The Value of 24-Hour Ambulatory Blood Pressure Monitoring versus in Office/Home Blood Pressure Measurement in Predicting LV Mass Index in Egyptian Hypertensive Patients on Medical Treatment

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ABSTRACT

Background: One of the outcomes of having chronic hypertension, especially if unrecognized or undertreated is LV hypertrophy (LVH) which is strongly correlated to cardiac morbidity and mortality, apart from the values of blood pressure and existing comorbidities.

Objective: This study aimed at comparing the 24-hour ambulatory blood pressure monitoring vs office/home BP measurement in predicting left ventricular mass in Egyptian hypertensive adults receiving anti-hypertensive medications.

Patients and methods: The present study included 100 known hypertensive patients aged above 18 years. They were on antihypertensive drugs coming for routine follow-up in Ain Shams University outpatient clinics and National Heart Institute between June 2021 and July 2022.

Results: The patients were assigned to 2 groups; group 1 (28 patients) with normal Left ventricular mass index (LVMI) and group 2 (72 patients) with increased LVMI. Female patients had larger LVMI ($P < 0.01$) and beta blocker users were more in group 2 ($P= 0.026$). Difference between average home and office blood pressure was not significant between both groups. Control of arterial blood pressure was better in ambulatory blood pressure monitoring in group 1 ($P= 0.042$). Moreover, 24-hour systolic, average day systolic, diastolic blood pressure, average day pulse pressure as well as reverse dipping had positive correlation with LVMI.

Conclusions: Superiority of ambulatory blood pressure over office and home measurement in predicting LV mass index in Egyptian hypertensive medicated patients.

Keywords: Ambulatory Blood Pressure Monitoring; Office Blood Pressure; LV Mass Index; Egyptian Hypertensive Patients; Medical Treatment.

INTRODUCTION

Around 1.28 billion adults worldwide are hypertensives, more than half of them are residing in low and moderate socio-economic countries. Around 40% of them are clearly diagnosed and receiving treatment. Moreover, only 1 of every 5 persons with hypertension are controlled with their medications. Hypertension is considered of the major causes of cardiovascular death globally [1]. The number of hypertensive patients is rising worldwide due to ageing of the population and increasing risk factors as harmful diets (i.e. increased salt intake) and sedentary lifestyle. Unfortunately, there is insufficient awareness, health education regarding hypertension control and treatment. So, the health authorities in the low and moderate socio-economic countries are facing a growing problem and burden because of this disease [2].

One of the complications of having chronic hypertension, especially if unrecognized or undertreated is LV hypertrophy. LV hypertrophy is strongly correlated to cardiac causes of morbidity and mortality, apart from the values of blood pressure and existing comorbidities. Among the long- term complications of chronic LVH are atrial fibrillation, heart failure, and sudden cardiac death. Predicting and early management of LVH, therefore, is of utmost importance in hypertensive patients [3].

So far, the standard tool to diagnose and monitor treatment of hypertension is office blood pressure measurement (OBPM). The ambulatory blood pressure monitoring (ABPM) importance originates from the fact that blood pressure fluctuates throughout the day. So, this tool is becoming more valuable nowadays as a good monitor for blood pressure [4].

AIM OF THE WORK

Evaluating the value of 24-hour ambulatory blood pressure versus in office/home BP measurement in predicting LV mass index in Egyptian adults with hypertension on antihypertensives.

PATIENTS AND METHODS

Study design:

The present study included 100 known hypertensive patients aged above 18 years. They were on antihypertensive drugs coming for routine follow-up in Ain Shams University outpatient clinics and National Heart Institute between June 2021 and July 2022.

Definition of hypertension:

When a patient’s systolic blood pressure was 140 mmHg or higher, or when diastolic blood pressure was 90 mmHg or higher, and/or when they were taking antihypertensive medication, they were considered to have hypertension [5].

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Exclusion criteria:
The following were excluded from the study to avoid misleading data:
(1) Refusal to sign an informed consent to use the data.
(2) Diabetic patients.
(3) Impaired left ventricular systolic function; (EF <50%).
(4) History of myocardial infarction.
(5) Significant valvular heart disease.
(6) Congenital heart disease.
(7) Primary cardiomyopathy.
(8) Chronic kidney disease (ESRD)/or on dialysis.

Methodology:
All patients were studied in a stepwise approach along the following scheme after obtaining written consent to share in the study.

A) History and clinical evaluation:

A Complete personal history was taken from all patients including age, gender, occupation as well as detailed medical history with emphasis on cardiac risk factors as well as the duration of hypertension, the type and number of medications taken by the patient and compliance of medications by the patient. Patients were asked about other medical conditions that were considered as exclusion criteria of the patient from the study such as: DM, myocardial infarction, structural heart disease.

Focused clinical examination was performed for every patient with focus on these data:

- **Weight and height** were used to determine body mass index (BMI), which is calculated as follows: kg/m^2, or weight in kilograms divided by height in meters squared [6].

- Also, using the Du Bois equation, we calculated the **body surface area** (BSA $[m^2]$ = Weight $[kg]^{0.425} \times$ height $(cm)^{0.725} \times 0.007184]$ [7].

- **Pulse:** full assessment of the pulse.

- **Assessment of arterial blood pressure:**

Office BP measurement: Blood pressure was measured in compliance with 2018 ESC guidelines [5]**:** i.e., from both upper limbs in the sitting position after letting the patient sit for three to five minutes before taking their blood pressure. A standard bladder cuff measuring 12-13 cm wide and 35 cm long was utilized. However, for large arms (with arm circumference > 32 cm) a larger one was used with the cuff at the heart level and the back and arm supported to prevent muscle contraction. To detect any discrepancy between both arms, measurement was done bilaterally during the first visit. The arm that had the greater value was regarded as the standard side.
Using a mercury sphygmomanometer and the auscultatory method, phase I and V (disappearance) Korotkoff sounds were used to assess the blood pressure, yielding the systolic and diastolic readings, respectively. Blood pressure was measured three times, one or two minutes apart, with extra readings taken only if the first two readings differed by more than 10 mmHg. The last two BP values were averaged to record blood pressure [8].

Home blood pressure measurement (HBPM):
Every patient was instructed to use an electronic or conventional blood pressure measuring device to record their blood pressure at home.

- **Focused local cardiac auscultation:** this was done to exclude the presence of pathological additional sounds or murmurs.

B) Ambulatory blood pressure measurement (ABPM):

The Contec Ambulatory Blood Pressure Monitor ABPM 50 device® was used to measure the ambulatory blood pressure (ABPM) of each patient.

The measurement frequency was set to occur every two hours during the day and night, and the device was programmed to record for a full 24 hours. The patient's note, which listed the times of day (awake), night (sleep), exercise, symptoms and medications, was interpreted. The patient's diary was used to define day and night more precisely. Numerical and graphical presentation of these readings were written in the ABPM report, which included all individual blood pressure readings, the percentage of successful readings, the averages for each timeframe (daytime, nighttime, 24 hours), and the "dipping" percentage (the percentage, the average blood pressure changes from the daytime to the nighttime). For the test to be deemed effective and included in the study, at least 70% of the readings had to be legitimate [9]. The supervisors who were blind to the patient data interpreted these data.

Controlled BP is defined if 75% of the readings are below 140/90 mmHg. The difference between day and night blood pressure is known as night dipping (typical dippers show a 10% fall in night blood pressure compared to day blood pressure).

Reverse dipping or night hypertension is defined as night BP is 10% higher than day BP.
Early morning surge is defined as 10% increase in early morning BP as compared to night BP [10].
If the mean systolic/diastolic blood pressure measured by ABPM was as follows: ≥130/80 mmHg for 24 hours, ≥135/85 mmHg during the day, or ≥120/70 mmHg at night, then the patient was assigned to have hypertension [10].

C) Laboratory work up:
Complete blood count, renal and hepatic function tests, fasting blood glucose, serum sodium and potassium.

D) Resting electrocardiogram:
Standard 12 lead ECG was done to detect conduction abnormalities that might hinder echocardiographic measurement, any ischemic patterns and previous or

recent myocardial infarction, detection of LVH. The Sokolow-Lyon LVH ECG criteria were applied, which are as follows: S wave depth in V1 + highest R wave height in V5-V6 > 35 mm [11].

E) Transthoracic standard echocardiography:
Using the **Simens Acuson X700** echocardiography equipment, all patients underwent a standard transthoracic echocardiography examination in accordance with the 2015 criteria of the American Society of Echocardiography. LV dimensions were measured using the M-mode, and the Devereux equation was used to conclude the LV mass [12].

LV mass (in grams) = 0.8{1.04[([LVEDD + IVSd + PWd]^3 − LVEDD^3)]} + 0.6

The LVMI was then calculated by indexing the LV mass to body surface area (BSA). For females, ≥95 g/m² and for males, ≥115 g/m² was considered abnormal LVMI [13].

Left atrial enlargement was diagnosed using the M-mode LA diameter, which was 4.1 cm or greater in men and 3.9 cm or greater in women [14].

The top normal value of aortic root diameter was found to be 3.3 cm for women and 3.7 cm for men when measured in the conventional PLAX view at end-diastole [15]. LV diastolic function was assessed using pulsed-wave Doppler echocardiography in the apical four-chamber view. Deceleration time (DT), the E/A ratio, and the velocities of the E and A waves were measured [14].

Patients were split into two groups according to the standard cut off value of LVMI, which is ≥ 95 g/m² for females and ≥ 115 g/m² for males. **Group 1**: LVMI was normal, and **Group 2**: LVMI was high.

Ethical approval:
The Helsinki Declaration guidelines were taken as a reference while performing this research. Also, the Cardiology Department Council and the Hospital's Ethical Committee of Ain Shams University approved the study. All subjects participating in the study had an insight of the study aim and assessment tools used and gave us written informed consents to be recruited to the study.

Statistical analysis
IBM SPSS version 23 was used to enter the data after they had been gathered, edited, and coded. When the quantitative data were parametric, they were shown as mean, standard deviations, and ranges; when they were nonparametric, they were shown as median and interquartile range (IQR). Additionally, percentages and numbers were used to represent qualitative characteristics, which were compared by the Chi-square test. Independent t-test was used to compare quantitative data and parametric distributions; Mann-Whitney test was used to compare non-parametric distributions. The allowable margin of error was set at 5%, while the confidence interval was set at 95%. Thus, the following p-value was deemed significant: P-values greater than 0.05 indicated non-significance (NS), less than 0.05 indicated significance (S) and less than 0.01 indicated high significance (HS).

RESULTS
In this cross-sectional observational study, 100 individuals with known hypertension who were taking antihypertensive drugs were included.

Patients' demographics:
The patients' mean age was 49.94 ± 6.76 years. Males were representing 60% of cases, the duration of hypertension varied greatly from 6 months to 15 years with a median of 8 years. 79% of our patients were employed. T**able (1)** displays these data.

Table (1): Patients' demographics

Variables		N = 100
Age (years)	Mean ± SD	49.94 ± 6.76
	Range	32 – 63
Sex	Male	60 (60.0%)
	Female	40 (40.0%)

Home and office BP measurements:
Patients were instructed on their first visit to measure their BP on three successive occasions at home using available machines. The mean home systolic/diastolic BP was 133.55 ±9.80/ 83.71±6.91 mmHg.
The mean office systolic/diastolic BP was 134.76 ±8.45 / 85.37±6.24 mmHg. That was insignificantly higher than average 3 home measurements.

Ambulatory blood pressure monitoring:
Most of the patients had controlled systolic and diastolic BP with impaired night dipping in 40% of patients, reversed dipping in 31% of patients and normal night dipping was found in 29% of patients. Exaggerated morning surge was recorded in 48% of patients.

After the proper patients' assessment, they were divided into 2 groups according to their LVMI (based on the normal cut off value of LVMI defined as ≥ 95 g/m² in females and ≥115 g/m² in males):
Group 1: That included 28 patients with normal LVMI, and **Group 2:** That included 72 patients with increased LVMI.
Both groups were compared according to demographics, anti-hypertensives, echocardiographic parameters, office and home BP readings and ambulatory BP monitoring.

Comparison regarding patients' demographics:
Both groups were comparable as regards demographic data with significantly high percentage of female gender in group 2 than group 1(54.2% vs.3.6%) as shown in **Table (2)**

Table (2): Comparison between both groups regarding demographics

		Group 1	Group 2	Test value	P-value	Sig.
		No. = 28	No. = 72			
Age	Mean ± SD Range	49.21 ± 5.98 42 – 60	50.22 ± 7.06 32 – 63	-0.668•	0.506	NS
Sex	Male Female	27 (96.4%) 1 (3.6%)	33 (45.8%) 39 (54.2%)	21.503*	<0.001	HS
Weight	Mean ± SD Range	93.36 ± 9.84 70 – 115	91.46 ± 9.38 70 – 115	0.896•	0.372	NS
BMI	Mean ± SD Range	32.38 ± 3.52 23.5 – 39.7	32.28 ± 4.01 22.4 – 41.4	0.118•	0.906	NS
Duration of HTN (years)	Median (IQR) Range	7 (5 – 10) 0.5 – 15	8.5 (5 – 10) 0.5 – 15	-0.566≠	0.571	NS

*Tests used: *: Chi-square; •: Independent t; ≠: Mann-Whitney*

Comparison regarding antihypertensive therapy:

Both groups were compared as regards the type, number and compliance to antihypertensive therapy, the use of beta blocker was significantly higher in group 2 as in **Table (3).**

Table (3): Comparison between both groups regarding antihypertensive therapy

		Group 1	Group 2	Test value	P-value	Sig.
		No. = 28	No. = 72			
Compliant medications	Yes No	15 (53.6%) 13 (46.4%)	36 (50.0%) 36 (50.0%)	0.103*	0.748	NS
No. of medications	1 2 3	13 (46.4%) 15 (53.6%) 0 (0.0%)	27 (37.5%) 37 (51.4%) 8 (11.1%)	3.531*	0.171	NS
Type of medications	BB ACE I ARB CCB HCTZ FRUSEMIDE	11 (39.3%) 6 (21.4%) 8 (28.6%) 13 (46.4%) 5 (17.9%) 0 (0.0%)	46 (63.9%) 30 (41.7%) 15 (20.8%) 24 (33.3%) 9 (12.5%) 1 (1.4%)	4.979* 3.584* 0.682* 1.483* 0.481* 0.393*	0.026 0.058 0.409 0.223 0.488 0.531	S NS NS NS NS NS

*Tests used: *: Chi-square.*

Comparison regarding echocardiographic parameters:

Both groups were compared as regards echocardiographic findings, patients in group 2 had significantly increased LVEDD, LVESD with reduced EF% though still in the normal range. Increased LA and aortic root diameters were significant in group 2 compared to group 1 (**Table 4**).

Table (4): Comparison between both groups regarding echocardiographic parameters

Variables		Group 1	Group 2	Test value	P-value	Sig.
		N = 28	N = 72			
EF%	Mean ± SD	63.00 ± 3.37	60.65 ± 3.62	2.970•	0.004	HS
	Range	58 – 67	54 – 67			
FS	Mean ± SD	34.11 ± 2.28	32.83 ± 2.32	2.477•	0.015	S
	Range	31 – 38	28 – 37			
LVEDD	Mean ± SD	46.43 ± 4.51	50.28 ± 3.84	-4.286•	<0.001	HS
	Range	37 – 55	37 – 57			
LVESD	Mean ± SD	29.75 ± 2.73	32.28 ± 4.03	-3.052•	0.003	HS
	Range	26 – 36	27 – 47			
LA	Mean ± SD	38.71 ± 4.18	41.28 ± 3.98	-2.852•	0.005	HS
	Range	30 – 44	30 – 55			
Aortic root	Mean ± SD	29.75 ± 2.80	31.44 ± 3.43	-2.330•	0.022	S

Tests used: •: Independent t.

Comparison regarding home and office BP:

No statistically significant difference was found between both groups regarding home blood pressure measurement and office blood pressure measurement as shown in **Table (5).** So, home and office BP measurement couldn't predict the increase in LVMI.

Table (5): Comparison between both groups regarding home and office BP measurement

Variable		Group 1 No. = 28	Group 2 No. = 72	Test value	P-value	Sig.
Average home SBP	Mean ± SD	133.25 ± 8.64	133.67 ± 10.28	-0.192•	0.848	NS
	Range	113.3 – 146.6	110 – 173.63			
Average home DBP	Mean ± SD	83.53 ± 6.69	83.78 ± 7.03	-0.157•	0.875	NS
	Range	65.3 – 93.63	60 – 93.33			
Average office SBP	Mean ± SD	133.48 ± 9.75	135.26 ± 7.90	-0.946•	0.346	NS
	Range	115 – 155	115 – 160			
Average office DBP	Mean ± SD	85.02 ± 5.90	85.51 ± 6.40	-0.353•	0.724	NS
	Range	70 – 95	62.5 – 100			

Tests used: •: Independent t

Comparison regarding ambulatory blood pressure monitoring:

ABPM controlled BP was defined as 75% of the readings are less than 140/90 mmHg, 58% of group 2 patients were uncontrolled by ABPM (P = 0.042) as shown in **Table (6)**. So, LVMI could be predicted by uncontrolled BP using ABPM.

Table (6): Comparison of BP control using ABPM in both groups.

Variables		Group 1 No. = 28	Group 2 No. = 72	Test value	P-value	Sig.
Ambulatory BP controlled	Yes	18 (64.3%)	30 (41.7%)	4.132*	0.042	S
	No	10 (35.7%)	42 (58.3%)			

*Tests used: *: Chi-square*

Comparison regarding different ABPM parameters:

Group 2 patients had significantly higher values of recorded average 24 hour systolic and diastolic BP values as well as average day and night systolic and diastolic BP values as shown in **Table (7).**

Table (7): Comparison of both groups regarding ABPM parameters

Variables		Group 1 No. = 28	Group 2 No. = 72	Test value	P-value	Sig.
Average 24 h systolic	Mean ± SD	117.57 ± 11.57	127.47 ± 13.21	-3.478•	<0.001	HS
	Range	103 – 145	107 – 158			
Average 24 h diastolic	Mean ± SD	71.29 ± 14.14	76.76 ± 7.71	-2.482•	0.015	S
	Range	50 – 97	58 – 96			
Average day systolic	Mean ± SD	115.25 ± 11.01	129.29 ± 13.23	-4.980•	<0.001	HS
	Range	105 – 148	106 – 158			
Average day diastolic	Mean ± SD	69.39 ± 11.99	79.21 ± 8.97	-4.454•	<0.001	HS
	Range	54 – 98	54 – 98			
Average day MAP	Mean ± SD	92.43 ± 15.88	94.38 ± 10.50	-0.715•	0.476	NS
	Range	74 – 116	69 – 116			
Average day P.P	Mean ± SD	45.82 ± 6.13	53.67 ± 12.06	-3.275•	0.002	HS
	Range	33 – 59	35 – 93			
Average night systolic	Mean ± SD	112.36 ± 12.20	122.19 ± 12.46	-3.565•	<0.001	HS
	Range	95 – 137	101 – 157			
Average night diastolic	Mean ± SD	65.07 ± 13.87	74.78 ± 9.88	-3.919•	<0.001	HS
	Range	45 – 92	55 – 96			
Average night MAP	Mean ± SD	88.32 ± 15.39	89.43 ± 9.75	-0.430•	0.668	NS
	Range	70 – 110	70 – 115			
Average night P.P	Mean ± SD	47.25 ± 8.40	49.92 ± 7.82	-1.499•	0.137	NS
	Range	32 – 60	34 – 65			

Tests used: •: Independent t.

Also, the presence of reverse dipping and exaggerated morning surge was significantly higher in group 2 as compared to group 1 as shown in **Table (8)**.

Table (8): Comparison between both groups regarding night dipping and exaggerated morning surge

Variables		Group 1 No. = 28	Group 2 No. = 72	Test value	P-value	Sig.
Night dipping	No	7 (25.0%)	34 (47.2%)	4.116	0.042	S
	Yes	17 (60.7%)	13 (18.1%)	17.470	<0.001	HS
	Reverse	4 (14.3%)	25 (34.7%)	4.089	0.043	S
Exaggerated morning surge	No	20 (71.4%)	32 (44.4%)	5.881*	0.015	S
	Yes	8 (28.6%)	40 (55.6%)			

*Tests used: *: Chi-square.*

Univariate and multivariate analysis showed that office records had no correlation to LVMI. On the other hand, average 24-hour systolic, average day systolic, diastolic BP, average day heart rate and pulse pressure as well as reverse dipping had positive correlations with LVMI as shown in **Table (9).**

Table (9): Correlation between LVMI and BP parameters of the studied patients

ABPM	LVMI (g/m^2) r	LVMI (g/m^2) P-value
Average 24 hr systolic	**0.216***	**0.031**
Average 24 hr diastolic	0.027	0.789
Average 24 hr MAP	0.003	0.973
Average 24 hr P.P	0.118	0.243
Average 24 hr HR	0.126	0.211
Average day systolic	**0.282****	**0.004**
Average day diastolic	**0.251***	**0.012**
Average day HR	**0.237***	**0.017**
Average day MAP	-0.101	0.316
Average day P.P	**0.274****	**0.006**
Average night systolic	0.141	0.162
Average night diastolic	0.105	0.300
Average night HR	0.145	0.150
Average night MAP	-0.077	0.446
Average night P.P	0.134	0.184
Night dipping %	0.122	0.319
Reverse night dipping %	**0.400***	**0.026**
Average office SBP	0.046	0.647
Average office DBP	0.037	0.714

P value for Spearman correlation coefficient sheet.

DISCUSSION

This work is considered a cross-sectional observational study on 100 Egyptian hypertensive medicated patients who have all undergone a standard full echocardiographic study as well as a 24-hour ambulatory blood pressure measurement as well as office and home BP measurement. This work was done in outpatient clinics of Ain Shams University and National Heart Institute between June 2021 and July 2022.

One hundred patients were recruited to our study, 60 males (60%) and 40 females (40%). Our mean age was 49.94 ± 6.76 years. Our inclusion criteria were any hypertensive medicated patients above the age of 18 on one or two anti-hypertensive medications. Our exclusion criteria included any history of ischemia and MI as it may deter the accurate measurement of LV dimensions and so LVMI measurement.

One of our exclusion criteria were diabetic patients because it was proven to be a cause of left ventricular hypertrophy in normotensive diabetic patients as stated by **Santra *et al.*** [16], this study revealed the prevalence of high LVMI in normotensive diabetic patients (Type 2) compared to matched counterparts non-diabetic normotensive individuals.

Our study showed that female gender was a contributing factor to abnormal LVMI, with 54.2% of our female patients had abnormally high LVMI, in contrast to 45% of our male patients. This result was further supported by **Gerdts *et al.*** [17] who concluded that LVH was more prevalent in women than in men (43.4% vs 32.2%. p<0.01). Another study that concluded a similar finding was conducted by the same author in 2008. The authors concluded that women had higher prevalence of LVH than men in hypertensive populations that included previously treated patients.

A third study supported the same finding by **Succurro *et al.*** [18]**.** However, this study was done on prediabetic and diabetic patients so there could be a confounding variable affecting the results.

In our study, patients having high LVMI utilized more beta blockers (p<0.026). The reason for this is probably because ESC guidelines on hypertension in 2018 have concluded that beta blockers are not as effective in reducing LVH as CCBs, ACEIs and ARBs. This was further confirmed by **Koracevic *et al.*** [19] who have demonstrated the inefficiency of beta blockers to reverse left ventricular hypertrophy.

Our study concluded that patients with larger left atrial size had higher LVMI, where the average LA size was 41.28 ± 3.98 mm in the abnormal LVMI group compared to 38.71 ± 4.18 mm in the normal LVMI group (P <0.005). **Altalhi and Abdalgbar** [20] stated that echocardiographic left atrial enlargement may be an early sign of hypertensive disease in patients with no other cause of left atrial enlargement.

In our study, aortic root size was larger in the abnormal LVMI group, with 31.44 ± 3.43 mm in the abnormal LVMI group versus 29.75 ± 2.80 mm in the normal LVMI group. **Parikh *et al.*** [21] stated that association of hypertension with aortic root dilatation is controversial.

While in 2009, **Cipolli *et al.*** [22] found that hypertensive patients with aortic root dilatation showed increased LV wall thickness and LV mass index.

In the present study, average 24-hour ambulatory systolic BP was highly correlated with an increase in LVMI. This finding is supported by **Weber *et al.*** [23] who concluded that ambulatory blood pressure measurement was able to predict left ventricular mass in hypertensive individuals.

Richey *et al.* [24] concluded that as systolic ABPM variables increase, there is greater likelihood for increased LVMI. However, this study was done on children aged 6-18 years.

In our study the average 24-hour MAP was not statistically significant in patients with abnormal LVMI compared to the other group. However, in **Rojek *et al.*** [25] it was strongly correlated with LVMI above the median range. This may be explained by the greater sample size in this study (205 patients versus 100 in our study).

Average 24-hour pulse pressure was significantly higher with abnormal LVMI in our study. This was concordant with a study conducted by **Kunišek and Kunišek** [26] which concluded a similar finding that pulse pressure was significantly higher in concentric LVH. However, this was done with office and home blood pressure measurements not with ambulatory BP measurement. Also, **Rizzo *et al.*** [27] concluded that ambulatory pulse pressure had statistically significant correlation with LVH.

Our study concluded that average day systolic blood pressure had a highly significant correlation with abnormal LVMI. This was further supported by **Blanch *et al.*** [28] who deduced the association between office, 24-hour, daytime and night time BP measurements and left ventricular hypertrophy, although their main aim was to find the association between central and peripheral BP measurement in assessing LVH in hypertensives.

Our study found that average systolic BP at night was highly linked to higher LVMI and therefore LVH. This was in concordance with **Felício *et al.*** [29] who concluded that night time SBP and hyperglycemia were associated with LVH. However, this study was done on diabetic patients and a correlation between diabetes and LVH was later discovered so there could be confounding results within this study.

In the present study, night non-dippers and reverse dippers had larger LVMI. This was supported by **Sang *et al.*** [30] who observed that non-dipping and reverse dipping pattern were associated with a higher LVMI and LVH.

Also, this was in concordance with **Son *et al.*** [31] and **Abdalla *et al.*** [32] who concluded that reverse dippers had in fact higher LVM than non-dippers.

In this study, exaggerated early morning surge had a statistically significant correlation with an increased LVMI. This came in agreement with **Durak *et al.*** [33] who found that patients with LVH and higher LVMI had higher nighttime systolic blood pressure values and morning blood pressure surges.

STUDY LIMITATIONS AND RECOMMENDATIONS

The study had the following limitations:

- The study included a relatively small number of patients.
- The use of LA diameter rather than LA volume to screen for LA dilatation.

RECOMMENDATIONS

- Larger community-based studies are needed.
- Other modalities to calculate LV mass and LA size can be used, e.g., cardiac MRI.

CONCLUSION

1. Ambulatory blood pressure monitoring is superior to office and home blood pressure measurement in predicting LV hypertrophy in patients with hypertension.

2. Many ABPM parameters correlate well with LVMI. Thus, ABPM is a good modality to monitor complications in hypertensive patients on medications.

ABBREVIATIONS

ABPM	Ambulatory blood pressure measurement
BMI	Body mass index
BP	Blood pressure
BSA	Body surface area
DBP	Diastolic blood pressure
HR	Heart rate
LVH	Left ventricular hypertrophy
LVMI	Left ventricular mass index
MAP	Mean arterial pressure
OBPM	Office blood pressure measurement
PP	Pulse pressure
SBP	Systolic blood pressure

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