

Association of Microalbuminuria with Abnormal Left Ventricular Geometry Patterns in Nigerian Normotensive Type 2 Diabetic Patients

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Abstract: To compare left ventricular (LV) geometry patterns among normotensive type 2 diabetics (NT2DM) with normoalbuminuria, NT2DM with microalbuminuria and healthy controls. A cross-sectional study conducted at the medical outpatient department of a Teaching Hospital from January 2013 to March 2014. Sixty-three normoalbuminuric NT2DM, 71 microalbuminuric NT2DM and fifty-nine healthy controls were recruited. Microalbuminuria was tested for using Micral test strips (Roche, Germany). Trans-thoracic echocardiography was carried out on all subjects. Relative wall thickness (RWT), left ventricular mass index (LVMI) and LV geometry patterns were compared among the three groups. The three groups were age and sex-matched and appropriate statistical tests were used for comparisons with $p < 0.05$. The proportions of abnormal LV geometry (33.3% vs 71.4% vs 84.5%), LVMI and RWT showed a significant stepwise increase from healthy controls through normoalbuminuric NT2DM and to microalbuminuric NT2DM (all $p < 0.01$). Concentric remodeling (CR) was the commonest pattern among the three groups. Left ventricular mass index and RWT correlated significantly with duration of DM and body mass index (all $p < 0.01$). Microalbuminuria showed a strong direct association with abnormal LV geometry (OR 3.27, 95% CI 1.63-6.57, $p < 0.01$) while duration of DM was found to be an independent predictor of LV geometry remodeling (OR 1.23, 95% CI 1.02-1.49, $p = 0.03$) among normotensive diabetics. Although CR was the commonest pattern across the three patient groups, those with microalbuminuria had the highest proportion and risk of LV remodeling. Early screening and prompt treatment of microalbuminuria in NT2DM is hereby recommended.

Keywords: Diabetes Mellitus, Left Ventricular Geometry, Microalbuminuria, Normotensive

1. Introduction

Diabetes mellitus (DM) is associated with diverse cardiovascular conditions such as myocardial infarction and heart failure (HF), which are the leading causes of diabetes-related morbidity and mortality [1, 2]. Previous studies elsewhere [3-5] and in Nigeria [6] have demonstrated left ventricular geometry remodeling and dysfunction in

diabetics, supporting the existence of diabetic cardiomyopathy (DMCMP). The Framingham Heart Study showed that the frequency of HF is twice as high in diabetic men and five times higher in diabetic women compared with age-matched controls, and that this increased incidence of HF persisted despite correction for age, hypertension, obesity,

hypercholesterolaemia and coronary artery disease (CAD) [7]. An increased risk for developing HF in prospective analyses after correction for confounding variables has also been reported [8].

1.1. Left Ventricular Hypertrophy and Diabetes Mellitus

Considerable clinical evidence supports a role for insulin resistance, neurohormonal and metabolic stimuli such as myocardial steatosis in the pathogenesis of left ventricular hypertrophy (LVH) [4]. LVH has similarly been linked with diabetes mellitus and abnormal glucose tolerance [9]. There is also evidence that after adjustment for age, sex, body mass index (BMI), blood pressure (BP) and antihypertensive treatment, the type 1 diabetes condition remained associated with smaller cardiac LVM and biventricular volumes, despite normal atrial sizes which is another form of cardiac remodelling [10].

Therefore, early screening for the presence of DMCM is essential for early detection and prevention of HF. The most sensitive non-invasive test for detection of LV geometry remodeling is two-dimensional echocardiogram [11]. As the cost of echocardiography is relatively high in our low-resource setting, a less expensive pre-screening test for monitoring further worsening of left ventricular remodeling in normotensive type 2 diabetes (T2DM) patients is needed.

1.2. Microalbuminuria and Diabetes Mellitus

Microalbuminuria (MCA), a known marker of glomerular endothelial dysfunction, is also associated with microangiopathy in T2DM patients [12]. It is suggested here that detection of MCA may also serve as an inexpensive pre-screening test for monitoring changes in left ventricular geometry pattern in normotensive T2DM Nigerian patients. This study was designed to determine whether the presence of MCA in normotensive T2DM Nigerian subjects could demonstrate further deterioration in left ventricular geometry remodeling in these patients.

2. Methods

The study was done in accordance with the World Medical Association Declaration of Helsinki and the protocol was approved by University of Uyo Teaching Hospital (UUTH) Institutional Health Ethical Research Committee (IHREC) with reference number UUTH/AD/S/96/VOL.XII/38. Written informed consent was obtained from all subjects after detailed explanation of the study to them. The study was conducted in the medical outpatient department of UUTH between January 2013 and March 2014. Of two hundred participants recruited, 134 consecutive diabetic patients, diagnosed according to the American Diabetes Association criteria [13] or those on oral antidiabetic drugs, as well as 59 non-diabetic age- and gender-matched controls completed the study.

2.1. Exclusion Criteria

Exclusion criteria were hypertension (blood pressure

$\geq 140/90$ mmHg or use of antihypertensive drugs), age above 65 years, macroalbuminuria, serum creatinine of ≥ 1.5 mg/dl, chest deformity or long-standing chest disease evidenced on chest X-ray, sickle cell disease, urinary tract infection, pregnancy, cardiac conditions such as arrhythmia, heart failure, valvular heart disease, pericardial disease, congenital heart disease, and ischaemic heart disease as evidenced by clinical, electrocardiographic and echocardiographic features.

2.2. Data Collection

Age, gender and duration of diabetes were recorded for each subject. Weight was determined in kilograms (kg) using a weighing scale, height using a stadiometer while waist and hip circumferences (WC and HC) were measured in centimetres (cm) using a tape measure. Body mass index (BMI), body surface area (BSA) and waist hip ratio (WHR) were calculated. Blood pressure was measured using an Accosson mercury sphygmomanometer with appropriate-sized cuff at the brachial artery. Korotkoff phase 1 was used for systolic (SBP) and phase 5 for diastolic blood pressure (DBP) after resting for at least 15 minutes in a sitting position. Pulse rate (PR) was measured at the radial artery with the mean of three consecutive measurements recorded. An overnight fasting venous blood sample was collected for measurement of plasma glucose, creatinine, urea and lipid profile using standard protocol.

2.2.1. Microalbuminuria Assay

A two-step microalbuminuria screening process was conducted. Combur 10 test strip (Roche Diagnostics, Mannheim, Germany), a visual colorimetric semi-quantitative urine test strip, was used to test for protein, blood, nitrite and leucocyte levels. If all were absent then detection of microalbuminuria was performed on the same urine sample. Microalbuminuria was determined using Micral test strips, an optically read semi-quantitative immunoassay method (Roche Diagnostics, Australia) with a sensitivity and specificity of 80 and 88%, respectively [14]. There are four colour blocks on the test strip corresponding to negative (or 0), 20, 50 and 100 mg/l of albumin. Microalbuminuria test was done on two occasions; the first was done using random urine samples (RUS) and the second was done using first morning void (FMV) urine samples of the subjects. Microalbuminuria was considered to be present when the two urine samples produced a reaction colour corresponding to 20 mg/l or more. The result from the FMV urine sample was recorded as the MCA status of the subject. It has been suggested that MCA detected in the FMV urine sample correspond better with 24-hour urinary albumin excretion (UAE) than microalbuminuria measured in a RUS, because it is less influenced by physical exercise and diet [15].

2.2.2. Left Ventricular Geometry Assessment

Echocardiographic examination was performed with the patient in the left lateral decubitus position using a Hewlett-Packard Sonos 4500 echocardiography machine with a 3.5-

MHz transducer. Measurements were taken under two-dimensional guided M-mode, as recommended by the American Society of Echocardiography (ASE) [16]. Left ventricular mass (LVM) was calculated using Devereux modified cubed formula which had been shown to have good interstudy reproducibility [17]. LV mass was indexed to BSA to give LV mass index (LVMI) in g/m^2 . Left ventricular hypertrophy (LVH) was defined as $\text{LVMI} \geq 134 \text{ g/m}^2$ in men and $\geq 110 \text{ g/m}^2$ in women [18]. Relative wall thickness (RWT) was calculated as:

$\text{RWT} = [\text{LV posterior thickness at end diastole (PWTd)} + \text{interventricular septal thickness at end diastole (IVSTd)}] / \text{left ventricular internal dimension in diastole (LVIDd)}$. A partition value of 0.45 for RWT was used for both men and women which represents the 96th percentile in normal participants [18]. LV geometry was classified into the following:

Left ventricle geometry	LVMI	RWT
Normal	Normal	<0.45
Concentric remodeling (CR)	Normal	≥ 0.45
Concentric hypertrophy (CH)	Increased	≥ 0.45
Eccentric hypertrophy (EH)	Increased	<0.45

LV systolic and diastolic function were estimated according to the standard recommendations [19, 20].

2.2.3. Data Analysis

Data obtained were analyzed using STATA 10. Continuous variables are expressed as mean (\pm standard deviation) and categorical variables as percentages. Categorical variables were analyzed using the chi-squared test. Student's *t*-test and analysis of variance (ANOVA) were used to analyze continuous variables. Correlates of LV function were determined using Pearson's rank correlation and predictors were assessed using logistic regression. A *p*-value ≤ 0.05 was considered statistically significant.

3. Results

One hundred and ninety-three participants comprising 71 T2DM patients with microalbuminuria (M group), 63 T2DM with normoalbuminuria (N group) and 59 controls (C group) were studied. The three groups were age and sex matched. In table 1, the duration since diagnosis of DM and FBS showed a significant difference between the M and N groups ($p = 0.02$ and $p = 0.001$) respectively. Waist circumference, SBP and PR showed a significant stepwise increase from control to microalbuminuric group ($p < 0.001$, $p = 0.03$, $p = 0.03$, respectively). Renal function, as assessed by estimated glomerular filtration rate (eGFR) using the Cockcroft-Gault formula was highest in the C group, although eGFR was reasonably preserved among the three groups. The mean values of all lipid components were normal and comparable, except for the low-density lipoprotein (LDL) cholesterol level and atherogenic ratio, which showed a significant stepwise increase from control to microalbuminuric group ($p = 0.0008$ and $p = 0.01$, respectively).

Table 1. Clinical characteristics of the three study groups.

Characteristics	Controls N=59	Normo N=63	Micro N=71	F/T	P
Age (years)	47 \pm 10	50 \pm 7	51 \pm 7	0.87	0.43
Sex (% male)	49	51	45	2.05	0.36
DM dur (years)	0	4.7 \pm 2.8	6.1 \pm 4.1	2.38	0.02
Weight (kg)	66 \pm 11	68 \pm 13	69 \pm 12	1.00	0.37
Height (cm)	1628	1628	1619	0.62	0.54
BMI (kg/m^2)	24.9 \pm 34.4	26.4 \pm 5.2	26.5 \pm 3.8	2.14	0.12
Waist (cm)	83 \pm 10*†	89 \pm 10	91 \pm 10	11.19	<0.01
SBP (mmHg)	116 \pm 11†	118 \pm 9	120 \pm 8	3.51	0.03
DBP (mmHg)	74 \pm 8	74 \pm 6	76 \pm 6	2.62	0.08
PR (beats/min)	79 \pm 12*	83 \pm 10	83 \pm 8	3.55	0.03
Creatinine (mg/dl)	0.9 \pm .19	1.0 \pm .31	1.01 \pm 2.4	2.64	0.08
Urea (mg/dl)	2.6 \pm .8*†	4.2 \pm 1.7	4.0 \pm 1.7	4.3	0.02
eGFR (ml/min)	102 \pm 20	79 \pm 31	86 \pm 30	2.38	0.10
TC (mmol/l)	4.0 \pm .6	4.6 \pm 1.1	4.5 \pm 1.2	1.17	0.32
TG (mmol/l)	0.9 \pm .4	1.3 \pm .8	1.1 \pm .5	2.33	0.10
HDL (mmo/l)	1.73 \pm .3	1.45 \pm .5	1.37 \pm .5	2.81	0.07
LDL (mmo/l)	1.74 \pm .6†	2.38 \pm 1	2.64 \pm .8	5.14	<0.01
AR	2.3 \pm .4*†	3.5 \pm 1.6	3.6 \pm 1.0	4.67	0.01
FPG (mmol/l)	5.0 \pm .5*†	8.1 \pm 4	9.3 \pm 4	3.72	<0.01

Controls = Normotensive non-diabetic healthy control group.

Normo = Normotensive type 2 diabetics with normoalbuminuria

Micro = Normotensive type 2 diabetics with microalbuminuria

F: F-test for ANOVA.

T: Student's T-test

*: $p < 0.05$ compared to normoalbuminuria by ANOVA

†: $p < 0.05$ compared to microalbuminuria by ANOVA.

DM dur: duration of diabetes mellitus BMI: body mass index

SBP: systolic blood pressure DBP: diastolic blood pressure

PR: pulse rate eGFR: estimated glomerular filtration rate

TC: total cholesterol TG: triglyceride

HDL: high density lipoprotein LDL: low density lipoprotein

AR: atherogenic ratio FPG: fasting plasma glucose

Table 2 shows a significant stepwise increase of PWTd, IVSTd, LVIDd from controls to microalbuminuria group ($p < 0.001$, $p < 0.001$, $p < 0.006$) respectively. Relative wall thickness, LVM and LVMI also followed a similar pattern (all *p* values < 0.001). In figure 1, the prevalence of abnormal LV geometry progressively increased from controls (42.4%) to microalbuminuric group (84.5%). Concentric remodeling was the most common form found in 56.3% of microalbuminuric and 55.5% of normoalbuminuric group. About a quarter of the microalbuminuric group had concentric hypertrophy (CH). Eccentric hypertrophy (EH) was the least common, found in 1.6% of normoalbuminuric and 6.8% of control groups respectively. In general, the prevalence of normal geometry pattern decreased stepwise from control (57.6%) to microalbuminuric group (15.5%), $p < 0.001$. Though EF and FS were normal in the three groups, FS showed a significant stepwise decrease from control to microalbuminuric group ($p < 0.001$).

Table 2. Echocardiographic parameters of left ventricular systolic function among the 3 groups.

Parameters	Controls N=59	Normo N=63	Micro N=72	F	P
IVSd (mm)	10±1.6*†	11±1.6†	12±1.8	27.25	<0.01
LVPWd (mm)	10±1.6*†	11±1.6†	12±1.8	23.89	<0.01
LVIDd (mm)	42±4.4†	40±4.9	38±4.3	7.84	<0.01
RWT	.49±.12*†	.57±.13†	.66±.14	23.08	<0.01
LVM (gm)	137±31†	148±34	161±36	7.67	<0.01
LVMi (gm/m ²)	80±17†	85±19	92±19	7.34	<0.01
EF (%)	62±7.3	63±8	60±6.2	1.99	0.14
FS (%)	36±5.5†	34±6.1†	31±4.1	11.39	<0.01
E/A ratio	1.2±.3†	1.0±.3	0.8±.2	31.51	<0.01
IVRT (ms)	79±13†	84±16	90±18	9.65	<0.01
PASP p (mmHg) 30±8	30±7†	33±9	4.22	0.02	
LADs (mm)	35±3.3	34±3.5†	36±3.6	4.5	0.01

Controls: Normotensive non-diabetic healthy control group.

Normo: Normotensive type 2 diabetics with normoalbuminuria

Micro: Normotensive type 2 diabetics with microalbuminuria

F: F-test for ANOVA.

T: Student's T-test

*: p < 0.05 compared to normoalbuminuria by ANOVA

†: p < 0.05 compared to microalbuminuria by ANOVA.

IVSd: interventricular septum thickness in diastole

LVIDd: left ventricular internal dimension in diastole

LVPWd: left ventricular posterior wall thickness in diastole

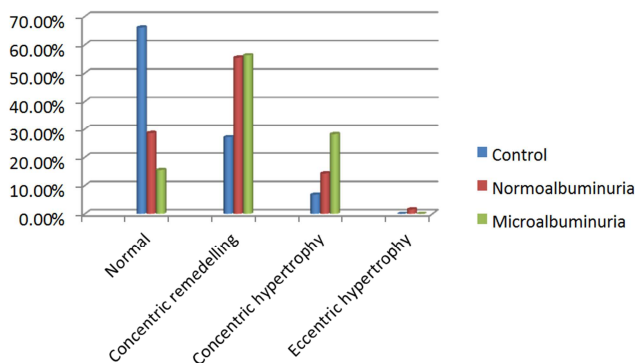
RWT: relative wall thickness LVM: left ventricular mass LVMi: left

ventricular mass index EF: ejection fraction FS: fractional shortening E:

transmitral early inflow velocity A: transmitral late atrial velocity IVRT:

isovolumic relaxation time PASP: pulmonary artery systolic pressure LADs:

left atrial diameter in systole

**Figure 1.** Composite Bar Chart comparing the Patterns of left ventricular geometry among the three groups.

$\chi^2 = 38.48$, $p < 0.01$

Legend 1: composite bar chart of the different patterns of left ventricular geometry among the three groups

χ^2 = chi square Control = Normotensive non-diabetic healthy control group

Normoalbuminuria = Normotensive type 2 diabetics with normoalbuminuria group

Microalbuminuria = Normotensive type 2 diabetics with microalbuminuria group

Table 3 shows clinical and biochemical parameters that correlated significantly with indices of LV geometry pattern (LVMi and RWT) among the normotensive diabetics. The strongest correlate of both RWT and LVMi were duration of DM ($p=0.002$ and $p=0.006$ respectively) and BMI (both $p=0.008$). Other parameters that correlated significantly with RWT were weight, WC, HC, SBP and serum creatinine level.

Table 3. Clinical and biochemical correlates of RWT and LVMi in normotensive diabetic subjects.

PARAMETERS	RWT		LVMi	
	Rho	P	Rho	P
Age (years)	0.18	0.06	0.14	0.13
Duration of DM (years)	0.28	<0.01 ^x	0.25	<0.01
Weight (kg)	0.20	0.03 ^x	-0.17	0.07
Body mass index (Kg/m ²)	0.25	<0.01	0.25	<0.01
Waist circumference (cm)	0.20	0.03	-0.10	0.27
Hip circumference (cm)	0.20	0.03	-0.18	0.05
Systolic BP (mmHg)	0.21	0.03	0.002	0.98
Diastolic BP (mmHg)	0.06	0.54	0.04	0.69
Pulse pressure	0.21	0.03	-0.08	0.40
Pulse rate (beat/min)	0.05	0.57	-0.11	0.23
Creatinine (mg/dl)	0.25	0.04	0.17	0.18
eGFR (ml/min)	-0.04	0.76	-0.09	0.44
Total cholesterol	0.01	0.94	0.21	0.12
LDL cholesterol (mmol/l)	-0.05	0.72	0.18	0.19

RWT: relative wall thickness LVMi: left ventricular mass index

Rho: correlation coefficient P: p value,

^x: p < 0.05 DM: diabetes mellitus

BP: blood pressure eGFR: estimated glomerular filtration rate

LDL: low density lipoprotein

The univariate and multivariate regression models analysis was shown in table 4, at the univariate level, normotensive diabetics with persistent microalbuminuria were 3 times more likely to have abnormal LV geometry pattern, also age (7% increase risk), BMI (13% increase risk), WC (9% increase risk) duration of DM (28% increase risk). After multivariate logistic regression analysis, only duration of DM remain an independent predictors of abnormal LV geometry, for every one year increase duration of DM there is a 23% increase risk of having abnormal LV geometry (95% CI of 2% to 49%, $p=0.03$).

Table 4. Logistic regression model for predictors of abnormal left ventricular geometry pattern in the normotensive diabetics.

Parameters	Univariate Analysis	Multivariate Analysis
	Odds Ratio (95%CI, P-value)	Odds Ratio (95%CI, P-value)
Age	1.07(1.04-1.11, <0.001) *	0.99 (0.93-1.05, 0.69)
Microalbuminuria	3.27(1.63-6.57, 0.001) *	1.97 (0.66-5.89, 0.22)
Sex	0.81(0.42-1.53, 0.51)	0.43 (0.23-1.89, 0.43)
BMI	1.13(1.04-1.22, 0.003) *	0.99 (0.84-1.18, 0.94)
Waist	1.09(1.05-1.13, <0.001) *	1.05 (0.97-1.14, 0.22)
Duration of DM	1.28(1.08-1.53, 0.004) *	1.23 (1.02-1.49, 0.03) *
Systolic BP	1.03(0.99-1.07, 0.07)	1.01 (0.93-1.10, 0.74)
Diastolic BP	1.04(0.99-1.09, 0.15)	0.97 (0.86-1.10, 0.64)

CI: confidence interval *P-value ≤ 0.05

BMI: body mass index DM: diabetes mellitus BP: blood pressure

Figure 2 shows a linear relationship between relative wall thickness and duration of DM as well as a linear relationship between left ventricular mass index and duration of DM in the diabetic groups.

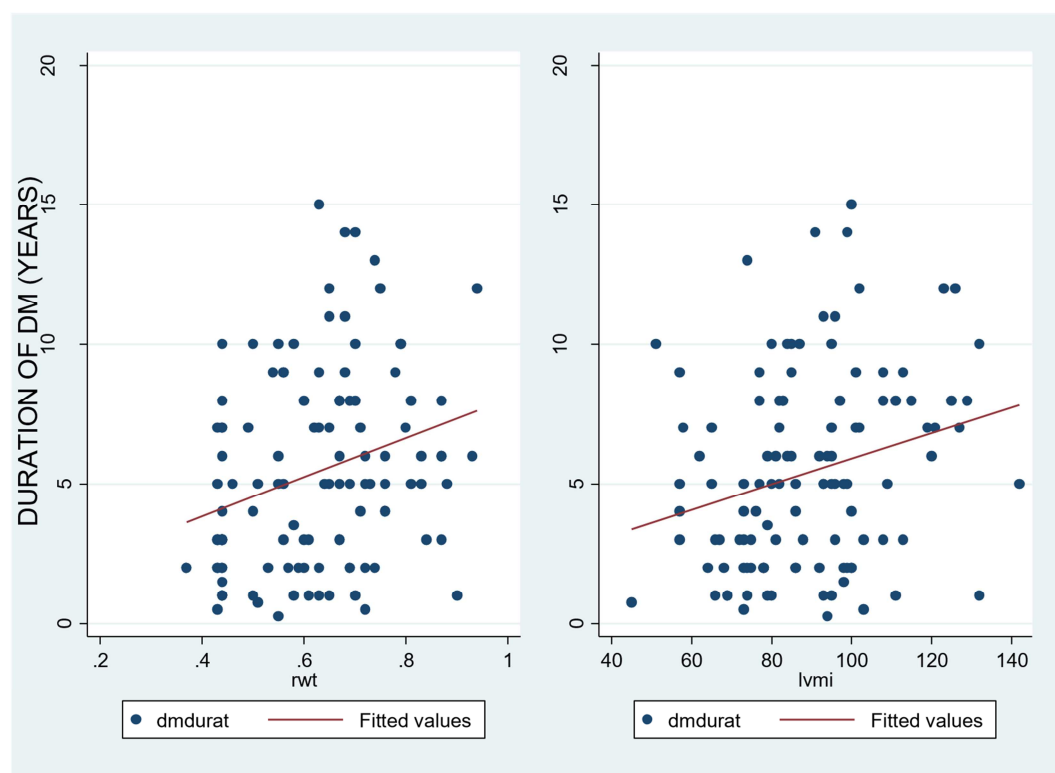


Figure 2. Scatter diagrams showing the linear relationship between: (A). Duration of diabetes mellitus and relative wall thickness. (B). Duration of diabetes mellitus and left ventricular mass index.

dm durat: duration of diabetes mellitus, rwt: relative wall thickness,
lvmi: left ventricular mass index

4. Discussion

In this study that focused on normotensive type 2 diabetics, we also observed that PWTd, IVSTd and LVID progressively increased from control group to microalbuminuric group, which resulted in the increased LVM, LVMI and RWT, thereby influencing the LV geometry remodeling. Diabetes has been implicated in the pathogenesis of cardiovascular abnormalities such as higher and lower LVM, more concentric left ventricular geometry remodeling and a lower myocardial function independent of age, sex, body size and arterial blood pressure [3, 6, 21-22]. These cardiovascular abnormalities are known to predict higher rates of cardiovascular events in both asymptomatic and symptomatic subjects and also contribute in part to the high rates of coronary heart disease and heart failure observed among diabetic patients [23, 24].

Likewise, left ventricular geometry remodeling in the general population can be referred to as a possible risk factor for incident diabetes mellitus, this was suggested by Modin et al in their study on 1710 individuals from the general population free of diabetes mellitus where they found in a multivariable model after adjusting for established DM risk factors such as HbA1c, BMI and plasma glucose, LV concentric geometry and RWT remained significantly associated with incident DM (LV concentric geometry:

hazard ratio (HR) 1.99, 95% CI 1.11–3.57, $p = 0.021$) (RWT: HR 1.41, 95% CI 1.06–1.86, $p = 0.017$, per 0.1 increase) [25].

Microalbuminuria is defined as abnormally elevated urinary albumin excretion (UAE) below the level of clinical albuminuria, which is equal to UAE rate of 20–200 $\mu\text{g}/\text{min}$ or 30–300 mg/24 hours. Microalbuminuria is associated with an increased risk of fatal and non-fatal cardiovascular disease and all-cause mortality [26]. Abnormality of vascular endothelium has been implicated as constituting a link between microalbuminuria and atherosclerotic cardiovascular disease in type 2 diabetes mellitus [27].

Data is scarce concerning the relationship between microalbuminuria and echocardiographic abnormalities of LV geometry in normotensive diabetics. In a population based study, Liu et al was the first to demonstrate an association of albuminuria with LVH in North American Indians with type 2 DM, 49% macroalbuminuric group compared to 31% of microalbuminuric and 23% normoalbuminuric had LVH [28]. Similarly Mohammed et al reported in a hospital based study, among type 2 DM in Egypt North Africa, 54% of those with microalbuminuria and 92% of those with macroalbuminuria has LVH, they confirmed that higher level of albuminuria (macroalbuminuria vs. microalbuminuria) is associated with increasing LVH and IHD [29].

Kanwar et al in their cross-sectional study done on 100

normotensive Indians with diabetes mellitus reported that the correlation between increased albuminuria and LVMI was found to be statistically significant (P value < 0.001) and the LV mass significantly increased as albuminuria increased along the continuum of normoalbuminuria to macroalbuminuria [30]. In our study, which is the first of its kind in Africa, we found that persistent microalbuminuria has a strong association with LV geometry remodeling, that microalbuminuric normotensive diabetics are three times more likely to have LV geometry remodeling than normoalbuminuric group.

This is similar to a study done among 333 diabetics of Asian descent, Nan Wu et al documented that a higher percent of those with microalbuminuria (66.3%) than those with normoalbuminuria (53%) had abnormal geometry pattern, they also identified albuminuria as an independent factor that influence LVMI with a regression coefficient of 13.6 ($p < 0.001$) and the odds ratio for developing LVH in the microalbuminuric subgroup was 2.473 (95% CI=1.370-4.464) after adjusting for age, gender, albumin, HbA1 [31]

Many studies previously have demonstrated a significantly higher left ventricular mass index and higher prevalence of left ventricular hypertrophy among diabetics independent of other confounders such as hypertension, age and obesity [32]. The observations from our study and those mentioned earlier therefore underscore the significant association of urinary albumin excretion with LV geometry remodeling and its prognostic implication in diabetics. The result from this study is the first from Nigeria to show that the damage caused by DM significantly worsens with microalbuminuria.

Microalbuminuria reflects systemic and renal trans-vascular albumin leakage which is perhaps due to the low vessel wall content of the heparan sulfate component of systemic endothelial glycocalyx, a protein rich surface layer on the endothelium [27, 33]. This generalized increased vascular permeability also causes leakiness of collagen, cholesterol and advanced glycated end products (AGEs) that have been reported in the myocardium of diabetics and is thought to contribute to geometry remodeling seen in diabetic patients [9].

It has therefore been suggested that microalbuminuria may be an early biochemical marker for alteration of LV geometry in normotensive diabetics. Though our study did not show microalbuminuria as an independent predictor of abnormal LV geometry, it can be suggested that there is a possible direct association between increased UAE and subclinical cardiovascular disease in type 2 diabetics which further gives value to using UAE to identify diabetics who may benefit from aggressive risk factor intervention via primary prevention of cardiovascular events. Despite this, as noted by Liu et al, a causative role of MCA for LV remodeling in DM can only be determined by a prospective study of albuminuria and LV geometry remodeling in diabetic patients.

5. Conclusion

Our study showed that the prevalence of LV geometry remodelling was significantly higher in microalbuminuric normotensive T2DM patients than in normotensive T2DM and controls. There was a strong direct association of microalbuminuria with abnormal LV geometry at the univariate level though this effect was attenuated following multivariate analysis. Duration of DM emerged as the only independent association of abnormal LV remodeling among type 2 diabetics increasing the risk of its occurrence by 23%. Despite the limitations of this study, periodic dipstick screening for microalbuminuria in normotensive diabetics could play a role in early detection and monitoring of LV remodelling in resource-poor settings and is hereby recommended.

Authors' Contributions

TTS, IOE, UEE and JJA contributed to the conception or design of the work. TTS, UEE, IOU, CTU, AAA, JJA contributed to the acquisition, analysis, or interpretation of data for the work. TTS and JJA drafted the manuscript. All critically revised the manuscript, gave final approval and agree to be accountable for all aspects of work ensuring integrity and accuracy.

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Declaration of Conflicting Interest

All the authors do not have any possible conflicts of interest.

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