTER 40 DAYS OF YOGA ASANAS										
Parameters n = 20	Before Yoga Mean $\pm$ S.E.				After Yoga Mean $\pm$ S.E.					
	Right		Left		Right		Left			
	Proximal	Distal	Proximal	Distal	Proximal	Distal	Proximal	Distal	Proximal	Distal
Amplitude	6.65 $\pm$ 0.3 <sup>ns</sup>	6.73 $\pm$ 0.3 <sup>ns</sup>	6.90 $\pm$ 0.4 <sup>ns</sup>	7.02 $\pm$ 0.4 <sup>ns</sup>	6.55 $\pm$ 0.3 <sup>ns</sup>	6.22 $\pm$ 0.3 <sup>ns</sup>	6.66 $\pm$ 0.4 <sup>ns</sup>	7.78 $\pm$ 0.6 <sup>ns</sup>		
Latency	7.48 $\pm$ 0.4 <sup>ns</sup>	4.34 $\pm$ 0.3 <sup>ns</sup>	7.81 $\pm$ 0.2 <sup>ns</sup>	4.34 $\pm$ 0.3 <sup>ns</sup>	7.30 $\pm$ 0.3 <sup>ns</sup>	4.27 $\pm$ 0.3 <sup>ns</sup>	7.81 $\pm$ 0.2 <sup>ns</sup>	4.27 $\pm$ 0.3 <sup>ns</sup>		
Velocity	52.81 $\pm$ 1.1 <sup>ns</sup>		52.46 $\pm$ 1.0 <sup>*</sup>		53.87 $\pm$ 1.1 <sup>ns</sup>		54.75 $\pm$ 1.1 <sup>*</sup>			

  

a	0.590	f	0.374	*	:	Significant at p $\leq$ 0.05
b	0.706	g	0.983	NS	:	Non Significant
c	0.670	h	0.402	Note	:	Proximal - Elbow and Distal - Wrist
d	0.394	j	0.236			
e	0.582	k	0.033			

## Findings of Diabetic Controls

The control group of Diabetics comprised subjects of comparable age and severity who did other physical exercises and who were on a diet regime and drug therapy, with mild physical exercise i.e. walking in place of *Yoga asanas*. The changes in the various parameters were recorded..

There was a general increase in weight and increased distribution of fat in the abdominal region. This was associated with an increase in the body mass index and decrease in lean body mass.

There was an increase in the fasting and postprandial blood glucose levels, with an increase in total cholesterol, triglycerides, LDL and VLDL cholesterol levels. Thus, there was poor glycaemic control in these NIDDM patients who were associated with deterioration in the serum lipid profile.

There was an increase in glycosylated haemoglobin in the NIDDM patients who were not undergoing the *Yoga* practice. An increase in the glycosylated haemoglobin was observed, thereby indicating that the Diabetes in the subjects of the control group was progressing uncontrollably.

It has been observed that there was no change in the insulin levels. There was a rise in the fasting malondialdehyde levels after 40 days of the study, thereby indicating that the level of lipid peroxidation / oxidative stress was increased.

However, there was a decrease in flow volumes.

It was observed that there was an increase in the heart rate besides an increase in systolic and diastolic blood pressure. The QTc intervals were also found to have been increased. The lung function also deteriorated. These observations suggested that the physical exercises on which the subjects were, shifted the autonomic equilibrium to the sympathetic side.

The patients suffered a progressive loss of function of the nerves, which was confirmed by analysing their nerve conduction velocity of the median nerve. There was a slowing of the conduction velocity along with a decrease in the distal amplitude. This showed that Diabetes is a progressive disease affecting not only the myelin sheaths, but also the axons.

These findings conformed to the general view in the medical fraternity that Diabetes Mellitus is a slowly progressive disease affecting most of the systems in the body and perpetually deteriorating their normal functioning. However, specific *Yoga asanas* along with prescribed meditation and diet helps in arresting the progress of further complications of the disease and perhaps slowing it down.

Further studies are required in this direction to substantiate receptor studies and

hormonal assays in more number of cases. Cognitive function studies need to be done to support the subjective feeling of wellbeing among the NIDDM patients.

**In conclusion**, it can be said that *Yoga asanas* in *mild to moderate* NIDDM cases, used in addition to normal medical therapy, would give benefit to the patient and improve the status of Diabetics in terms of use of less medicine, improvement of physical well being, improvement in mental alertness and activity and leading a complication free life. Consequently, it is suggested that *Yoga asanas* and *pranayamas* may be used as an adjunct to reduce Diabetes Mellitus. In overweight NIDDM patients on *Yoga asanas*, insulin levels were brought back to normal from a very high basal level.

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# Annexure 1

## PROFORMA

S.No. OPD/Clinic	Date:	Ref. By:	
Name:	Age:	Sex : Male / Female	
Occupation:	Income:	Address:	
Educational Status			
	Y / N	Since	Quantity
<b><u>Personal Habits</u></b> Smoking Alcohol Tobacco Chewing			
	Frequency of Intake per Day		
<b><u>Dietary Habits</u></b> Meat / Fruits / Vegetables High Fat Diet (Oil, Butter, Ghee) High Sugar Diet (Sweets, Sugar Intake) Vitamin C / Vitamin E			
<b><u>Environment Pollution</u></b> Vehicular Fumes / Workplace Fumes / Cooking (Firewood / Kerosene) Smoke			
	Y / N	Duration	Remarks

Presenting Complaints and History of Present Illness			
Frequent Urination / Increased Urine Output (Polyuria)			
Excessive Thirst (Polydipsia)			
Excessive Hunger (Polyphagia)			
Feeling of Tiredness / Fatigue / Cramps			
Weight Loss			
Fasting Symptoms (Stupor, Tremors, Nervousness, Sweating, Feeling Cold)			
Constipation / Diarrhea			
Blurred Vision / Cataract / Stye			
Conjunctival Infection / Iris Inflammation			
Corneal Ulceration / Glaucoma			
Recurrent Boils / Candidiasis			
Postural Unsteadiness / Drowsiness			
Distal Muscle Wasting / Weakness			
Sensory Loss / Pain / Tingling / Burning			
Corns / Ulcers / Skin Colour Changes			
Abdominal Pain / Nausea / Vomiting			
<b>Burning Micturation</b>			
<b>Unhealthy Gums / Pus Discharge</b>			
<b>Coldness of Feet / Colour Changes</b>			
<b>Gastric Acidity / Fullness of Abdomen</b>			
Delayed Wound Healing / UV Burns			
Sick Look / Dehydrated /			
<b>Kussmaul Breathin</b>			
<u>Associated Diseases</u> Obesity / Malnutrition (Emaciation) Hypertension Tuberculosis Acromegaly / Mumps Pregnancy / Big Baby Fever / Thyrotoxicosis Gall Stones / Colic			
<u>Family History</u> <b>Diabetes Mellitus</b> Tuberculosis Hypertension Obesity	Parent(s) / Sibling(s) / Second Degree Relative(s)		
	Name	Dose	Duration

<u>Drug History</u>  <b>OCPs</b> Steroids Antihypertensive Drugs Diabetogenic Drugs  Insulin				
Dietary Advise Breakfast  Lunch  Snacks  Dinner				
				Remarks
<u>Physical Activities</u> At Work / Home At Leisure Time	Mild Walking	Moderate Sports	Severe Relaxation	
	Y / N	Remarks		
<u>Psychological History</u> Stress Aggression Restlessness Quarrelling Temperamental Nature Hysteria				

### EXAMINATION

General Physical Examination

**Before Yoga**

**After Yoga**

**Remarks**



<b>Pallor</b>			
<b>Icterus</b>			
<b>Edema</b>			
<b>Cyanosis</b>			
<b>Lymphadenopathy</b>			
Anthropometric Measurements			
<b>Height (cms)</b>			
<b>Weight (kgs)</b>			
<b>Waist Hip Ratio (WHR)</b>			
<b>Lean Body Mass for Male (LBM)</b> ( $1.10 \times \text{wt (kg)} - 128(\text{wt}^2/100 \times \text{height (m)})^2$ )			
<b>Lean Body Mass for Female (LBM)</b> $1.07 \times \text{wt (kg)} - 148(\text{wt}^2/100 \times \text{height (m)})^2$			
<b>Surface Area (<math>m^2</math>)</b> $0.20247(\text{height}^{0.725} \times \text{weight}^{0.425})$ .			
<b>Body Mass Index (BMI) (<math>\text{wt}/\text{ht}^2</math>)</b>			
Vitals			
<b>Temperature</b>			
<b>Pulse Rate (per min)</b>			
<b>Respiratory Rate (per min)</b>			
<b>Blood Pressure (mm Hg)</b>			
Systemic Examination			
<b>Chest</b>			
<b>Cardiovascular</b>			
<b>Abdomen</b>			
<b>Nervous System</b>			

<u>PARAMETERS</u>		
	<b>Before Yoga</b>	<b>After Yoga</b>
<i>Biochemical Investigations</i>		
<b>Blood Glucose</b>		
Fasting		
Post Prandial		
Lipid Profile		
<b>Serum</b>		
<b>Cholesterol</b>		
<b>Serum</b>		

<b>Triglycerides</b> Serum HDL Serum LDL Serum VLDL				
<b>Serum Insulin</b>				
Blood MDA Level				
<b><u>Blood Glycosylated Hemoglobin</u></b>				
<b><u>Respiratory Parameters</u></b>	<b>Before Yoga</b>		<b>After Yoga</b>	
	Predicted	Observed	Predicted	Observed
SVC (lt)				
FEV <sub>1</sub> (lt / s)				
FVC (lt / s)				
FEV <sub>1</sub> / FVC (%)				
PEFR (lt / s)				
MVV (lt / min)				
<b><u>Cardiac Parameters</u></b>				
<b>ECG (QTc Interval)</b>				
<b><u>Electrophysiological Parameters (Nerve Conduction Studies)</u></b>				
<b><u>Median Nerve</u></b> Amplitude <b>Latency</b> Distance Velocity				
<b><u>Miscellaneous Investigations</u></b>  <b>Ophthalmoscopy</b>  Urine Examination  <b>Hormonal Assay</b>				