

Effect of Sudarshan Kriya Yoga and Physical Exercise on Fasting Blood Sugar and Perceived Stress in Prediabetic SubjectsPramod Kumar Narnolia¹, Bijendra Kumar Binawara², Mamta Mehra³, Poornima Vyas⁴¹ PhD Scholar, Department of Physiology, SP Medical College, Bikaner Rajasthan, India² Senior Professor, Department of Physiology, SP Medical College, Bikaner Rajasthan, India³ Associate Professor, Department of Pathology, SK Govt. Medical College, Sikar, Rajasthan, India⁴ Senior Demonstrator, Department of Physiology, SP Medical College, Bikaner Rajasthan, India

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Abstract**Objective:** The present study is performed to study the effect of Sudarshan kriya yoga and physical exercise on fasting blood sugar and perceived stress level in prediabetic subjects.**Material and Methods:** One hundred prediabetic subjects were enrolled in this study at Department of Physiology, S.P. Medical College, Bikaner, with informed consent. They were divided into two groups SKY and PE, having 50 subjects in each group. Then they were undergone the prescribed interventions regularly for the duration of three months. Fasting blood sugar and perceived stress level were measured at baseline and after 3 months of SKY and PE interventions.**Results:** SKY intervention resulted in statistically highly significant decrease in FBS and PSS ($p < 0.001$) after 3 months of regular practices in the study subjects. PE intervention also caused statistically highly significant decrease in FBS and PSS ($p < 0.001$) after 3 months of regular brisk walking practices in the study participants.**Conclusion:** SKY and PE interventions are found to statistically significant decrease in FBS and PSS in study participants. Application of SKY and PE in early course of development of DM2 may be helpful to prevent development of these clinical cases. The underlying mechanism to decrease FBS and PSS in the study participants, may be by increased parasympathetic activity along with decreased sympathetic activity.**Keywords:** Sudarshan Kriya Yoga (SKY), Physical Exercise (PE), Pre-Diabetics, Fasting blood sugar (FBS), Perceived stress scale (PSS).

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Introduction

WHO recommends Subjects with fasting blood glucose level 100-125 mg/dl as pre-diabetics. Pre-diabetics have 25-40% risk over the next 5 years to develop DM type 2 and also have an increased risk of cardiovascular diseases. Diabetes mellitus, a prevalent disorder of carbohydrate metabolism marked by hyperglycemia due to insulin deficiency or resistance, has seen a dramatic rise in cases. The International Diabetic Federation predicts the number of Diabetic patients will escalate to 642 million by 2040, driven by dietary changes, reduced physical activity and increasing obesity. [1]

The PSS is a psychological tool used to measure an individual's perception of stress. It is widely employed to assess the recent stress levels experienced by individuals. The scale consists of

questions that inquire about the intensity of feelings and thoughts over the past month. [2]

In today's modern industrialised, fast life along with smoking, alcohol abuse, stress, unhealthy eating habits and no regular physical activity has made people more prone to lifestyle diseases like hypertension and diabetes. Lifestyle modifying interventions like yoga meditation and physical exercise have implications in the prevention as well as management of diabetes mellitus and many other lifestyle diseases. Therefore yoga meditation and physical exercise may be adopted as lifestyle modifying health promoting interventions.

Yoga: The word 'yoga' in Sanskrit means "to unite". Yoga is considered as an Indian science and tradition. Yoga establishes mind over body. Sage Patanjali in his Yoga sutras proposed a systematic

approach to bring man to the highest state of advancement on physical, mental and spiritual planes. [3]

The Art of Living Foundation teaches Sudarshan Kriya and its associated practices globally as techniques for health promotion and management. Modern medical research has confirmed their health benefits, showing their potential to harmonize the body and mind. [4]

The autonomic nervous system (ANS) regulates the body's visceral functions. The previous belief that the ANS cannot be controlled voluntarily has evolved. It is now understood that interventions such as yoga, meditation, and other relaxation techniques can influence the ANS. One such technique is SKY. It came into being in 1982 in Shimoga, India when Sri Sri went into a ten days period of silent meditation. [5]

Regular physical exercise has the potential to slow the aging process, mitigate the risk of various degenerative and metabolic disorders, and promote both a healthier and longer life. Exercise can serve as a preventive measure against diseases or as a treatment for existing conditions. Aerobic exercises, such as "brisk walking, jogging, swimming, and dancing", are particularly beneficial for enhancing physical fitness and fostering overall well-being. [6]

Physical exercises offer significant potential in managing various health conditions such as cardiovascular diseases, diabetes, and mental illnesses. [7]

The rising prevalence of diabetes mellitus among individuals is a concerning trend in society. This has sparked a strong desire to focus on pre-diabetic individuals with the goal of preventing their progression to clinical cases. Non-pharmacological lifestyle interventions, such as Sudarshan Kriya Yoga and physical exercise, offer promising approaches for promoting better health and preventing the development of these conditions. By incorporating these practices into daily life, individuals can adopt healthier lifestyles and reduce their risk of developing diabetes mellitus.

Material and Methods

The current study enrolled 100 participants aged 30-60 with pre-diabetes. They were divided into two groups SKY (Sudarshan Kriya Yoga) and PE (physical exercise) each comprising 50 individuals, they were engaged to perform their respective activities for one hour daily over three months.

SKY involved yoga practice, while PE included a regimen of "slow walking warm-up, brisk walking, and cool down". This study was conducted at the Department of Physiology, S.P. Medical College, Bikaner, from December 2017 to March 2023 with informed consent of the subjects. The ethical approval was obtained from the human ethical committee of S.P. Medical College, Bikaner. Before starting the intervention baseline parameters (i.e. FBS and PSS) were measured for all the study subjects, three months after completion of study period the same set of observations was repeated. All the subjects participated voluntarily in the study. The patients suffering from coronary artery disease, diabetes mellitus, Pulmonary tuberculosis, asthma, any other major illness and non-cooperative subjects were excluded from the study.

Fasting Blood Sugar (FBS) levels were assessed using the glucose oxidase method, employing enzymatic kits known as GOD-POD kits". This method utilizes the glucose oxidase enzyme to accurately measure blood sugar levels in the samples collected from the study participants.

Results

Statistically highly significant benefits of SKY and PE interventions were obtained in fasting blood glucose level and perceived stress scale after 3 months of practices in prediabetic subjects.

Table 1 and 2 show the demographic profile of prediabetic subjects practicing SKY and PE interventions according to age and gender. The association between both the groups was found non-significant. ($p > 0.05$).

Table 3 and 4 showing the distribution of prediabetic subjects according to fasting blood sugar and perceived stress scale respectively at pre interventions i.e. SKY and PE and the association found between both the groups was non-significant. ($p > 0.05$).

Table 5 shows statistical analysis of FBS and PSS between pre and post treatment in pre-diabetic SKY group. There was statistically significant decrease in FBS and PSS after three months of SKY intervention in pre-diabetic subjects. ($p < 0.001$)

Table 6 shows statistical analysis of FBS and PSS between pre and post treatment in pre-diabetic PE group. There was also statistically highly significant decrease in FBS and PSS after three months of PE intervention in pre-diabetic subjects. ($p < 0.001$)

Table 1: Distribution of cases according to age group

Age Group (years)	Pre DM				Total	
	Yoga		PE		No.	%
	No.	%	No.	%		
34-40	11	22.0	2	4.0	13	13.0
41-50	28	56.0	26	52.0	54	54.0
>50	11	22.0	22	44.0	33	33.0
Total	50		50		100	
Mean	45.82		49.46			
SD	6.22		4.50			
t	1.619					
p	0.109					

Table 2: Distribution of cases according to gender

Gender	Pre DM				Total	
	Yoga		PE		No.	%
	No.	%	No.	%		
Female	17	34.0	17	34.0	34	34.0
Male	33	66.0	33	66.0	66	66.0
Total	50		50		100	
χ^2	-					
p	-					

Table 3: Distribution of cases according to fasting blood sugar (mg/dl) at pre-treatment

FBS (mg/dl)	Pre DM				Total	
	Yoga		PE		No.	%
	No.	%	No.	%		
<108	0	-	0	-	0	-
108-126	50	100	50	100	100	100
>126	0	-	0	-	0	-
Total	50		50		100	
Mean	114.84		115.12			
SD	7.20		6.43			
t	0.205					
p	0.838					

Table 4: Distribution of cases according to PSS at pre-treatment

PSS	Pre DM				Total	
	Yoga		PE		No.	%
	No.	%	No.	%		
≤20	14	28.0	16	32.0	30	30
>20	36	72.0	34	68.0	70	70
Total	50		50		100	
Mean	23.52		23.36			
SD	4.16		4.29			
t	0.189					
p	0.850					

Table 5: Statistical analysis of FBS and PSS between pre and post treatment in pre-diabetic SKYgroup

Parameters	Pretreatment		Post treatment		t	p
	Mean	SD	Mean	SD		
Fasting Blood Sugar	114.84	7.20	87.36	7.34	25.344	<0.001
PSS	23.52	4.16	4.40	1.67	30.946	<0.001

Table 6: Statistical analysis of FBS and PSS between pre and post treatment in pre-diabetic PE group

Parameters	Pretreatment		Post treatment		t	p
	Mean	SD	Mean	SD		
Fasting Blood Sugar	115.12	6.43	90.62	8.01	24.050	<0.001
PSS	23.52	4.16	7.00	1.65	25.350	<0.001

Discussion

Lifestyle modification through SKY and PE interventions have been found beneficial in the management of stress related chronic diseases associated with sedentary life and unhealthy dietary habits like diabetes mellitus. SKY is a complete package of yoga, meditation, pranayama and art of living knowledge points.

The scientific study done by Verma MR *et al* investigated random blood sugar levels following a seven-day SKY course in both non-diabetic individuals and patients with type 2 diabetes mellitus. The findings indicated a decrease in blood sugar levels among participants. Remarkably, the reduction was significantly greater ($p < 0.05$) in diabetic individuals compared to non-diabetics. This suggests that yoga therapy may increase insulin secretion, leading to decreased blood sugar levels. Consequently, mind-body interventions such as SKY have demonstrated utility in managing diabetes mellitus. [8]

Short-term yoga-based lifestyle interventions have proven to be beneficial in reducing fasting blood sugar levels in both pre-diabetic individuals and diabetic patients. [9,10]

Stress-induced elevation of glucocorticoids (GCs) and catecholamines inhibits the response of GLUT-4, thereby reducing glucose absorption and utilization by the active skeletal muscles. Consequently, this leads to an increase in blood glucose levels. [11]

The activation of the parasympathetic nervous system through yoga has been found to be beneficial in improving insulin sensitivity, optimizing insulin secretion as well as having positive effect on immune function. [12,13]

Yogic practices exert a dual effect: they inhibit sympathetic nervous system activity and reduce stress, thereby playing a beneficial role in stress-related diseases and lowering blood glucose levels. [14]

Review study conducted by Wang *et al*, which demonstrated favorable effects of various yoga practices on stress reduction in healthy individuals [15] Stress reduction through yoga may involve both psychological mechanisms, such as positive affect, mindfulness, and self-compassion, and biological mechanisms, including inhibition of stress-related hormones like cortisol. [16]

The combination of stretching exercises, asanas, and controlled breathing in SKY enhances circulation and oxygen supply to vital organs while releasing excess CO_2 , promoting relaxation and relieving tension. Guided meditation during SKY reduces stress perception, anxiety, and oxidative stress, contributing to overall well-being.

Reduction in serum lactate levels post-SKY practices suggest induction of a relaxation state. [17]

EEG study during meditation showed decreased beta/alpha power while increased alpha/delta power which is suggestive of highly focused, concentrated and calm alert state of mind. [18]

Mourier *et al* found in their study that PE significantly improved insulin sensitivity ($p < 0.001$) after 2 months. Physical exercises performed were cycling for 45 minutes per week and an intermittent exercise one time per week for two months significantly improved insulin sensitivity ($p < 0.001$) along with loss of visceral adipose tissue in the patients of NIDDM. [19]

In a review study it is found that PE are beneficial in the management of blood glucose, blood pressure, body fat, lipid profile, psychological stress, anxiety and many more clinical conditions so they have important role to prevent emergence of many chronic diseases. [20]

In a research study it is concluded that physical exercise significantly decreased FBS in patients of type 2 Diabetes mellitus. [21]

Stress-related health issues are associated with mental and physical health decrements, and poor well-being. Physical exercise is one intervention that may be very useful for stress reduction. PE interventions are effective to cope up with every day stress among non-clinical population. [22]

Atlantis E *et al* performed RCT study to determine the effectiveness of PE to improve mental health and quality of life for the duration of 24 weeks. Their results showed significant improvement in mental health, quality of life and stress. [23] Acute exercises resulted in decreased blood pressure and cortisol. On review of some studies, it was concluded that physical exercises decrease stress reactivity in the adult participants. [24]

Physical exercises had resulted to decrease the magnitude of hyperarousal states with the stress response. PE regulate autonomic nervous system activity by inhibiting SNS so beneficial in stress related diseases like cardiac arrest, platelet aggregability and many more. [25]

PE play positive role to keep the stress levels lower through decreasing SNS activity, HPA axis and plasma cortisol level and made the subjects felt positive. [26]

Moderate intensity stress even related to daily life, if present chronically may be a precipitating factor in neuropsychiatric disorders. Regular physical activity has a positive effect on the central nervous system functions, leading to an improvement in mood and cognitive abilities and is correlated with

a rise in the expression of the neurotrophic factors and markers of synaptic plasticity as well as decrease in the inflammatory markers. Many studies had shown that the energy challenge caused by physical exercise can affect the CNS by improving cellular bioenergetics, stimulating the processes responsible for the removal of damaged organelles and molecules, and attenuating inflammatory processes. Regular physical activity brings another important benefit: increased stress robustness. The evidence from animal studies showed that a sedentary lifestyle was associated with stress vulnerability, whereas a physically active lifestyle was associated with stress resilience. [27]

Conclusion

Sudarshan Kriya Yoga and physical Exercise have been found to decrease blood glucose level and improve perceived stress in the participants. They establish balance between the activity of parasympathetic and sympathetic nervous system. While further controlled clinical trials are necessary to establish the benefits of comprehensive intervention programs like SKY and PE in the prevention of emergence of diabetes mellitus. Current evidence suggests their potential as a low-risk adjunct for managing diabetes mellitus, stress-related conditions as well as improving overall well-being and stress tolerance.

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