Diastolic dysfunction of the Left Ventricle in a prediabetic population from rural central India

ABSTRACT:

According to a growing body of research, in people with type 2 diabetes mellitus (T2DM), Cardiovascular diseases are a leading cause of mortality. Many studies for all intents and purposes have sought to understand the many pathways that may play a role in CVD in diabetics in a major way. According to research, patients particularly had a much higher overall morbidity and mortality rate. The culprits are hyperglycemia-induced macrovascular diseases, autonomic neuropathy, and generally diabetic cardiomyopathy, which is quite significant. Diabetic people might be diagnosed with cardiomyopathy even if they generally are initially asymptomatic and show no clinical indications of the disease, or so they essentially thought. Echocardiography provides the opportunity to measure not only systolic but also diastolic function, which specifically is fairly significant. A significant risk factor for developing diabetes appears to be prediabetes with risk of conversion is approximately 70% in the next ten years, with similar microvascular and cardiovascular consequences to diabetes. Immunological factors , Cytokines , advanced glycosylation end product accumulation and oxidative stress are some of the common processes involved. Diastolic dysfunction alters diastolic filling and increases isovolumetric relaxation time in diabetic patients. One of the independent markers for assessing the propensity of developing Cardiovascular disease in a diabetic population is Insulin Resistance. Normotensive patients, on the other hand, have been linked to left ventricular dysfunction, even when omitting those with coronary artery disease (CAD), which for all intents and purposes is quite significant. According to experts at the Indian Institute of Cardiology (ICC) in Bangalore, even people with normal blood pressure and prediabetes exhibit asymptomatic diastolic dysregulation.

Keywords: Prediabetes, Diastolic dysfunction, Left Ventricle, Cardiovascular disease

INTRODUCTION

According to a growing body of research, cardiovascular diseases are in a large part accountable for the numerous deaths that occur in people with Type 2 diabetes Mellitus. Many researchers have made efforts to state various mechanisms that can lead to CVD in such cases. The chances developing a cardiovascular disease are conclusively increased with conditions such as Diabetes, obesity , ageing & hypertension[**1**]. Studies conducted on diabetic populations have shown an overall increase in Mortality as well as Morbidity. Credit goes to hyperglycemia-induced macrovascular diseases, autonomic neuropathy, and diabetic cardiomyopathy. Diabetic subjects, if initially asymptomatic, showing no early signs clinically related to cardiomyopathy, can still be detected to have cardiomyopathy with the assistance of echocardiography. Significant risk factor for developing diabetes appears to be prediabetes, with complications comparable to those of diabetes. Not much data has been provided in the past studies regarding the association between a decline in Left ventricle performance and the condition of prediabetes ,compared to the vast quantity of data found in favour of an

association between diabetes and left ventricular dysfunction [2]. Researchers particularly have laid down generally many hypotheses on the pathogenesis concerning the injury inflicted to the cardiac myocytes , the dilatation of the ventricles in the heart and disordered fuctioning of the myocardium, out of which the most common mechanisms actually include immunological factors , Cytokines , advanced glycosylation end product accumulation and oxidative stress. [3-5]. Moreover, 8% of the American population has diabetes, which is fairly significant.**[6].**

The weighted overall comparision between the occurrence of prediadetes and diabetes in Jharkhand, Tamil Nadu,Maharashtra and Chandigarh, was, 5.3% (95% CI: 4.5-6.1%), 10.4% (95% CI: 9.0-11.0%,8.4% (95% CI:7.5-9.3%) and 13.6% (95% CI:12.8- 15.2%) versus , 8.1%, ,8.3%, 12.8% and 14.6% respectively. Differently put, the population suffering from diabetes vs. prediabetes in the state of Jharkhand,Chandigarh,Tamil Nadu, and Maharashtra has shown to be, 0.96 million vs. 1.5 million,0.12 million vs. 0.13 million,4.8 million vs. 3.9 million, 6.0 million vs. 9.2 million respectively, with the highest prevalence was observed in Chandigarh, then Maharashtra, followed by Tamil Nadu and finally Jharkhand [**7**]. An estimated risk of conversion to diabetes from prediabetes in the next 10 years appears to be approximately 70 % with similar macrovascular, microvascular , cardiovascular complication as seen typically in diabetes. The condition of prediabetes has been defined as having an impaired tolerance to glucose measured Two hours after an oral dose of 75 grams of dextrose with the plasma levels of glucose ranging between 140 to 199 miligrams per decilitre alternatively having the blood glucose levels after fasting between 110 to 125 miligrams per decilitre or glycosylated haemoglobin levels in blood between 5.7 to 6.4 % [HbA1c] **[8-11]**. An increment of 20% in the risk of developing cardiovascular disease has been noted when compared with people who do not have hyperglycemia . A dysfuntion of beta cells in pancreas along with resistance to the insulin hormone is presumed to be a common pathophysiological disturbances in both prediabetes and diabetes mellitus [**12**]. Various studies have shown that cardiovascular mortality is similar in both diabetes and prediabetes, which shows us the requirement of aggressively managing these two hyperglycemic populations [**13-18**]. The ability to assess not just systolic but also diastolic function has been offered through echocardiography.Increased time to isovolumetric relaxation along with a decrease in ejection time and fraction is seen with a dysfunction of the systolic performance of the Left ventricle.

On the other hand,diastolic dysfunction of the same results in an increased time required for isovolumetric relaxation also altering the filling of blood in the ventricle during the diastolic phase [**19,20].** Studies have shown that in people with type 2 diabetes , the incidence of this dysfunction is increased.One of the independent markers for assesing the propensity of cardiovascular disease in a diabetic population is Insulin Resistance which also plays a pathogenic role in the disease. [**21,22]**

Rationale:

Resistance to insulin and an intolerance to glucose can be associated with dysfunction of the myocardium since the frequently precede the development of frank diabetes. On the other hand, T2DM, normotensive subjects excluding those with diseased coronary arteries ,have shown a corelation to left ventricular dysfunction. Not much light is shed on the adverse effects that prediabetes can have on the diastolic and systolic functions of the left left ventricle. This study will explore the effects prediabetes has which cause diastolic dysfunction, using conventional 2D echocardiographic techniques.

There are numerous studies done outside India, and even normotensive prediabetes subjects have asymptomatic diastolic dysfunction. However, In India, only two studies describe diastolic dysfunction among patients with T2DM [**23,24].** We cannot identify any studies from India, which have related diastolic dysfunction among the prediabetes population.

Hence, our study will be investigating the hypothesis by evaluating the diastolic function of left ventricular in prediabetic adults [**25–31**].

Aims and Objectives

Aim:

To find out how common left ventricular diastolic dysfunction (LVDF) is in Prediabetics from a rural area of central India.

Objective(s):

1) To compare the diastolic function of the left ventricle in prediabetic subjects with Age and sex matched controls, from the rural area of central India.

2) To ascertain the correlations between cardio-metabolic risk factors and diastolic dysfunction of the left ventricle in prediabetic individuals.

METHODOLOGY

BACKGROUND:

The study will be conducted in the Acharya Vinoba Bhave Rural Hospital (AVBRH), a 1200 bedded, tertiary care teaching hospital situated in Wardha district with a population of around 1.2 million.

TYPE OF STUDY:

This study will be a case-control study.

SUBJECT SELECTION:

1. Persons with prediabetes and age and sex match controls attending the medicine department AVBRH must be interviewed and examined for the diastolic dysfunction of the left ventricle.

CRITERIA FOR INCLUSION :

Case:

- Individuals diagnosed with Prediabetes in accordance with the guidelines laid down by the WHO.**[32].**
- Age: more than 25 years old but less than 50 years old 60 years.
- Gender: male and female.
- Consent: persons who are voluntarily willing and capable of giving consent will be inducted in the study.

Controls:

- Age: two years on either side of a prediabetic case and is of the same gender. They will also have the below-mentioned exclusion criteria.

Exclusion Criteria:

- Hypertension (High Blood Pressure).
- Diabetes (as per who criteria).
- Diseased Heart valves.
- Coronary heart disease.
- Dilated Cardiomyopathy.

- Renal Diseases [GFR > 60]
- Chronic Severe Anaemia.
- Pregnancy.
- Tobacco user
- Harmful use of alcohol **[33]**

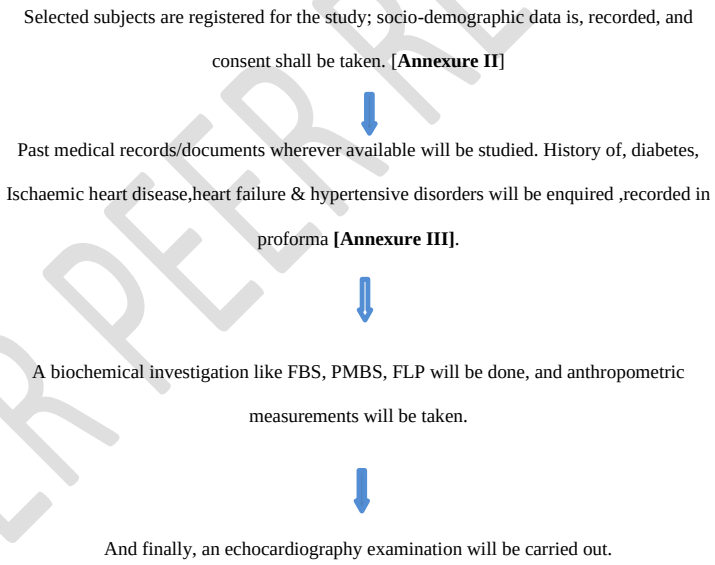
SAMPLE SIZE:

Desired minimum sample size is 100 , assuming 50% prevalence of left ventricular diastolic function in prediabetic subjects with a confidence interval of 95% , 10% being the Absolute precision. Due to Lack of any population-based research pertaining to the prevalence of left ventricular diastolic function in people with type 2 diabetes from rural India and Factoring in a confidence level of 95 % with an absolute precision of 10 % we will assume prevalence of left ventricular function in pre-diabetes to be 50% since this yeilds the maximum sample size. Therefore, the total sample size will be 200 (100 prediabetes and 100 age/sex match control).

ETHICS

Only after receiving the Clearance from the institutional committee on ethics at DMIMS (DU), Sawangi, Wardha, will the study be initiated.

METHOD(S) :



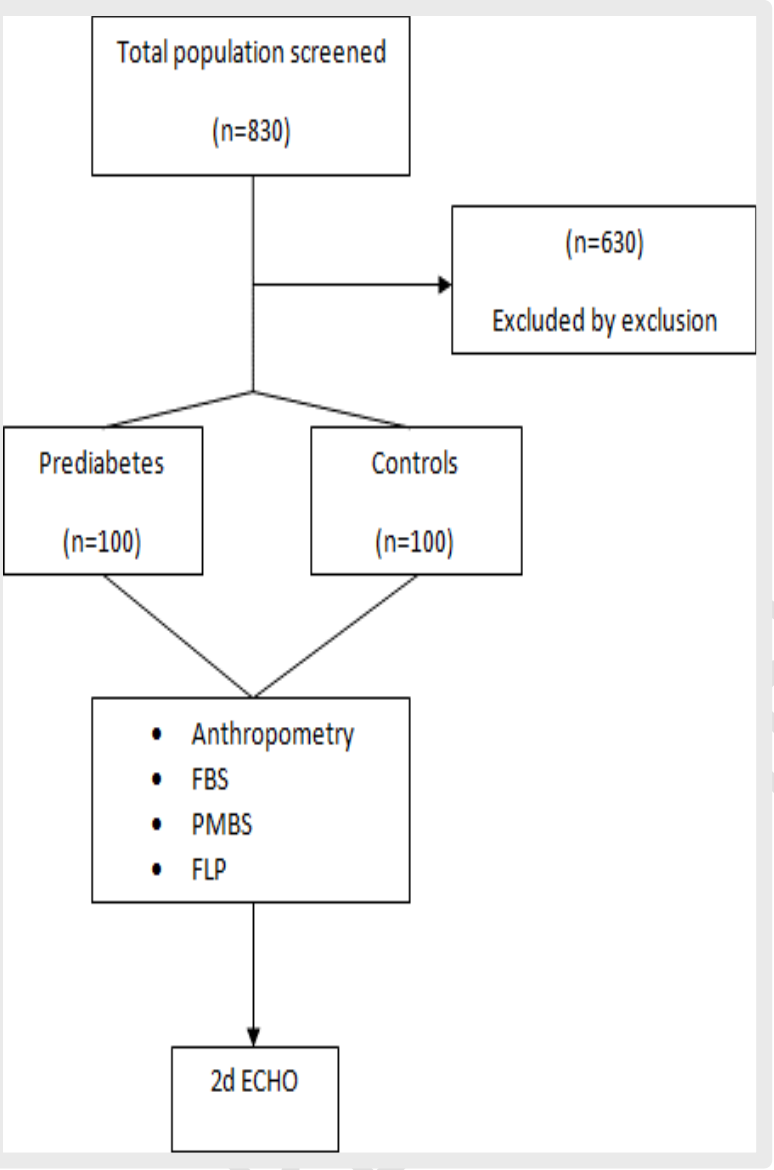
Pic 1. Flow chart.

Figure 01. A brief discussion of data collection.

Data collection

A questionnaire will be designed to collect information regarding demographics,Age, Sex ,presence of any cardiovascular diseases , Significant family history, dyslipidemia, hypertensive disorders, and a sedentary lifestyle,as they are all risk factors. Tobacco and alcohol abuse are both hazardous (all forms). The questionnaire will be pilot tested prior to data collection.

Persons with prediabetes attending AVBRH will be interviewed with the help of the questionnaire. Informed written consent will be taken in their mother tongue, and participants, guaranteed their privacy. They will be interviewed in the Marathi language. Socio-demography



information, family history of diabetes or CVD, anthropometric measured waist circumference, hip ratio, height, weight, BMI, blood pressure, pulse.

All patients will be subjected to anthropometric measurements and BMI and will be investigated for FBS, PMBS and a fasting lipid profile which includes the Total serum cholesterol levels along with serum Triglycerides , and HDL-C, LDL-C VLDL-C levels .Accepted lab techniques will be employed for all the biochemical measurements.

Each participant's blood pressure is measured two times while in a sitting position using a mercury sphygmomanometer, the mean of the measured values is used for analysis. Using standardized equipment and procedures Body weight in kilograms, waist and hip circumference in centimeteres and height in meters will be measured **[34]**. To determine bodyweight measured to within the closest half a kilogram, subject will stand still with their feet separated ,ensuring equal weight distribution on both legs,on the measuring scale. Subject's body height is measured to within closest half a centimeter against a vertical scale. The inferioir margin of the subject's bony orbits has to at the same level as the top part of their external auditory opening of the ears.

Body Mass Index, [kg/m^2], can be calculated by dividing the body weight in Kilograms with height in meters.

The waist circumference definitely is measured when the individual is standing. The particularly individual literally holds up the gown as the examiner stands behind them, palpating the hpg area and the right iliac crest. The examiner draws a sort of horizontal line from the highest point on the subject"s illiac crest to their mid-axillary line and then crosses it. The examiner stands on the subject\'s right side and wraps the measuring tape in a horizontal plane around the trunk at the level designated on the trunk\'s right side. The recorder moves around the person to verify that the tape essentially is parallel to the ground and very taut but without crushing the skin**.[35]**.

Measurement of Hip Circumference: The subject stands straight, feet together, and body weight equally distributed over both feet, holding up their examination gown. The recorder specifically stands behind the patient and folds the really material with their thumb to for the most part gather the side seams of the test pants above the hips. The examiner squats on the subject"s right side and puts the measuring tape around the buttocks, while the recorder securely grips the folded sides of the subject\'s exam trousers, which is fairly significant. A measuring tape is wrapped around the hips at their widest point. While inspecting the front and sides, the recorder checks that the tape\'s plane is horizontal and aligns the sides of the measuring tape.

Zero end of the measuring tape is held below the measurement. At broadest extent of the buttocks , the hip circumference is measured.**[36]**

The tape should be held parallel to the level of the floor where the measurements are taken. It should not be grasped so tightly that it hinders the subject"s mobility (WHO, 2008b). Use a stretch resistant tape with a special indication buckle that ensures a consistent tension of 100grams; this avoids changes in the tightness of the tape around the subject\'s body. As a result, it specifically is preserved with sufficient tenacity, which is fairly significant**.[36][37]**

Detailed clinical cardiovascular examinations are then performed for heart rate, abnormal heart sounds, and murmurs.

Then the subject will undergo echocardiography.

BIOCHEMICAL PARAMETER ESTIMATION:

Under all aseptic precautions, from the vein of the subjects ,a blood sample is collected in the plain bulb and fluoride bulb, respectively.

The sample is immediately centrifuged, and serum will be separated.

Biochemical parameters will then be analyzed by RANDOX DAYTONA **(Made in Japan)** (Figure 02) random analyses by turbidimetry.

Figure 02. Randox Daytona.

SPECIMEN COLLECTION

Venous blood sample after 8 hrs. of fasting is to be collected in fluoride bulb and plain bulb for FBS, FLP respectively and Venous blood sample after 2 hrs. of the meal for PMBS in fluoride bulb.

TOTAL SERUM CHOLESTEROL ESTIMATION:

Estimation of the total serum cholesterol is done using CHOD-PAP method which is liquid stable using the Semi-auto chemical analyser, Robonik.

SPECIMEN COLLECTION

overnight fasting of atleast ten to 12 hours, venous samples subjects are taken collected in a plain bulb.

PROCEDURE

1000µL of reagent is added to 10µL of plasma (dissolved in anticoagulant). Incubation is done for 15 minutes at room temperature and read by theRobonik analyser .

SERUM TRIGLYCERIDES LEVELS ESTIMATION:

Using a GPO – PAP method which is liquid stable using the Robonik analyser.

PROCEDURE

1000µL of reagent is added to 10µL of plasma. Incubation is done for 15 minutes at room temperature and read by Robonik Analyser.

SERUM HDL LEVEL ESTIMATION :

Utilising the Direct Enzymatic Method with the Robonik Analyser.

PROCEDURE

375µL of HDL – D reagent 1(L1) is mixed with 5µL of the calibrator and 5µL of the sample.After incubating the sample at room temperature for five minutes, read the calibrator absorbance (A_1) & test against blank, HDL –D REAGENT 2 (L 2) 125µL is added and mixed with a five minute incubation at room temperature. Read Calibrator absorbance (A_2) & test against blank. The change in absorbance ΔA is calculated for both the calibrator and test.

EXAMINATION by ECHOCARDIOGRAPHY:

Philips HD 11 XE echo machine with 2–4-megahertz multi-frequency probe will be used for this study. (Figure 03).

Figure 03. Echocardiography Machine, (HD 11 XE)

For the best acoustic window, patients should be evaluated in the left lateral decubitus posture. After doing a sector scan to acquire four chambers, a two-chamber 2D echo (CW and PW) evaluation particularly is done in a big way. Several observations and measurements must be made and documented on the standard proforma sheet. All observations will be subjected to routine statistical analysis at the end of the research, and conclusions will basically be formed, contrary to popular belief. The Simpson"s rule is currently one of the most often used methods for calculating ventricular volumes (rule of the disks), which is quite significant. An apical, four-and/or two-chamber picture particularly is to generally be acquired at end-diastole and end-systole, from which the endocardial boundary actually is to be defined, contrary to popular belief.Along its basically long axis, the ventricle is mathematically split into a series of discs of equal height, which is quite significant. Individual disc volume actually is calculated as the product of disc height and disc area, with disc height assuming the entire length of the left ventricle long axis and the number of discs or segments (area = r2), or so they thought. Finally, the ventricular volume is calculated by adding the volumes of the discs in a subtle way. [Table 01] demonstrates this strategy in a subtle way.**[38]**.

The difference between diastolic and systolic volumes can be used to for all intents and purposes calculate stroke volume after measuring diastolic and systolic volumes. In the absence of mitral or aortic insufficiency, forward cardiac output basically equals the product of heart rate times stroke volume. The difference between diastolic and systolic left ventricular volume, which is the total volume pumped by the ventricle, represents the sum of forward stroke volume plus mitral and aortic regurgitation volume, if present. The ejection fraction may be calculated by dividing the stroke volume by the end-diastolic volume, which is quite significant.**[38]**

Without using planimetry, the Left Ventricular Ejection Fraction (LVEF) can be calculated by measuring 8 averaged Left Ventricular internal dimensions at various levels of the left ventricle in the parasternal long-axis, apical four chambers, and long-axis views at end-diastole (LVEDD) and end-systole (LVESD), while accounting for long-axis contraction. Significant wall motion difficulties and deformed ventricles are among the limitations.**[39] [40]**

$\%\Delta D^2 =$	$\frac{LVEDD^2 - LVESD^2}{LVEDD^2}$
$LVEF =$	$(\%\Delta D^2) + [(1-\%\Delta D^2)(\%\Delta L)]$

Table 01. Simpson's Rule

The sort of transmitral flow velocity profile specifically is then estimated from the for all intents and purposes apical four-chamber perspective using the pulsed wave Doppler sample volume positioned at the tips of mitral leaflets during diastole. The apical long-axis view is used to record the left ventricular outflow velocity pattern, with the pulsed wave Doppler sample volume positioned directly below the aortic valve. For each measurement, five successive beats must specifically be measured and averaged.**[41]**. To quantify left ventricular diastolic function, Doppler interrogation of transmitral velocity at actually early (E) and late (A) left ventricular filling was utilised. The mitral inflow definitely signal will be used to determine the velocity of A, E & the ratio between the two, along with time required for deceleration during the early phase of diastolic filling in the left ventricle. Furthermore, a raw

measurement of for all intents and purposes active left ventricular relaxation measured between aortic valve closure and mitral valve opening is the time required for isovolumetric relaxation. Averaging many cardiac cycles yields offline Doppler values. At the same time, the heart rate will basically be measured.**[42]**.The average of Three simultaneous beats are taken with a pulsed wave tissue Doppler imaging at the junctions situated on the lateral & septal mitral annulus. E'medial and E'lateral early diastolic velocities are recorded, and the mean value (E' average) is computed from E' at the medial and lateral mitral annuli. The ratios E/Medial, E/Lateral, and E/E'(average) are calculated. Dysfunction of the diastolic performance is defined by the european & american echocardiography socitie's consensus reports as a complete assessment of diastolic function utilising standard techniques of Doppler tissue imaging. (Table 02).

Table 02 Echo-Doppler Modalities for Evaluating Diastolic Function.

Echo-Doppler Modalities for Evaluating Diastolic Function[81]		
parameters	Modalities	significance
IVRT	Pulsed Doppler	Information on LA pressure, rate of early active LV relaxation
Mitral inflow:	*Pulsed Doppler*	
E/A ratio	Pulsed Doppler	Reflects the gradient between LA and LV during early and late diastole & helps define stages
Deceleration time	Pulsed Doppler	Information on LV chamber compliance
Annular velocity:	*Tissue Doppler*	
E/e' ratio	Tissue Doppler	Predicts Left ventricular filling pressure; Helps distinguish between RCM and constrictive pericarditis
LA (left atrium), LV (left ventricle), RCM (restrictive cardiomyopathy), IVRT (isovolumic relaxation time) ,		

EVALUATION FOR DIASTOLIC DYSFUNCTION:

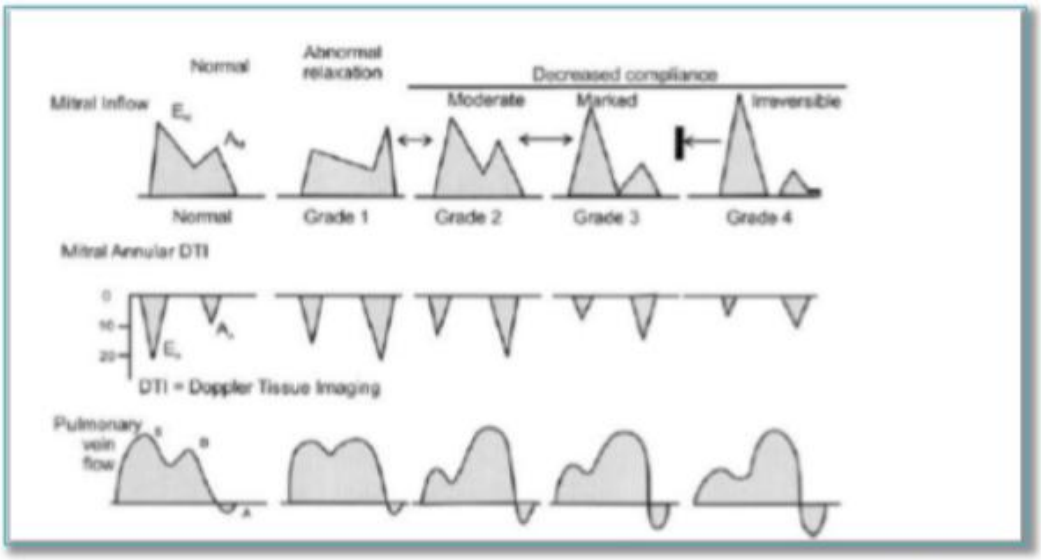


Figure 04.Left ventricular diastolic dysfunction (LVDD) was graded according to the ASE guidelines (2009) [43].
Gradings of LVDD was defined as (Table 03)

STATISTICAL ANALYSIS:

All analyses must be carried out using Stata data analysis and statistical software (Stata 14 software). Unless otherwise noted, the data are provided as the average for variables that are continous or as a percentage for variables that are categorical in nature. A value for Pearson's coefficient being less than zero point zero 5 are considered significant and require a Bonferroni correction when comparisons are multiple.when comparing 2 groups that are independent in nature, Wilcoxon-Mann-Whitney-Test is used whereas when comparing 2 or more independent groups of samples the Kruskal Wallis test is used. When comparing two sets of binary data, Fisher"s test will be used, and when comparing generally more than two sets of category variables, the c2 test will be used. Pearson\'s linear correlation coefficients will be generated to evaluate a probable relationship between variables.By using multivariate analysis for regression models of logistic and covariance, which integrate the features that are highly predictive for the dependent variables. The important outcome variables specifically are left ventricular diastolic function [IVRT, E/A ratio, Deceleration time, e′ (septum), e′ (lateral), E/e′ ratio (septum), E/e′ ratio (averaged). The prevalence of left ventricular diastolic function is estimated and compared in patients with prediabetes and healthy people (with a 95 percent confidence interval). Numerous cofounders, such as age, smoking, and dyslipidemia, will be considered in the weighted analysis.

Definitions

The following definitions are being adopted for the purpose of the study:

Prediabetes:

Fasting plasma glucose level from (110 mg/dL) to (125 mg/dL) (This test measures blood glucose in people who are fasting for at least 6--8 hours)
Post-meal plasma glucose levels are between 140 to 199mg/dl (after 2 hours of the meal) WHO criteria.

Normoglycemia (controls):

An FBG or Fasting plasma glucose level < 110 mg/dL (This test measures blood glucose in people who are fasting for at least 6--8 hours) post-meal plasma glucose levels less than 140 (after 2 hours of the meal) WHO criteria.

Overweight:

Participants in the study will be categorised based on their BMI according to WHO recommendations, enlisted in [Table 03]
The definition of Abdominal Adiposity is determined by circumference of the subject's waist being greater than one hundered and two centimeters in males and greater than eighty eight centimeters in females, and a ratio of hip to wait circumferences of one centimetres in males and zero point eight in females**[44]**.

Table 03. BMI Cutoff for Asians and Asian Americans.

BMI Cutoff for Asians and Asian Americans	NIH BMI Cutoff	Comments
<18.5	<18.5	in the past
18.5 - 22.9	18.5 - 24.9	Normal
23 - 26.9	25 - 29.9	Over weight
≥27	≥30	Obese

Blood pressure: A subject is said to have Hypertension when the readings of systolic & diastolic pressures is greater than Hundered and forty and Ninety millimeters of mercury or being on blood pressure-lowering medication being based on the guidelines laid down in accordance with 8th report by the Joint National committee. **[45]**

Table 04. The ATP [III] Classification of LDL, HDL & Total Cholesterol, Triglycerides (mg/dL) **[46]**

LDL Cholesterol (mg/dL)	
<100	Optimal
100-129	Near-optimal/above optimal
130-159	Borderline high
160-189	High
>190	Very high
Total Cholesterol (mg/dL)	
<200	Desirable
200-239	Borderline high
>240	High
HDL Cholesterol (mg/dL)	
<40	Low
>60	High
Serum Triglycerides (mg/dL)	
<150	Normal
150-199	Borderline high
200-499	High
>500	Very high

Hypercholesterolemia: Optimal levels of serum lipid levels are determined Using the recommendations given by the Adult Treatment Panel III (NCEP ATP III) mentioned in [Table 04] **[46]** .

Tobacco use: Tobacco use in smoked or non-smoked forms , currently or in the past by the subjects is considered a risk factor.

Detrimental alcohol use : According to the guidelines laid down by the American Diabetes Association ,alcohol intake is greater than one daily drink for females (>10g alcohol) or two or more daily drinks for males (>20g alcohol).

Left ventricular diastolic dysfunction:

Table 05. Defining Stages of Diastolic Dysfunction: Normal and Abnormal Values for Adults.

Stages			Stage I	Stage II	Stage III	Stage IV
Parameter	Units	Normal	Impaired Relaxation	Pseudonormal	Restrictive Filling (Reversible)	Restrictive Filling (Irreversible)
IVRT	ms	70-90	>90	60-90	<70	<70
E/A ratio	Unitless	0.9-1.5	<0.9	0.9-1.5	>1.8	>2.0
Δ with Valsalva	%	Both E & A decrease, ratio unchanged	Both E & A decrease, ratio unchanged	E decreases, A increases, ratio reverses	Ratio decreases, but still >1	No response
Deceleration time	ms	140-240	>240	140-200	<140	<130
e' (septum)	cm/sec	>10	<10	<8	<5	<5
e' (lateral)	cm/sec	>12	<10	<8	<8	<8
E/e' ratio (septum)	cm/sec	5-10				
E/e' ratio (averaged)	cm/sec		<8	9-12	>15	>15

Table 06. Distinguishing Normal from Pseudonormal Using Echo-Doppler Markers

Parameter	Normal	Pseudonormal
E/A ratio	0.9-1.5	0.9-1.5
Δ with Valsalva	Both decrease No change in ratio	E decreases more than A Ratio decreases (<1)
e' (cm/sec)	>10	<8
E/e' (septum)	<10	>15

Definition of Diastolic Heart Failure

When the ventricular chamber is unable accept blood volumes sufficient for maintaining adequate pressures during the diastolic phase or for maintaining an optimal stroke volume , diastolic heart failure is said to have occurred. This is often accompanied by a decreased relaxation of the ventricle or an increased stiffness of the same.
Signs & symptoms due to heart failure can emerge which is classified into classes I through IV by the new york heart association based on the functional limitations of activity.

Definition of Diastolic Dysfunction

Diastole is the moment when the myocardium loses its ability to generate force, shortens, and then reverts to its former length and force. Diastolic dysfunction occurs when these processes are slowed, stopped, or are insufficient. The measurements that reflect changes in this normal function are primarily influenced by the decline in pressure and filling of the ventricle in terms of the rate, extent and the onset. Using Wiggers' classic concepts or Brutsaert constructs the correlations between volume & pressures or strain-stress during diastolic phase, can be defined. .If we assume that the diastolic function is normal the volume at the end of diastole of the ventricle along with the stroke volume , heart rate & blood pressures must remain normal at rest or under the stresses generated by a change in volume at the end of diastole, stroke volume, blood pressure and heart rate.

Discussion:
Echocardiography provides the opportunity to measure not only systolic but also diastolic function, which specifically is fairly significant. A significant risk factor for developing diabetes appears to be prediabetes with risk of conversion is approximately 70% in the next ten years, with similar microvascular and cardiovascular consequences to diabetes. Immunological factors , Cytokines , advanced glycosylation, end product accumulation and oxidative stress are

some of the common processes involved. Diastolic dysfunction alters diastolic filling and increases isovolumetric relaxation time in diabetic patients. One of the independent markers for assessing the propensity of developing Cardiovascular disease in a diabetic population is Insulin Resistance. Normotensive patients, on the other hand, have been linked to left ventricular dysfunction, even when omitting those with coronary artery disease (CAD), which for all intents and purposes is quite significant **[47-50].**

Conclusion:

Prediabetes has a significant prevalence amongst the Indian population. Most patients are often asymptomatic and thus unaware of their condition until symptomatic Diabetes mellitus has set in. Prediabetes can damage the cardiovascular system in a fashion akin to Diabetes mellitus itself. This study aims to establish the aforementioned facts using robust, anthropometric ,Biochemical and Radiological modalities to help patients and physicians in early detection and management of the same . Additionally , prompt treatment during the Prediabetes phase of the illness can prevent or at least delay the progression to diabetes mellitus and the associated complications ,with cheap oral hypoglycaemic agents and regular monitoring,a notion backed by substantial evidence .

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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