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RESEARCH ARTICLE

EFFECT OF YOGA THERAPY ON FREQUENCY DOMAIN PARAMETERS OF HEART RATE VARIABILITY IN PREDIABETICS

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Abstract

Introduction: Prediabetes is the budding stage of type 2 diabetic mellitus and imposes the elevated risk for cardiovascular diseases (CVDs) with significant morbidity and mortality. Non pharmacological strategies such as yoga therapy have marked impact in the mitigation of prediabetes. In this backdrop, the present study was conducted to study the effect of six months yoga intervention on heart rate variability in patients diagnosed with prediabetes. Further, it has been used as tool for the maintenance of autonomic nervous system and to reduce the progression of diabetes.

Material and Method: The study was conducted on 250 prediabetic adults aged ranging from 30-50 years attending the OPD of Jaipuria Hospital and from different yoga centers. Then the effect of yoga intervention on frequency domain parameters of heart rate variability such as Low frequency (LF),High frequency (HF), Ratio of LFto HF. The patients were divided into two groups as follows, Group A (n=125) were subjected to intervention with yoga exercises and Group B (n=125) were not advised for any yoga exercises. Data analysis was done by Oneway ANOVA for comparison between the groups and significance was analysed post hoc analysis followed by Tukey's and Schaffe's tests.

Results : In group A, yoga intervention leads to significant ($p < 0.001$) decrease in LF component with an substantial elevation in HF component and the LF/HFratio shifted towards the parasympathetic dominance as compared to group Bat baseline, 3 and6 months.

Conclusion: Thus the study reveals that yoga intervention for six months significantly shifted ANS system towards the parasympathetic dominance in prediabetic patients. Thus, routine yoga session could alleviate the cardiometabolic risk factors in individuals affected with prediabetes.

Introduction:-

Diabetes, is a highly prevalent metabolic disorder with a global increase from366to552 million people between the year 2011 to 2030, in which 101million people from India.[1]Individuals affected with prediabetes have elevated risk of type 2 diabetes along with comorbidities like cardiovascular diseases and stroke .[2,3]

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Prediabetes is condition in which there is an elevated blood sugar level but the level is not sufficient to diagnose it as diabetes. Pre-diabetes represents the initial stage of diabetes and it may develop to diabetes when pancreatic betacells lacks the capability to produce insulin todecrease the insulin resistance leading to hyperglycemia.[4]The diagnostic criteria proposed by American Diabetes Associationfor prediabetes is the fasting plasma glucose level between 100-125 mg/dl, glycated haemoglobin (HbA1c) level ranging between 5.7% to 6.4% and plasma glucose level between140-199/dl after oral glucose tolerance test .[5]

The autonomic nervous system (ANS) orchestrates a vital role in the pathogenesis of various conditions such as diabetic neuropathy and cardiovascular diseases .[6]The cardiovascular physiology is orchestrated by various mechanism encompassing nervous and hormonal pathways. The parasympathetic mediated by vagus nervesand thesympathetic system, encompassing adrenal medullamediates an important role in cardiovascular physiology.[7] Autonomic dysfunction mediated by elevatedsympathetic and decreased parasympathetic activity and hyper sympathetic activity are majorly involved in thedevelopment of arrhythmia and cardiac arrest.[7] Alteration in the regulation of cardiovascular autonomic functions leads to elevated sympathetic and decreasedparasympathetic tone and overture in the progression ofcoronary artery disease and cardiac arrhythmia.[8] Measurement of Heart rate variability (HRV) is the predominant non invasive method for the assessment of autonomic function at sinoatrial level.Cardiac autonomic dysfunction(CAN)evaluated using HRV is linked with metabolic disorders such as obesity, prediabetes and diabetes. HRVis defined as the change in the time interval between heartbeats and controlled by ANS.[9,10] Heart rate variability (HRV) is a reliable parameter to measure the autonomic regulation and used as an marker to evaluate the changes during exercise and mind body which is regulated by autonomic systems.[11]HRVarises as a result of vagal tone and it signifies the association between sympathetic and parasympathetic system. HRVevaluation encompasses series of measurement such as Interbeat(RR) interval variationsoriginated in sinus which elicits the details of autonomic tone.[11]During the year 1996, European society of cardiology and North American Society of Pacing and Electrophysiology framed the criteria for evaluation, physiological and pathological interpretation and clinical utility of HRV.[12] Time and frequency domain indices[13,16], geometric measures[14] i.e poincare plot and histogram [15] are chief parameters used for the evaluation.Frequency domain analysisreveals the oscillations of heart rate signal at various time points decomposed at array of frequencies and amplitudes and also elicits its quantum of relative intensity and referred as power in the heart's sinus rhythm.[17] Yoga exercisesrestores bodyinternalbalance andhomeostasisby acting on the neuroendocrine level and thus influences the various organ system..The body encompasses various glands which has both internal and external hormone release. The classical example is pancreas which releases insulin. Thus Yoga therapy reactivates the internal hormone secretion to normal and maintains the viability of endocrine structures .[18] Yogic postures are the effective non pharmacological strategies to mitigate stress, anxiety, depression and also increases cortisol level with significant reduction in sympathetic activity.[19]The yoga therapy mediates it action though decreasing the probably hypothalamic pituitary adrenal axis(HPAA) activation and triggers the vagus nerve that elevates the parasympathetic activity which in turn increase insulin sensitivity, glucose tolerance and also maintains lipid profile.[20] Yoga therapy has mounting merits such as low economy, easy accessible and reduces the cardiometabolic risk factors and increases the exercise capacity in individuals affected with prediabetes.[21]

Till date no studies are available on the effect of yoga on heart rate variability in prediabetes subject and in this backdrop the present study was undertaken to evaluate the of effect of yoga on heart rate variability in prediabetes individuals. So the main aim of the study was to assess the outcome of Integrated Approach of Yoga Therapy on Frequency domain parameter of Heart Rate Variability.

Materials And Methods:-

This was a prospective comparative study conducted among the adults aged between 30 to 50 years in RUHS college of Medical Sciences and Associated Rukmani Devi Beni Prasad Jaipuria in Jaipur city for the period between July to December 2018. The written patient consent form was obtained and the study was approved by Institutional ethics committee (Registration No.ECR/762/) of RUHS College of Medical Sciences. In this study 2000participants were screened in a tertiary health care canter and out of these 250 were prediabetic. The prediabetes prevalence rate in this was 12.5 %. The information collection proforma contained details about the age, gender, family history, sociodemographic, lifestyle, physical activity, Stress scale by Cohen perceived scale ,Body mass index (BMI), dietary habits by semi-quantitative Food Frequency Questionnaire (FFQ), personal history medical factors. Data collected by an interviewed questionnaire, anthropometric measurements and laboratory investigation. Base line parameters like Anthropometric, blood pressure , pulse and Heart rate variability Frequency

domain low frequency (LF),high frequency (HF) and LF/HF ratio were recorded by Analogue Digital Instrument(AD) ,physiograph (Model number 3818).

Table 1:- Possible Risk Factors for prediabetes.

S.No	Variable	PREDIABETES
1.	Age= 30 to 50 years	250
2.	Female gender	150
3.	Family history of diabetes	125
4.	BMI>25	170
5.	Central obesity	175
6.	Physical inactivity	200
7.	Psychosocial stress	200
8.	Vegetables< 2 servings a day	200
9.	Red meat, chicken, fish and egg> once time a week	40
10.	Fruit < one time in a week	152
11.	Green leafy vegetable < 3 times a day	178
12.	Bakery Items > once time a week	60
13.	Deep Fried Snacks	72
14.	Carbonated drinks>once a week	22
15.	Sweet> 3 time a week	80
16.	Tobacco use	40
17.	Alcohol use	60

Sample size calculation: As the prevalence of diabetes in India is 8% taking it as a reference the sample size is calculated using the appropriate size formula z2pq/d2 where p & q were taken as .08 and .92 to get the maximum sample size with 5% permissible error(precision) and 10% non response rate the desired sample size is 250 with 95% confidence interval.

Participants should fulfil the inclusion criteria i.e, Fasting blood glucose level of: 110 to 125 mg/dL (6.1 mM/L to 6.9 mM/L) & Glycated haemoglobin 5.7 to 6.4 (ADA criteria) [5] and subjectswith no history of cardiovascular disease or in first-degree relatives, and no current history of anti diabetic medications. Exclusion criteria was subjects those have Fasting blood glucose < 100mg/dl &>126 mg/dl ,Oral Glucose Tolerance Test (OGTT)< 140 &>200 mg/dl [5], Liver disease , alcoholic individuals, Renal dysfunction, Diabetic Retinopathy and Neuropathy , spinal injury and interstitial fibrotic disease or any other major complications. Those being treated with anti-inflammatory medication were not included in the study.

HRV is evaluated based on the 5 minute or 24 hours recording of ECG and also beat -to-beat intervals (R-R intervals) are obtained from ECG. The software based analysis was carried out and eachnorrnal cardiac cycle will lead to peripheral pulse and pulse peak-to-peak interval corresponds to theR-R interval .

Procedure: Power Labdevice is started and USB cable was fixed to computer. Then the Finger Pulse Transducer is connected to the Power Lab front panel .The electrodes were placed on pressure pad of the Finger Pulse Transducer. The HRV analysis in the frequency domain reflects the speed variation in heart rate. Further, this method also gives information about differentfrequency components of the N-N intervals and their power, or variance.

Required Equipment

1. LabChart software
2. PowerLab Data Acquisition Unit
3. Finger Pulse Transducer

Study group, (n=125) were engaged in lectures on yoga ,prayer, omkar recitation, practice of yoga postures (asana), regulated breathing (pranayama) and Control group (n=125) had not performed any sessions.

Analogue Digital physiograph Instrument are eight channel digital physiograph for assessing Heart rate variability, electrocardiogram ,Galvanic skin resistance, Reaction time and Hand grip dynamometery. In this study, HRV was estimated frequency domain analysis which denotes HR signal oscillations at different time points, decomposed at various frequencies andamplitudes and gives information on the quantum of relative intensity and referred as variance or power in the heart's sinus rhythm.[22] Power spectral was evaluated by two methods, the first one was by fast Fourier transformation (FFT), which elicits discrete peaks for various frequency components and the second one byautoregressive model evaluation by continuous smooth spectrum of activity. During FFT, the singleRR intervals are converted to bands with various spectral frequencies. The power spectrum encompasses four frequency bands ranging from 0 to 0.5 Hz such as ultra low frequency, very low frequency, low frequency and high frequency band.[23]

Figure 1:- Analysis of frequency domain parameters by digital physiograph.

The Integrated Approach of Yoga Therapy included Prayer, Omkar recitation, yoga postures (asanas), breathing (pranayama) techniques,Shavasana ,Counseling and diet i.e food that are considered sattivic include most vegetables, ghee ,fruits,legumes and whole grain). Yoga was employed as an interventional therapy in this study. Yogaasanas were guided and demonstrated by certified yoga instructor .Yoga sessions were approximately 45 minutes six days per week for six months. To facilitate and guide home practice, participants were given a video recording (CD) of the Integrated Approach of Yoga Therapy recorded under direction of the certified yoga instructor and session in morning 7 to 7.45 AM ,compliance of subjects were checked by message daily and weekly telephonic conversions. Evaluation was done before yoga intervention then after three and six months post intervention. The components of our intervention using Integrated approach of yoga therapy are detailed in table 2 , shows the protocol of yoga practices in this study, in this protocol a cycle of 46 minutes that included prayer, omkar recitation, pranayama different asanas and posture that included suryanamaskar ,sukhasana,bhujangasana,pashimottanasana,padmasana,tadasana,trikonasana,sarvangasana,ardhmatsyendrasana,pawanmuktasana,vajrasana,dhanurasana,shavasana.

Table 1:- Schedule of yoga practices.

S.No.	Yogic Practices	Duration
1	Prayer	3 Minutes
2	Omkar recitation	3 Minutes
3	Pranayama	5 Minutes
4	• Asans (SuryaNamaskar,Sukhasana,Bhujangasana,Pashimottanasana,Padmasana,Tadasana,Trikonasana,Sarvangasana,Ardhmatsyendrasana,Pawanmuktasana,Vajrasana,Dhanurasan)	30 Minutes
	• Shavasana	5Minutes

Statistical Analysis:
Mean and standard deviations were calculated for each parameter. The appropriate tool for comparison the change in the level of a variable is student's paired t test for Intragroup comparison before applying this test the Smirnov-Kolmogorov test was performedto assess the normality of each parameter. Apart from comparing the various parameters of the data with respect to before and after Yoga, comparison is made with respect to a control group. There were125 persons in this group. To show that initially the two groups are on the same platform for each parameter, student's unpaired t test was conducted for Intergroup comparison. The value of $p>0.05$ was considered as non-significant , between the two groups comparison at baseline ,three months and six months by using one way analysis of variance and significance was tested by post hoc analysis by Tukey's and Scheffe's tests.

Results:-

All the parameters of the data are quantitative variables. The main aim of the study was to compare the levels of these parameters before initiating Integrated approach of yoga therapy (IAYT) and after three month and six month of practicing IAYT. Apart from comparing the various parameters of the data with respect to before and after Yoga, comparison is made with respect to a control group. There were 125 prediabetics in each study and control groups.

Table 3:- Age and gender of the patients.

Age group	Male	Female	Total
30-40years	25	50	75
41-50 years	75	100	175
Total	100	150	250

Table 4;- Intragroup comparison of Results of Heart Rate variability.

S.NO	Control	Study base line	Study 3 month	Study 6 month	F	P Value
LF/HF Ratio	2.20 ± 1.05	2.19 ± 1.09	1.01 ± .54	.57±.20	81.081	<.001

p value <.001 Highly significant

Table 4 shows mean values of LF, HF, LF/HF Ratio for control and study groups Intergroup Comparison of Results of heart rate variability in control and study groups. One way analysis of variance (ANOVA) for measures taken at different times, significance level tested by Post Hoc test Tukey's test and Scheffe's test.

Discussion:-

The present study results showed the importance of yoga intervention for shifting of autonomic nervous system towards the parasympathetic limb. The present study highlights that yoga sessions would be a possible cardiovascular risk reduction strategy for prediabietics. Regular yoga practices help in reducing cardiovascular risk factors and improve homeostasis at the neuro endocrinal level which increased exercise self-efficacy for pre diabetics that perform yoga postures.[24]

Yoga postures enhances autonomic regulation and vagal dominance as evidenced by HRV values. Alteration in HRV during yoga elicits resonance outcomes betwixt respiration, muscle contractions, heart rate, and baroreflexes which increasesautonomic potential. The The parasympathetic vagus nerves and sympathetic adrenal medulla orchestrates a vital role in the maintenance of cardiovascular system. Further, daily yoga postures leads to decreased stress by enhancing the serotonin levels.

Lifestyle modification (LSM) strategy is the first line of treatment before pharmacological management to mitigate the development of prediabetes to diabetes.LSM is highly effective, low cost and devoid of side effects during the prevention of type 2 diabetes .[25]

Autonomic balance is the body's capacity to maintain equilibrium when there is internal and external stimuli. This system orchestrates a predominant role in bringing about adaptation of human body to environmental changes, thereby modulating the sensory, visceral, motor and neuroendocrine functions regulate the activity of all muscles and certain glands.[26]Hyperactivity of sympathetic nervous as a result of hyperglycemiadue to epinephrineresponse and in association with increased level of endogenous opioid peptidesis the main etiological factor during the progression type II diabetes.[27]HRVis simple and non invasive marker to estimate the sympathovagal balance at the sinoatrial level for the evaluation of autonomic and fitness status of the individual[28]In this present study LF component and LF/HF ratio decreased and HF component increased as compared to control which was similar with Sarang[29] et al reported that cyclic meditation activates the sympathetic system, while performing different yoga posture followed by cyclic meditationthere is a dominance of parasympathetic nervous system ., Vempati et al reported that 10 min yoga intervention decreased LF ,Increased HF and decreased LF/HF ratio as compare to control group which was similar with present study.[31,] AnH [26]et al reported that nonlinear measure was the sampling entropy i.e increase in the meditative group as that of the control group. Several studies reported by Howorka K [27],Pitale et al[31] , Muralikrishnan k [32] et al reported thatindividuals performing yoga elicited well balanced activity of vagal efferents, and sympathovagalsystem as compared to the individuals not performing the yoga, which is line with the present study . Friis AM [33] reported that individuals practising yoga for extended period has effectiveautonomic flexibility. Satin JR [34] reported that Yogis and runners displayed increased parasympathetic activity respective to time or frequency domain which is concurrent with the present study. In contrary, Chaya[35] et al reported that the individuals practising yoga displayed increased low frequency power and decreased normalized high-frequency power.

Limitations

The findings of this study need to be explored in larger sample size involving prediabetics. Future research is highly vital to evaluate the effect of yoga practice for chronic period on heart rate variability inprediabetic individuals to determine the yoga effect on autonomic homeostasis . In this study only one component of heart rate variability i.e Frequency domain analyzed other components time domain, poincare plot and histogram and comparison of their result should be done on larger sample.

Conclusion:-

This study highlights importance of six month s yoga intervention on autonomic nervous system,. The present preliminary study showed that the yoga therapy is a suitable strategy to reduce the risk of developing type 2 diabetes in prediabetes subjects. Further, yoga programs would be an effective strategy to reduce cardiovascular risk factors and also increase the exercise capability in prediabetic individuals performing yoga. Yoga therapy effectively improves autonomic regulation and increases vagal dominance which is evident from the results of HRV.

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