Determinants of left ventricular hypertrophy among elderly hypertensive in Malaysia

SIEW MOOI CHING1*, YOOK CHIN CHIA2,3, WEI PENG CHONG4 and MEHRDAD JALALIAN5

Left ventricular hypertrophy (LVH) has high prognostic value on cardiovascular mortality and morbidity. However, echocardiography is not routinely performed among elderly hypertensives in the primary-care setting due to limited resources. The aim of this study was to determine the prevalence of LVH and its associated risk factors in a multi-ethnic elderly hypertensive population in a primary-care clinic in Malaysia.

This study was a sub-analysis of a cross-sectional study of 359 patients with hypertension in a primary-care clinic. All test subjects recruited for the study were hypertensive patients aged 60 and above. Blood pressure, height and weight were measured. All patients underwent an echocardiogram examination for diagnosis of LVH.

One hundred and ninety-nine patients were studied for the analysis. The mean age and duration of hypertension was 64.8 (SD 2.9) and 10.4 (SD 7.7) years, respectively. The study found that 44.7% of respondents achieved target blood pressure. The prevalence of LVH was 23.6%. Using multiple logistic regression, factors associated with LVH among elderly patients with hypertension were diabetes (odds ratio [OR] 3.346, 95% confidence interval [CI] 1.458-7.676), higher diastolic blood pressure (OR: 1.088; 95% CI: 1.024-1.156), higher body mass index (OR: 1.113; 95% CI: 1.031-1.203) and poorer blood pressure control.

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**Keywords:** left ventricular hypertrophy, LVH, elderly, hypertension, obesity, diabetes, primary care, Malaysia

**INTRODUCTION**

Hypertension is a leading contributory cause of mortality and morbidity from cardiovascular disease worldwide, and yet it is also the most common preventable cause of death (Lenfant et al. 2003, Whitworth 2003, Kearney et al. 2005). Several studies have proven that the incidence of associated cardiovascular disorder was reduced with antihypertensive agents (Klingbeil et al. 2003, Graham et al. 2007, Staessen et al. 1997). Left ventricular hypertrophy (LVH) is one of the sources of early target-organ damage among patients with hypertension. Numerous studies have shown that LVH has an important predictive value for cardiovascular events, particularly myocardial infarction, stroke, heart failure, and sudden death (Devereux et al. 2004, Okin et al. 2004, MacMahon et al. 1989). Treatments of high blood pressure with the angiotension receptor blockers (ARB) have been shown to prevent the development of LVH, as well as promote the reversal of LVH (Okin et al. 2003, Okin et al. 2004).

Although the proportion of hypertensives who receive treatment has increased, overall blood pressure (BP) control is suboptimal (Chobanian et al. 2003). In Malaysia, studies report similar findings, where only 26% of patients with hypertension achieve BP control (Public Health Institute 2006, L. Rampal et al. 2008). Malaysia is expected to have more elderly people and see its share of elderly population exceed 7% and become an aging society in 10 years (Mehta 2012). Doing a comprehensive review of literature, few writers have been able to draw on any structured research assessing the prevalence of LVH among elderly hypertensives, particularly in primary-care settings. Half of the studies evaluated failed to specify whether the assessment of an echocardiogram for an uncomplicated elderly hypertensive is needed, especially in primary care settings, which face budget constraints and limited resources. The purpose of this study is to determine the prevalence of LVH and its associated factors among elderly hypertensives in a primary health care clinic in Malaysia.

**MATERIALS AND METHODS**

This was a sub-analysis of a study on “prevalence and determinants of left ventricular hypertrophy in patients with hypertension registered at the Department of Primary Care Medicine Clinic, University of Malaya Medical Centre (Ching et al. 2012). Those complicated cases from the outpatient clinic were referred here as this is a teaching-hospital-based outpatient clinic in the Klang Valley, Malaysia.
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All hypertensive patients at least 60 years old were recruited for the analysis. Patients with hypertension were included when their case records fulfilled the criteria as specified by either the: (a) Documented diagnosis of hypertension according to WHO-International Hypertension Society (ISH) criteria or (b) Those whose current treatment consisted of lifestyle modification or anti-hypertensive agents. Data on patients’ height and weight were taken using a Seca digital machine. Blood pressure was taken via an “Accoson” mercury sphygmomanometer. Body mass index (BMI) was calculated as weight in kg divided by the square of height in m. Using the Asian Pacific’s obesity guideline, obesity is defined as a BMI of more than 27.5 kg/m² (WHO Health Communications 2000). The average of three blood-pressure readings was used to determine the recorded BP. Target BP was defined as <140/90mmHg among hypertensive patients (Chobanian et al. 2003) and <130/80mmHg among hypertensive patients with diabetes (Ministry of Health Malaysia 2009). The definition of premature coronary heart disease is defined as a cardiovascular event occurring among those first-degree male relatives under the age of 55 or female relatives under the age of 65 (Phillips et al. 1974).

All eligible patients went through echocardiogram (echo) examination. A standard two-dimensional M-mode transthoracic echocardiogram was used to detect LVH in the study. Echo was performed by a trained technician in a tertiary-care center who followed the standard protocol. LVH was affirmed when both the left ventricular posterior wall and inter-ventricular septal thickness were greater than 11 mm on the echocardiogram (Mark 1997).

Echocardiography results were interpreted by a cardiologist. Patients with echocardiography evidence of myocardial infraction, rhythm disorder (e.g. atrial fibrillation, bundle branch blocks, Wolf-Parkinson-White syndrome or other conduction abnormalities) or structural heart disease (ventricular septal defect, aortic stenosis or mitral regurgitation) were excluded from the study, as these are the confounders for the presence of LVH.

SPSS version 21 (SPSS Inc. Chicago, Illinois, USA) was used to perform statistical analysis. Chi-square tests were used to find associations in elderly hypertensive patients with LVH. The interactions among major associated factors were checked with multiple logistic regressions. A significant level was set up at \( p<0.05 \). Ethics approval was obtained from the Ethics Committee of University of Malaya Medical Centre.

RESULTS

Data from a total of 199 patients were analyzed. The mean age was 64.8 years with a standard deviation (SD) of 2.9 years. More than half of the cases (56.3%) were females and most were Chinese (63%), followed by Malays (20%), Indians (16%) and others (1%). A vast majority (81.4%) were married and 9% were widowed. Two-thirds had secondary education and 90% were retirees (Table 1). The mean systolic BP and diastolic BP were 137 mmHg (SD 14) and 80 mmHg (SD 8), respectively. The mean duration of hypertension was 10.4 (SD 7.7) years. More than half of the test subjects reported having a home BP monitoring device and 44.7% achieved target blood pressure. Forty percent of respondents had underlying diabetes with
a mean HbA1c of 7.09%, which is higher than normal. In addition, 48.8% of obese patients were reported to have diabetes, compared to 38.4% in the non-obese group. About one-fifth (17%) had an underlying family history of premature coronary heart disease. The mean BMI was 25.7 kg/m² (SD 4.5). Only 3% of the participants used tobacco and one-third consumed alcohol (Table 1).

Table 1. Socio-demographic characteristics of the subjects (N =199).

<table>
<thead>
<tr>
<th></th>
<th>Total (N =199)</th>
<th>LVH (n=47)</th>
<th>No LVH (n=152)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age years (mean SD*)</td>
<td>64.8(2.9)</td>
<td>64.4(3.0)</td>
<td>64.9(2.9)</td>
<td>0.501</td>
</tr>
<tr>
<td>Male Gender (n % )</td>
<td>87(43.7)</td>
<td>24(51.1)</td>
<td>63(41.4)</td>
<td>0.573</td>
</tr>
<tr>
<td>Systolic BP mmHg (mean SD*)</td>
<td>137(14)</td>
<td>137(15)</td>
<td>137(14)</td>
<td>0.901</td>
</tr>
<tr>
<td>Diastolic BP mmHg (mean SD*)</td>
<td>80(8)</td>
<td>82(8)</td>
<td>79(7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Duration of BP years (mean SD*)</td>
<td>10.4(7.7)</td>
<td>9.8(5.7)</td>
<td>10.6(8.3)</td>
<td>0.643</td>
</tr>
<tr>
<td>BMI# kg/m² (mean ± SD)</td>
<td>25.7 ± 4.5</td>
<td>27.7 ± 5.0</td>
<td>25.2 ± 4.2</td>
<td>0.001</td>
</tr>
<tr>
<td>Obese BMI# ≥ 27.5 (n %)</td>
<td>55(27.6)</td>
<td>19(40.4)</td>
<td>36(23.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Hypertension only (n %)</td>
<td>28(14.1)</td>
<td>8(17.0)</td>
<td>20(13.2)</td>
<td>0.449</td>
</tr>
<tr>
<td>Diabetes (n %)</td>
<td>81(40.7)</td>
<td>26(55.3)</td>
<td>55(36.2)</td>
<td>0.029</td>
</tr>
<tr>
<td>Home BP monitoring (n %)</td>
<td>102(51.3)</td>
<td>25(53.2)</td>
<td>77(50.7)</td>
<td>0.449</td>
</tr>
<tr>
<td>Target BP control (n %)</td>
<td>89(44.7)</td>
<td>21(44.7)</td>
<td>68(44.7)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*SD = standard deviation; BMI# = Body mass index; n = Number; % = percentage; BP = blood pressure.

The prevalence of LVH was 23.6%. Almost all subjects (97.8%) had mild LVH and only one respondent had a moderate degree of hypertrophy.

With respect to univariate analysis, we found out those who developed LVH had obesity, higher diastolic blood pressure, poor blood pressure control, and underlying diabetes. Variables that were significant (p<0.05) in the univariate analysis with LVH were subsequently entered into the multiple logistic regression model.

Using the Multivariate Logistic Regression analysis for adjusting the potential confounding factors, we found that higher diastolic blood pressure, presence of diabetes, obesity, and poor blood pressure control were predictors of development of LVH among elderly hypertensives.

Table 2 shows the results of the association among different predictors and LVH using Multivariate Logistic Regression. According to the findings, higher BMI (OR: 1.113, 95% CI: 1.031, 1.203) and diastolic BP (OR: 1.088, 95% CI: 1.024, 1.156) were prone to develop LVH. In a same way, hypertensive patients with underlying diabetes also had a higher risk of developing LVH (OR: 3.346, 95% CI: 1.458, 7.676) and patients with poor blood pressure control were prone to have LVH (OR: 2.924, 95% CI: 1.180-7.258).
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Table 2. Predictors of development of left ventricular hypertrophy among elderly hypertensive at the University of Malaya Medical Center (N =199).

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Adjusted OR (95% CI)*</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI increased at 1 kg/m²²</td>
<td>1.113 (1.031-1.203)</td>
<td>0.008</td>
</tr>
<tr>
<td>Diastolic BP increased at 1 mmHg</td>
<td>1.088 (1.024-1.156)</td>
<td>0.007</td>
</tr>
<tr>
<td>Presence of DM in HPT</td>
<td>3.346 (1.458-7.676)</td>
<td>0.004</td>
</tr>
<tr>
<td>Poorer BP control</td>
<td>2.924 (1.180-7.258)</td>
<td>0.021</td>
</tr>
</tbody>
</table>

OR- Odds Ratio; CI- Confidence Interval; DM- diabetes; HPT- hypertension.

*Adjusted for BMI, diastolic blood pressure, diabetes and blood pressure control.

**DISCUSSION**

Nearly one-fourth of the elderly patients in this study who had hypertension developed LVH. This prevalence was high and consistent with other studies in primary-care settings (Daniel et al. 2007). In addition to hypertension as the conventional cause of LVH, studies reported that diabetes can actually cause some form of cardiomyopathy (Seferović Mitrović et al. 2012, Ernande & Derumeaux 2012, Murarka & Movahed 2010, Khavandi et al. 2009, Sharma et al. 2006). The features of diabetic cardiomyopathy not only can be presented as LVH or myocardial fibrosis, it also can appear in the form of abnormal diastolic function, left ventricular systolic dysfunction, or even clinical heart failure if the hypertension is untreated and/or in the presence of myocardial ischemia (Bell 1995, Ching et al. 2012).

Similarly, in this study, diabetes was found to be the predictor for the development of LVH. Retrospectively, the association between diabetes and cardiomyopathy was not clear until 1972, when the autopsies of patients with diabetic nephropathy and congestive heart failure were found to have apical scarring together with the accumulation of interstitial collagen instead of coronary obstruction (Rubler et al. 1972). Furthermore, studies showed that this type of cardiac abnormality is absent among the young diabetics, but present in older diabetic patients (Bell 1995).

The present study found that obesity is one predictor of LVH. This is consistent with other studies (Salvetti et al. 2012, Chadha et al. 2009, Wong et al. 2004, Iacobellis et al. 2003). Insulin resistance and deregulation were believed to be correlated with the cardiac hypertrophy (Iacobellis et al. 2003). It is believed that the signaling cascade activated by insulin can also cause the neurohormonal growth agonist IGF-1 and angiotensin II to be released, in which both hormones are involving in the regulation of cell growth and protein synthesis, which leads to cardiac hypertrophy (Wong et al. 2004). One study reported that obese patients are more prone to develop insulin-resistant diabetes than non-obese patients (Wang et al. 2012). Similarly, in our study, 48.8% of obese patients were reported to have diabetes, compared to 38.4% in the non-obese group. Thus, all these may contribute the development of cardiac hypertrophy (Wang et al. 2012, Salvetti et al. 2012, Chadha et al. 2009, Wong et al. 2004, Iacobellis et al. 2003, Iacobellis 2004).

The Framingham study has shown that systolic blood pressure is far more important than diastolic blood pressure in estimating cardiovascular risk among
patient with hypertension (Kannel 1999). However, the findings of the current study do not support the previous research. The systolic BP level in our study showed no correlation with the development of LVH. This rather contradictory result may be due to systolic BP in this study being quite low (137mmHg) which may prevent the formation of LVH. Thus, it is difficult to get the expected relationship. This is further supported by another study that showed that a tight control of systolic BP significantly reduces the risk of developing LVH, compared to usual blood-pressure control (González & Astorga 2005). Similarly, our findings of poor blood pressure control as a predictor of LVH reaffirmed similar findings from previous studies that showed that good blood pressure control is important for preventing LVH and reducing overall morbidity and mortality (Trialists’Collaboration 2000, Ogden et al. 2000, Verdecchia et al. 2009).

There was no relationship found between age and LVH in our cohort. This could be explained by the fact that LVH could be regressed among elderly groups since their BP control was better than the young (43.4 vs.38.8%).

In terms of duration of blood pressure, there was no relationship noted as well. The negative relationships between LVH and duration of BP could be explained by several reasons. Patients with longer duration of BP were given more agents, and that may contribute to better BP control, which can cause the regression of LVH (average of two drugs and 1.3 drugs were prescribed for patients with high blood pressure for 15 years or more compared to those patients with high BP duration of less than five years, respectively).

The strength of the current study is the standard test for diagnosing LVH is available. However, the small sample size and the fact that only one primary-care center was involved means this may not be generalized or represent true prevalence in Malaysia.

CONCLUSION

Prevalence of LVH was high among elderly hypertensive patients in Malaysia’s primary care setting. Our findings highlight that hypertensive patients with underlying diabetes, obesity, poorer blood pressure control, particularly higher diastolic blood pressure are prone to develop LVH. Thus, it is important to order an echocardiogram for those high-risk patients even though the ECG test is normal. A larger, randomized, multi-center population survey may be needed in the future.

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