

# Effect of integrated yoga therapy on glycemic control and pulmonary function tests in borderline noninsulin dependent diabetes mellitus patients of Central India

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## ABSTRACT

**Background:** Diabetes initiates degenerative changes in various organs of body. Lungs are also affected, producing restrictive and obstructive abnormalities and predisposing them to infections including tuberculosis. These may lead to decrease in pulmonary functions. Timely intervention can lead to reversal of this problem. Yoga can offer simple and cost-effective adjunct. **Objectives:** To study the effect of integrated yoga therapy (IYT) on glycemic control and pulmonary function tests (PFTs) in borderline noninsulin dependent diabetes mellitus (NIDDM) patients of Central India. **Materials and Methods:** Randomly selected 50 newly diagnosed patients of borderline NIDDM in the age group of 30-60 years who were not put on any antidiabetic medicines and were advised diet therapy and exercise as therapeutic measures by their physicians prospective study. We offered IYT and diet therapy for 3 months to these patients. Fasting blood glucose (FBG), postprandial blood glucose (PBG), glycosylated hemoglobin (HbA1c), and PFTs were measured at the outset of study and at the end of 3 months. Statistical analysis is done by paired *t*-test. **Results:** Showed a significant decrease in FBG (117.8-99.56 mg/dl), PBG (177.8-154.82 mg/dl), HbA1c (5.93-5.71%) and improvement in PFTs (forced vital capacity [FVC] 2.59-2.95 L, forced expired volume 1 (FEV1) 2.05-2.41 L, FEV1/FVC 79.09-81.54%, peak expiratory flow rate 6.99-7.33 L/s). **Conclusion:** Our study demonstrated the efficacy of IYT in lowering of FBG, PBG, HbA1c and improving the lung functions, i.e. preventing the targeting of lungs in NIDDM.

**KEY WORDS:** Fasting Blood Glucose; Postprandial Blood Glucose; Glycosylated Hemoglobin; Pulmonary Function Tests; Yoga

## INTRODUCTION


Noninsulin dependent diabetes mellitus (NIDDM) is a glycemic disorder diagnosed on the basis of elevated blood glucose level. It is characterized by multiple and interrelated metabolic abnormalities.<sup>[1]</sup> During the course of NIDDM, many organs are affected including lungs leading to decrease in lung functions. Thus, it poses great economical impact on our society in its management.

Beneficial effect of yoga on NIDDM and on pulmonary function test (PFT) is reported by many studies. If NIDDM is diagnosed at the early stage, i.e., borderline stage and intervened by diet therapy and yoga therapy, it may improve outcome.

This study was undertaken to demonstrate the effect of integrated yoga therapy (IYT) on glycemic control and PFTs in the newly diagnosed patients of borderline NIDDM.

## MATERIALS AND METHODS

It was a prospective study undertaken to know the effect of IYT on blood sugar levels, glycosylated hemoglobin (HbA1c), and PFT parameters in 50 newly diagnosed patients of borderline NIDDM. These patients were selected from

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outpatient department of diabetes of Government Medical College, Nagpur, Central India. These patients were not put on antidiabetic drugs and only advised diet therapy and exercise by their physicians.

Newly diagnosed patients of NIDDM with Borderline diabetes in the age group of 30-60 years with fasting blood glucose (FBG) between 110 and 125 mg/dl and postprandial blood glucose (PBG) between 140 and 200 mg/dl and who were not put on any oral hypoglycemic drug/insulin were included in the study. Patients who were following diet therapy and yoga therapy, patients who are drugs which can affect blood sugar level and patients suffering from cardiorespiratory diseases and hypertension were excluded from study.

The study was approved by Institute Ethics Committee of this Medical College. Informed consent was taken from all the participants. Permission of Yoga center was taken.

After relevant history, general examination, and systemic examination 65 patients were identified. After applying above inclusion and exclusion criteria, 55 patients were selected. Patients were informed about all the steps of research work and five patients did not agree for work. Finally, 50 subjects were selected which included 29 males and 21 females. They were permitted to withdraw from study at any stage for any reason.

Standing height was measured by means of stadiometer on barefoot to the nearest cm. Weight was measured by weighing machine in kg. Body mass index (BMI) was calculated. Blood glucose was estimated by Autoanalyzer erba-xl 300 (Normal range: FBG: 60-110 mg/dl, PBG: 90-140 mg/dl and HbA1c: 4.5-6.3%). PFTs were carried out by Medspirer Spirometer (RMS Helios 401). Before carrying out PFTs, the procedure was explained and demonstrated to the subjects. Subjects were encouraged to carry out the test smoothly. Patients were asked to sit upright in the chair in front of the apparatus. Subjects were asked to take maximum inspiration and close the nostrils with the help of nose clips and then expire forcefully and completely in the mouth piece of instrument. After first trial attempt procedure was repeated for three consecutive times with the adequate rest in between and best reading was chosen. In PFTs, forced vital capacity (FVC), forced expired volume 1 (FEV1), FEV1/FVC, and peak expiratory flow rate (PEFR) were selected.

At the beginning height, weight, FBG, PBG, HbA1c, and PFTs were measured in all the subjects. By consulting dietician, all the subjects of were advised diet as per manual - Dietary guidelines for Indians by National Institute of Nutrition, Hyderabad, India.<sup>[2]</sup> Subjects were put on IYT for 60 min a day, 5 days a week for 3 months under supervision of yoga expert. The schedule of IYT was as prescribed by Swami Vivekanand Yoga Anusadhana Samsthana, Bengaluru, India.<sup>[3]</sup> Module included following practices,

1. Prayer: 2 min
2. Loosening exercises: 4 min
3. Instant relaxation technique: 1-2 min
4. Asana: 25 min
5. Quick relaxation technique: 3 min
6. Pranayama: 15 min
7. Deep relaxation technique: 10 min.

Asana were performed daily alternating upper body, lower body, and abdominal asana. Subjects were motivated regularly with diabetic education to avoid absentee and drop out of subjects from therapy session.

All the subjects were again subjected to estimation of FBG, PBG, HbA1c, and PFTs at the end of 3 months. No subjects withdrew from the study.

### Statistical Analysis

Continuous variables (Age, FBG, PBG, HbA1c, and PFT parameters) were presented as mean  $\pm$  standard deviation. Continuous variables were compared by paired *t*-test. Correlation coefficient (*r*) was calculated to assess the strength of relationship between two variables. *P* < 0.05 was considered statistically significant. Statistical significance STATA version 13.1 was used for statistical analysis.

### RESULTS

Out of the 50 participants, 29 were male and 21 were female. Their mean age in years was  $45.18 \pm 3.59$ , mean height in cm was  $160.56 \pm 7.79$ , mean weight in kg was  $82.68 \pm 9.13$ , and mean BMI in  $\text{kg}/\text{m}^2$  was  $32.00 \pm 1.88$ .

Table 1 shows the values of FBG, PBG, and HbA1c and PFT parameters at 0 weeks and at the end of 3 months. Table 2 shows the correlation of FBG, PBG, and HbA1c with PFT parameters.

**Table 1:** Observations of FBG, PBG, HbA1c, and PFTs (FVC, FEV1, FEV1/FVC, PEFR)

Parameters	Study duration			<i>t</i> value	<i>P</i> value
	0 week	3 months			
Mean FBG (mg/dl)	117.8 $\pm$ 4.33	99.56 $\pm$ 4.76	28.34	<0.0001	
Mean PBG (mg/dl)	177.8 $\pm$ 11.95	154.82 $\pm$ 12.38	13.15	<0.0001	
Mean HbA1c (%)	5.93 $\pm$ 0.13	5.71 $\pm$ 0.13	19.88	<0.0001	
Mean FVC (l)	2.59 $\pm$ 0.53	2.95 $\pm$ 0.57	30.278	<0.0001	
Mean FEV1 (l)	2.05 $\pm$ 0.46	2.41 $\pm$ 0.51	36.8625	<0.0001	
Mean FEV1/FVC (%)	79.09 $\pm$ 1.64	81.54 $\pm$ 5.05	4.61	0.0012	
Mean PEFR (L/s)	6.99 $\pm$ 1.38	7.33 $\pm$ 1.43	3.73	<0.0001	

FBG: Fasting blood glucose, PBG: Postprandial blood glucose, HbA1c: Glycosylated hemoglobin, PFT: Pulmonary function test, FVC: Forced vital capacity, FEV1: Forced expired volume 1, PEFR: Peak expiratory flow rate

**Table 2:** Correlation of FBG, PBG and HbA1c with PFTs

Parameters	Duration	FVC		FEV1		FEV1/FVC		PEFR	
		r-value	P-value	r-value	P-value	r-value	P-value	r-value	P-value
FBG	0 week	0.1253	0.559	0.066	0.644	-0.093	0.517	0.031	0.831
	3 months	0.626	<0.0001	0.4514	<0.0001	0.9548	<0.0001	0.6261	<0.0001
PBG	0 week	-0.293	0.0386	-0.2837	0.0087	-0.093	0.517	-0.3279	0.0201
	3 months	0.9415	<0.0001	0.9885	<0.0001	0.6261	<0.0001	0.9886	<0.0001
HbA1c	0 week	-0.1313	0.3639	-0.1753	0.2234	-0.306	0.03, S	-0.2162	0.1316
	3 months	-0.0026	0.9857	-0.0308	0.8318	-0.043	0.7645	-0.0444	0.7596

FBG: Fasting blood glucose, PBG: Postprandial blood glucose, HbA1c: Glycosylated hemoglobin, PFT: Pulmonary function test, FVC: Forced vital capacity, FEV1: Forced expired volume 1, PEFR: Peak expiratory flow rate

**DISCUSSION**

Beneficial effects of yoga are studied and scientifically proved but lot of research work is needed to be done on yoga. Aim of this study was to demonstrate the effect of IYT on blood sugar levels, HbA1c and PFT parameters. The study was carried out in 50 newly diagnosed patients of borderline NIDDM who were not put on any hypoglycemic medications and who were advised diet therapy and exercise by their physicians.

Baseline values (at 0 week) of FBG, PBG, HbA1c, and pulmonary parameters, i.e., FVC, FEV1, FEV1/FVC, and PEFR were recorded in all subjects. All subjects were prescribed diet therapy as per a manual - Dietary guideline for Indians by National Institute of Nutrition, Hyderabad, India. The participants were subjected to IYT in prescribed format for 3 months by trained yoga teacher. All parameters were recorded at the end of 3 months in all subjects. The readings were compared at the end of 3 months.

In our study, Table 1 shows physical parameters of subjects.

Our study showed effect of diet therapy and IYT on FBG, PBG, and HbA1c (Table 2). The mean values of all were decreased after 3 months ( $P < 0.0001$ ).

Our findings were consistent with studies by Sharma and Gupta (2014),<sup>[4]</sup> Shende et al. (2013),<sup>[5]</sup> Baljinder et al. (2012),<sup>[6]</sup> Hegde et al. (2011),<sup>[7]</sup> Monroe et al., (2010),<sup>[8]</sup> Singh et al. (2008),<sup>[9]</sup> Bijlani et al. (2005),<sup>[10]</sup> Malhotra et al. (2004),<sup>[11]</sup> Singh et al. (2004),<sup>[12]</sup> Agrawal et al. (2003),<sup>[13]</sup> Malhotra et al. (2002),<sup>[14]</sup> Jain et al. (1993),<sup>[15]</sup> Sahay and Murthy (1993),<sup>[16]</sup> Kerr et al. (2002).<sup>[17]</sup>

The beneficial effects of asana, pranayama, and relaxation techniques in NIDDM may be due to reduction of insulin resistance, increase in release of insulin like factors from muscles into the circulation, decrease in secretion of adrenaline from diminished sympathetic tone leading to inhibition of glycogenolysis or improvement in antioxidant status.<sup>[4-17]</sup>

Long standing NIDDM leads to decrease in pulmonary functions. It may be possibly because of nonenzymatic glycosylation tissues of lungs leading to decrease in compliance of lungs and decrease in lung volumes. It was studied by Venkatesh and Girija (2014),<sup>[18]</sup> Zaman et al. (2014),<sup>[19]</sup> Niazi et al. (2013),<sup>[20]</sup> Sweety et al. (2012),<sup>[21]</sup> Bae et al. (2012),<sup>[22]</sup> Irfan et al. (2011).<sup>[23]</sup>

Malhotra et al. (2002)<sup>[14]</sup> showed the effect of yoga asana on improvement in PFT parameters in NIDDM patients. Improvement in PFT may reduce oxidative stress which in turn may benefit in the management of NIDDM.

Table 2 also shows the effect of IYT and diet therapy for 3 months on pulmonary functions such as FVC, FEV1, FEV1/FVC, and PEFR. The mean values were significantly increased ( $P < 0.0001$ ).

Many studies including that of QR Ahmed et al. (2010)<sup>[24]</sup> Yadav and Das et al. (2001),<sup>[25]</sup> Mullar et al. (2012),<sup>[26]</sup> and Gupta and Sawane (2012)<sup>[27]</sup> showed improvement in PFT parameters after practice of yoga in healthy population.

Beneficial effects of yoga therapy on PFTs may be due to<sup>[26-29]</sup> strengthening of respiratory muscles, reduction in stress, increase in parasympathetic tone, lung inflation causing more release of surfactant leading to more compliance and release of prostaglandins leading to decrease in bronchial smooth muscle tone.

**Correlation of Blood Glucose Level with PFT Parameters**

Table 2 shows the correlation of FBG and PBG with FVC, FEV1, FEV1/FVC, and PEFR with at 0 week which was not significant and at 3 months it was negative correlation which was highly significant with  $P$  value  $< 0.0001$ , whereas HbA1c had weak negative correlation with PFTs (with FEV1/FVC was significant and with FVC, FEV1, and PEFR not significant). Hence, as glycemic control improves by IYT, PFT parameters also improve.

The strength of the study is that IYT can act as an adjunct in the management of NIDDM. Limitation of this study was, it was done in small geographical area and NIDDM is influenced by variety of factors outside the small geographic area, hence further studies with bigger sample size, covering large geographical area and studies on long-term should be carried out to know the effect of IYT on blood sugar levels (FBG and PBG), HbA1c and PFT parameters in cases of borderline NIDDM.

Since exercise forms one of the main element of management of NIDDM, further studies in borderline NIDDM comparing the effect of IYT and other form of exercise are advocated. Consistency and regularity in IYT/exercise is limiting factor, hence social group of NIDDM is the necessity of time.

## CONCLUSION

We conclude, by practicing IYT FBG, PBG, and Hb1Ac were reduced, and PFT parameters were improved in patients of borderline NIDDM in central India. These changes when correlated showed improvement in PFT parameters with improvement of glycemic control.

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