# Clinical Determinants of Increased Left Ventricular Mass on Echocardiogram in Medically Treated Afro-Caribbean Hypertensive Patients

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***ABSTRACT***

*Increased left ventricular mass (LVM) on echocardiogram is an independent risk factor for cardiac complications from hypertension. It is associated with a four-fold increase in untoward cardiac events when present. Data were reviewed for 100 treated hypertensive Afro-Caribbean patients, aged 29 to 65 years, recruited from village health clinics. Age, gender, height, weight, systolic and diastolic blood pressure, echocardiogram (ECHO) and drug history were recorded for each patient. The best single predictor of increased LVM was blood pressure with systolic (163* vs *152 mmHg,* $p < 0.01$*) and diastolic blood pressure (105* vs *98,* $p < 0.01$*) being significantly higher in patients with increased LVM. Systolic blood pressure over 150 mmHg was associated with increased LVM in 64%* vs *44% below 150 mmHg (*$p < 0.10$*). Diastolic blood pressure over 95 mmHg was associated with increased LVM in 63%* vs *36% below 95 mmHg (*$p < 0.02$*). BMI showed a trend (31.1 vs 29.7 kg/m$^2$,* $p < 0.20$*) toward higher values in patients with increased LVM. BMI above 28 kg/m$^2$ was associated with increased LVM in 61%* vs *44% below that value (*$p < 0.15$*). Females more than males had increased LVM (61%* vs *44%,* $p = 0.30$*) possibly due to higher BMI (31* vs *29.4 kg/m$^2$) and higher systolic blood pressure (160* vs *155 mmHg). Age (48.3* vs *46.5 years,* $p = 0.30$*) and years of hypertension (8.6* vs *7.3 years,* $p = 0.33$*) were not significantly different between the two groups. Drug treatment was reported in 90% (69% mono-therapy, 27% > one drug, 4% > 2 drugs) and no drug was associated with significant difference in LVM compared to others. Only 15% of treated hypertensive patients had systolic blood pressure below 140 mmHg and 8% had diastolic blood pressure below 90 mmHg. The major determinant of increased LVM in this group of Afro-Caribbean hypertensive patients appears to be poorly controlled hypertension with obesity being a possible contributing factor.*

# Determinantes Clínicas del Aumento de la Masa Ventricular Izquierda en los Ecocardiogramas de Pacientes Hipertensos Afro-caribeños Bajo Tratamiento Médico

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***RESUMEN***

*El aumento de la masa ventricular izquierda (MVI) en los ecocardiogramas es un factor de riesgo independiente en las complicaciones cardíacas de la hipertensión. Se haya asociado con el aumento cuádruple en eventos cardíacos adversos cuando está presente. Se revisaron datos de 100 pacientes afro-caribeños hipertensos, de 29 a 65 años de edad, reclutados de clínicas de salud de diferentes pueblos. Para cada paciente, se registró la edad, el género, la altura, el peso, la presión sanguínea sistólica y diastólica, los ecocardiogramas (ECHO), y la historia de los medicamentos. El mejor predictor simple del aumento de la MVI fue la presión sanguínea, siendo la presión sanguínea sistólica (163 versus 152 mmHg,* $p < 0.01$*) y la diastólica (105 versus 98,* $p < 0.01$*) significativamente más alta en los pacientes con MVI aumentada. La presión sanguínea sistólica por encima de los 250 mmHg estuvo asociada con el aumento de la MVI en 64% versus 44% por debajo de los 150 mmHg (*$p < 0.10$*). La presión sanguínea diastólica por encima de 95 mmHg estuvo asociada con el aumento de MVI en 63% versus 36% por debajo de 95 mmHg (*$p < 0.02$*). El IMC mostró una tendencia (31.1 versus 29.7 kg/m$^2$,* $p < 0.20$*) hacia valores más altos en pacientes con aumento de MVI. El IMC por encima de 28 kg/m$^2$ estuvo asociado con el aumento de MVI en 61% versus 44% por debajo del valor (*$p < 0.15$*). El*

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*aumento de la MVI había sido mayor en las hembras que en los varones (61% versus 44%,* p = *0.30), debido posiblemente a un IMC más alto (31 versus 29.4 kg/m²) y a una presión sanguínea sistólica más elevada (160 versus 155 mmHg). La edad (48.3 versus 46.5 años,* p = *0.30) y los años de hipertensión (8.6 versus 7.3 años,* p = *0.33) no mostraron diferencias significativas entre los dos grupos. El tratamiento con medicamento fue reportado en 90% (69% monoterapia, 27% > un medicamento, 4% > 2 medicamentos) y no se asoció ningún medicamento a diferencias significativas en la MVI en comparación con los otros. Sólo el 15% de los pacientes hipertensos tratados tuvo presión sanguínea sistólica por debajo 140 mmHg y 8% tuvo presión diastólica por debajo de 90 mmHg. Se halló que el determinante mayor del aumento de la MVI en este grupo de pacientes hipertensos afrocaribeños, es la hipertensión controlada pobremente, siendo la obesidad uno de los factores contribuyentes posibles.*

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## INTRODUCTION

Cardiovascular disease, including hypertension, ischaemic heart disease and cerebrovascular disease, are increasing in the Caribbean and accounted for about 30% of the mortality in 1990 (1). In Antigua and Barbuda, these diseases accounted for about 40% of the mortality in 1998 (2). In the Caribbean, it is estimated that 40% of people by age 40 years and 50% by 65 years will have hypertension (3). Hypertension is associated with increased left ventricular hypertrophy, congestive heart failure, ischaemic heart disease, arrhythmias and cerebrovascular accident (4–6). Increased left ventricular mass (LVM) on echocardiogram (ECHO) is an independent risk factor for untoward cardiac events secondary to hypertension, increasing the risk by a factor of four compared to patients without this finding in both Caucasian and Afro-American male and female patients (7–11). Increased LVM on ECHO is associated with male gender, the degree of hypertension, obesity and African descent in patients in the USA (12–15). This report is an attempt to identify clinical factors associated with increased LVM on ECHO in a group of medically treated, Afro-Caribbean hypertensive patients in Antigua and Barbuda.

## SUBJECTS AND METHODS

One hundred patients were recruited from village health centres to participate in a study of the cardiac effects of hypertension. Antigua and Barbuda is a country of 65 000 people, average income $6000 US per year, 70% from tourism. Patients were all Afro-Caribbean, as is 98% of the population. Patients were informed of the rationale of the study and consent for participation was obtained from all patients. Patients remained on their medications during the evaluation. Age, gender, height, weight, systolic and diastolic blood pressure and hypertensive drug history were recorded. Body mass index (BMI) was calculated (weight in kilograms divided by height in metres squared) and expressed as kg/m$^2$. Echocardiogram was performed by one researcher (TCM) blinded to blood pressure results on a Toshiba Sonolayer V SSA-100A machine (Toshiba Corp., Tokyo, Japan 1988).

Measurements of the left ventricle internal diameter (LVID), intraventricular septal thickness (IVS) and posterior wall thickness (PWT) were taken. Using the method of Devereux and Reichek (16), left ventricular mass was calculated: LVM in grams = 1.04 X [(LVID + IVS + PWT)$^3$ - (LVID)$^3$] - 13.6. This was indexed to height and expressed as g/m. Increased LVM was defined as over 143 g/m in men and over 102 g/m in women (16). Comparisons between groups with increased LVM and without increased LVM were made using a two-sample Student's t-test or chi-square analysis where appropriate using STAT101 software (Addison-Wesley, Reading MA, USA, 1993).

## RESULTS

The mean age of recruited patients was 47.5 years (range 29 to 65 years). There were 66% women. The mean BMI was 30.5 kg/m$^2$ (range: 21.8 to 43.4 kg/m$^2$). Of the patients studied, 49/100 (49%) had BMI < 30 kg/m$^2$. There were 11/100 (11%) patients with non-insulin dependent diabetes mellitus. The mean systolic blood pressure for the population was 158.1 mmHg (range 120 to 230 mmHg). The mean diastolic blood pressure was 101.8 mm/Hg (range 80 to 140). Only 15/100 (15%) of patients had blood pressure recordings of 140/90 mm/Hg or less. Of the 100 patients studied, 55/100 or 55% had increased LVM on ECHO. Those with increased LVM on ECHO were compared with those without LVM on ECHO.

### Blood Pressure

The best association with increased LVM on ECHO was with blood pressure. Both systolic blood pressure (163 *vs* 152 mmHg, $p < 0.02$) and diastolic blood pressure (105 *vs* 98 mmHg, $p < 0.02$) were higher in patients with increased LVM compared with those without. Systolic blood pressure over 150 mmHg was associated with a trend toward higher incidence of increased LVM on ECHO than systolic blood pressure 150 or less (64% *vs* 44%, $p < 0.10$). Diastolic blood pressure over 90 mmHg was associated with a higher incidence of increased LVM on ECHO than diastolic blood pressure 90 or less (63% *vs* 36%, $p < 0.05$). The presence of increased LVM on ECHO increased with the stage of both systolic (Table 1) and diastolic hypertension (Table 2) by National Institute of Health classification (17).

### Body Mass Index

Increasing BMI was associated with a trend toward increased LVM on ECHO. BMI demonstrated a trend toward being

Table 1: The prevalence of increased left ventricular mass index on echocardiogram as a function of stage of systolic blood pressure in Afro-Caribbean hypertensive patients in Antigua and Barbuda.

| | Normal LVM | Increased LVM |
|---|---|---|
| Systolic BP (mmHg): | | |
| Normal, 120 to < 140 or Stage 1, 140 to < 160 | 55% | 45% |
| Systolic BP (mmHg): | | |
| Stage 2, 160 to <180 or Stage 3, 180 to <210 | 37% | 63% |
| Systolic BP (mmHg): | | |
| Stage 4, 210 or higher | 20% | 80% |

BP = blood pressure, LVM = left ventricular mass

Table 2: The prevalence of increased left ventricular mass index on echocardiogram as a function of stage of diastolic blood pressure in Afro-Caribbean hypertensive patients in Antigua and Barbuda.

| | Normal LVM | Increased LVM |
|---|---|---|
| Diastolic BP (mmHg): | | |
| Normal, 80 to < 90 or Stage 1, 90 to < 100 | 66% | 34% |
| Diastolic BP (mmHg): | | |
| Stage 2, 100 to < 110 or Stage 3, 110 to < 120 | 38% | 62% |
| Diastolic BP (mmHg): | | |
| Stage 4, 120 or higher | 23% | 77% |

BP = blood pressure, LVM = left ventricular mass on echocardiogram

higher in patients with increased LVM on ECHO (31.1 *vs* 29.7 kg/m$^2$, $p < 0.20$). BMI of over 28 kg/m$^2$ was associated with a trend toward increased LVM on ECHO (61% *vs* 44%, $p < 0.15$).

### Gender

Female patients had a trend toward higher prevalence of increased LVM on ECHO compared to males (61% *vs* 44%, $p < 0.15$) although the non-indexed value for LVM for females was less than for males (125 *vs* 139 g/m). Females had insignificantly higher systolic blood pressure (159.5 *vs* 155.5 mmHg) and higher BMI (31.0 *vs* 29.4 kg/m$^2$) than the males.

### Age, Diabetes and Years of Hypertension

Age (48.3 *vs* 46.5 years, $p = 0.30$) did not differ significantly between those patients with increased LVM on ECHO and those without. The contribution of diabetes to LVM was not analysed due the small number of diabetic patients studied. The years of hypertension (8.6 *vs* 7.3 years, $p = 0.30$) did not differ significantly between those patients with increased LVM on ECHO and those without.

### Drug Treatment

Drug treatment was reported in 90% of patients. Of those, 69% were on monotherapy, 27% had more than one drug and 4% had more than two drugs. The most frequently used drugs were calcium channel blocking agents 32% (32/100) and patients using these drugs had increased LVM on ECHO 56% *vs* 54% of patients not using these drugs ($p = 0.85$). Diuretics were used in 28% of patients, and patients using these drugs had increased LVM on ECHO 54% *vs* 56% of patients not using these drugs ($p = 0.85$). Angiotensin converting enzyme inhibitors were used in 27% of patients and patients using these drugs had increased LVM on ECHO 48% *vs* 58% of patients not taking these drugs ($p = 0.45$). Alpha methyldopa was used in 16% of patients and increased LVM on ECHO was seen in 63% *vs* 54% of patients not using this drug ($p = 0.82$).

Beta adrenergic blocking drugs were used in 15% of patients and increased LVM on ECHO was seen in 40% *vs* 58% of patients not on these drugs ($p = 0.20$). Vasodilators (3%) and reserpine (2%) were not used often enough to analyse differences.

## DISCUSSION

The major observation in this study is the high prevalence of increased left ventricular mass (LVM) on echocardiography (ECHO) in this population of treated Afro-Caribbean hypertensive patients in Antigua and Barbuda. The analysis suggests that blood pressure is the major determinant of LVM in this population. Poor control of blood pressure appears to be the major contributing factor. Data from overseas suggest that only 23 to 34% of patients with hypertension have blood pressure controlled (18, 19). A recent report from Barbados showed hypertension control in only 18% of patients (20). Results were similar in Trinidad and Tobago (21). In a one-year follow-up of a six-month intervention in Jamaica, blood pressure was controlled in 26% to 30% of patients (22). This group of patients in Antigua and Barbuda had normal systolic blood pressure (< 140 mmHg) in 15% of patients and normal diastolic blood pressure (< 90 mmHg) in 8%.

Persons of African ethnicity in the USA are twice at risk for developing left ventricular hypertrophy at a given blood pressure than persons of European ethnicity (14, 23, 24). A recent report of autopsy data from Jamaica suggests that Afro-Caribbean people also have higher rates of left ventricular hypertrophy (25). Left ventricular hypertrophy is seen in a high proportion of Afro-Caribbean people in Tobago (26). Increased left ventricular mass was seen in 10% of school children with normal blood pressure in Antigua (27). Increased LVM was seen in 21% of patients with blood pressure of 140/90 mm/Hg or less in the present study. In this study hereby reported left ventricular mass was indexed to height. Although indexing to other body size

measures have been proposed (28, 29), the high correlation among measures suggests indexing to height alone is the simplest method and is adequate (30).

Obesity is increasing in the Caribbean, with 10% of men and 30% of women dangerously overweight (31, 32). In this report, BMI > 30 kg/m$^2$ was seen in 49% of patients. Efforts must be made to control this risk factor. Body mass index was the factor most strongly associated with left ventricular mass in Antiguan school children (27). Diabetes was seen in 11% of these hypertensive patients suggesting that multiple cardiac risk factors characterize the group.

Diabetes can increase left ventricular mass independent of body mass and blood pressure (33). Non-pharmacologic interventions including diet, exercise, smoking cessation and weight reduction must be strongly encouraged as the first step in control of hypertension (34–36).

Lowering blood pressure has been shown to prevent disease progression, left ventricular hypertrophy and congestive heart failure in hypertension treatment trials (37). Decreasing LVM lowers the risk of cardiovascular morbidity (38). Antihypertensive drugs differ in their ability to reduce increased LVM on ECHO (39, 40). Angiotensin converting enzyme inhibitors, diuretics and beta-adrenergic blocking drugs appear to work best (39, 40). Racial difference in response to drugs for hypertension exist (41) and point to genetic differences yet to be discovered (42). Hypertensive patients of African ethnicity are relatively less likely to have elevated renin levels and more likely to be salt sensitive, suggesting that calcium channel blockers and diuretics may be more effective (41). But these effects are relative not absolute. Grell's seminal work at the University of the West Indies with Afro-Caribbean hypertensive patients proposed the initial use of diuretics and beta-adrenergic blocking agents (43) and the synergistic use of diuretics and beta-adrenergic blocking agents (44) is still valid today (34, 45). There is some evidence that angiotensin receptor blockers are not as effective in hypertensive patients of African ethnicity as they are in those of European ethnicity (46, 47). But the key is to lower blood pressure effectively. The reason that this study showed little difference among drugs on LVM on ECHO was that blood pressure was not controlled on medication.

Any discussion of treatment of blood pressure in the Caribbean must take cost of medication into consideration (17). Patients who can obtain medications at low or no out-of-pocket cost are more likely to have blood pressure controlled (70%) than those who must pay for them [38%] (48). Patients in Antigua and Barbuda have access to hypertensive medications with no out-of-pocket costs through the Medical Benefits Scheme, which suggests that blood pressure control could be improved. Listening to patient concerns about medication and using motivational interviewing techniques might improve compliance through the development of a therapeutic alliance (49).

Advertising may influence doctors to prescribe more expensive, less substantiated medications over those proven to be useful (50). For example, hydrochlorothiazide has been shown to be superior to isradipine in reducing systolic blood pressure and left ventricular mass (51).

These are more than academic points. In Antigua and Barbuda, left ventricular hypertrophy is seen in 44% of patients with atrial fibrillation or flutter (52), in 75% of patients with congestive cardiac failure (53) and in 76% of patients experiencing a cerebrovascular accident (54). In summary, inadequate control of hypertension was the major determinant of increased left ventricular mass in this group of Afro-Caribbean hypertensive patients. Increased LVM is directly related to the degree of blood pressure elevation. Obesity may be a significant contributing factor.

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## REFERENCES

1. Holder Y, Lewis JL. Epidemiologic overview of morbidity and mortality, In: Health Conditions in the Caribbean. Pan American Health Organization, Scientific Publication No. 561, Wasington DC, USA 1997: 22–61.
2. Health Information Division. Mortality (Section C). In: Health Statistical Digest, 1999 Edition. Ministry of Health, Government of Antigua and Barbuda, St John's, Antigua 2000: 20–33.
3. Fraser HS. Treatment of hypertension for all before the year 2000. West Indian Med J 1993; **42 (Suppl 3):** 22.
4. Aronow WS, Ahn C, Kronzon I, Koenigsberg M. Congestive heart failure, coronary events and atherothrombotic brain infarction in elderly blacks and whites with systemic hypertension with and without echocardiographic and electrocardiographic evidence of left ventricular hypertrophy. Am J Cardiol 1991; **67:** 295–9.
5. Frohlich ED, Apstein C, Chobanian AV, Devereux RB, Dustan HP, Dzau V et al. The heart in hypertension. N Engl J Med 1992; **327:** 998–1008.
6. Porter JN, Petch MC. Hypertension and the heart. Post Grad Doctor Carib 1994; **10:** 124–8.
7. Levy D, Garrison RJ, Savage DD, Kanell WB, Castelli WP. Prognostic implications of echocardiographically determined left ventricular mass in the Framingham Heart Study. N Engl J Med 1990; **322:** 1561–6.
8. Casale PN, Devereux RB, Milner M, Zullo G, Harshfield GA, Pickering TG et al. Value of echocardiographic measurement of left ventricular mass in predicting cardiovascular morbid events in hypertensive men. Ann Intern Med 1986; **105:** 173–8.
9. Liao Y, Cooper RS, Mensah GA, McGee DL. (1995) Left ventricular hypertrophy has a greater impact in women than in men. Circulation 1995; **92:** 805–10.
10. Nunez E, Arnett DK, Benjamin EJ, Oakes JM, Liebson PR, Skelton TN. Comparison of the prognostic value of left ventricular hypertrophy in African-American men versus women. Am J Cardiol 2004; **94:** 1383–90.
11. Taylor HA, Penman AD, Han H, Dele-Michael A, Skelton TN, Fox ER et al. Left ventricular architecture and survival in African-Americans free of coronary heart disease (from the Atherosclerosis Risk in Communities [ARIC] Study. Am J Cardiol 2007; **99**: 1413–20.
12. Savage DD, Drayer JIM., Henry WL, Mathews EC, Ware JH, Gardin JM et al. Echocardiographic assessment of cardiac anatomy and function in hypertensive subjects. Circulation 1979; **59:** 623–9.
13. Devereux RB, Alonso DR, Dutas D. Echocardiographic assessment of left ventricular hypertrophy: comparison with necropsy findings. Am J Cardiol 1986; **57:** 450–8.

14. Lee DK, Marantz PR, Devereux RB, Klingfield P, Alderman MH. (1992) Left ventricular hypertrophy in black and white hypertensives. Standard electrocardiographic criteria overestimate racial differences in prevalence. JAMA 1992; **267:** 3294–9.
15. Gardin JM, Brunner D, Schreiner PJ, Xie X, Reid CL, Ruth K et al. Demographics and correlates of five-year change in echocardiographic left ventricular mass in young black and white adult men and women: the Coronary Artery Risk Development in Young Adults (CARDIA) Study. J Am Coll Cardiol 2002; **40:** 529–35.
16. Devereux RB, Reichek N. Echocardiographic determination of left ventricular mass in man. Anatomic validation of the method. Circulation 1977; **55:** 613–8.
17. Fraser HS. Hypertension: rationale and cost effective treatment. Post Grad Doctor Carib 1996; **12:** 240–8.
18. Hyman DJ, Pavlik VN. Characteristics of patients with uncontrolled hypertension in the United States. N Engl J Med 2001; **345:** 479–86.
19. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr et al. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: The JNC 7 Report. JAMA 2003; **289:** 2560–72.
20. Alert CV, Fraser HS, Taylor J. Quality of blood pressure monitoring and control in primary care in Barbados (Abstract). West Indian Med J 1996; **45 (Suppl 2):** 24.
21. Mahabir D, Bickram L, Picou D, Gulliford MC. Quality of blood pressure monitoring and control in primary care in Trinidad and Tobago (Abstract). West Indian Med J 1995; **44 (Suppl 2):** 15.
22. Duff EMW, Wilks R. Six-month hypertension intervention study: one-year follow-up. West Indian Med J 2003; **52:** 219–22.
23. Koren MJ, Mensah GA, Blake JH, Laragh JH, Devereux RB. Comparison of left ventricular mass and geometry in black and white patients with essential hypertension. Am J Hypertens 1993; **6:** 815–23.
24. Gardiner JM, Wagenknecht LE, Anton-Culver H, Flach J, Gidding S, Kurosaki T et al. Relationship of cardiovascular risk factors to echocardiographic left ventricular mass in healthy young black and white adult men and women. Circulation 1995; **92:** 380–7.
25. Coard KCM, Jackson M. Heart weight and heart weight/body weight ratio in a Jamaican adult autopsy population. A preliminary study. West Indian Med J 2003; **52:** 41–8.
26. Patrick AL, Boyd-Patrick A, Henry R, Ince W, Holder Y, Bunker C. Left ventricular hypertrophy: a common finding in an adult African population in Tobago, West Indies. West Indian Med J 1995; **44 (Suppl 3):**20.
27. Martin TC, Cross VH, Warner E, Cruickshank JK. Age, obesity, blood pressure: which determines echocardiographic left ventricular mass index in Antiguan school children? (Abstract). West Indian Med J 2006; **55 (Suppl 2):** 30–1.
28. Bella JN, Devereux RB, Roman MJ, O'Grady MJ, Welty TK, Lee ET et al. Relations of left ventricular mass to fat-free and adipose body mass: The Strong Heart Study. Circulation 1998; **98:** 2538–44.
29. Hense H-W, Gneiting B, Muscholl M, Broeckel U, Kuch B, Doering A et al. The association of body size and body composition with left ventricular mass: impacts for indexation in adults. J Am Coll Cardiol 1998; **32:** 451–7.
30. Liao Y, Cooper RS, Durazo-Arvizu R, Mensah GA, Ghali JK. Prediction of mortality risk by different methods of indexation for left ventricular mass. J Am Coll Cardiol 1997; **29:** 641–7.
31. Hoyos MD. Understanding obesity in the Caribbean. Post Grad Doctor Carib 1993; **9:** 130–6.
32. Fraser HS. Obesity: diagnosis and prescription for action in the English-speaking Caribbean. Rev Panam Salud Publica/Pan Am J Public Health 2003; **13:** 336–40.
33. Palmieri V, Bella JN, Arnett DK, Liu JE, Oberman A, Schuck M-Y et al. Effect of type 2 diabetes mellitus on left ventricular geometry and systolic function in hypertensive subjects: Hypertension Genetic Epidemiology Network (HyperGEN) Study. Circulation 2001; **103:** 102–7.
34. Commonwealth Caribbean Medical Research Council. Managing Hypertension in Primary Care in the Caribbean. CCMRC Publication No. 98–02. Petit Valley, Trinidad 1998.
35. Appel LJ, Moore TJ, Obarzanek E, Vollmer WM, Svetkey LP, Sacks FM et al.A clinical trial of the effects of dietary patterns on blood pressure. N Engl J Med 1997; **336:** 117–24.
36. August P. Initial treatment of hypertension. N Engl J Med 2003; **348:** 610–7.
37. Moser M, Hebert PR. Prevention of disease progression, left ventricular hypertrophy and congestive heart failure in hypertension treatment trials. J Am Coll Cardiol 1996; **27:** 1214–8.
38. Verdecchia P, Schillaci G, Borgioni C, Ciucci A, Gattobigio R, Zampi I et al. Prognostic significance of serial changes in left ventricular mass in essential hypertension. Circulation 1998; **97:** 48–54.
39. Gottdiener JS, Reda DJ, Massie BM, Materson BJ, Williams DW, Anderson RJ et al. Effect of single drug therapy on reduction of left ventricular mass in mild to moderate hypertension: comparison of six antihypertensive agents. Circulation 1997; **95:** 2007–14.
40. Sheridan DJ. Regression of left ventricular hypertrophy: do antihypertensive classes differ? J Hypertens 2000; **18 (Suppl 2):** S21–7.
41. Walker H, Jackson G. Hypertension – a practical approach to racial differences. Post Grad Doctor Carib 1999; **15:** 37–46.
42. Wood AJJ. Racial differences in the response to drugs – pointers to genetic diffences. N Engl J Med 2001; **344:** 1393–6.
43. Grell GAC. Clinical aspects of the management of hypertension in the Caribbean. West Indian Med J 1980; **26:** 163–74.
44. Grell GAC, Alleyne GAO, Robinson HM, Anderson M. Treatment of Jamaican hypertensives with atenolol and chlorthalidone. West Indian Med J 1981; **30:** 124–8.
45. Radevski IV, Valtchanova SP, Candy GP, Tshele EF, Sareli P. Comparison of acebutolol with and without hydrochlorothiazide versus carvedilol with and without hydrochlorothiazide in black patients with mild to moderate systemic hypertension. Am J Cardiol 1999; **84:** 70–5.
46. Flack JM, Oparil S, Pratt JH, Roniker B, Garthwaite S, Kleiman JH et al. Efficacy and tolerability of eplerenone and losartan in hypertensive black and white patients. J Am Coll Cardiol 2003; **41:** 1148–55.
47. Julius S, Alderman MH, Beevers G, Dahlof B, Devereux RB, Douglas JG et al. Cardiovascular risk reduction in hypertensive black patients with left ventricular hypertrophy. The LIFE Study. J Am Coll Cardiol 2004; **43:** 1047–55.
48. Gandelman G, Aronow WS, Varma R. Prevalence of adequate blood pressure control in self-pay or Medicare patents versus Medicaid or private insurance patients with systemic hypertension followed in a university cardiology or general medicine clinic. Am J Cardiol 2004; **94:** 815–6.
49. Benson J, Britten N. Patient's decision about whether or not to take antihypertensive drugs: a qualitative study. BMJ 2002; **325:** 873–6.
50. Wang TJ, Ausiello JC, Stafford RS. Trends in antihypertensive drug advertising, 1995–1996. Circulation 1999; **99:** 2055–7.
51. Papademetriou V, Gottdiener JS, Narayan P, Cushman WG, Zachariah PK, Gottdiener PS et al. Hydrochlorothiazide is superior to isradipine for reduction of left ventricular mass: results of a multicenter trial. J Am Coll Cardiol 1997; **30:** 1802–8.
52. Martin TC. Echocardiographic findings in a contemporary Afro-Caribbean population referred for evaluation of atrial fibrillation or flutter. West Indian Med J 2001; **50:** 294–6.
53. Martin TC. Comparison of Afro-Caribbean patients presenting in heart failure with normal versus poor left ventricular systolic function. Am J Cardiol 2007 (in press).
54. Martin TC. M-mode echocardiographic findings in an Afro-Caribbean population referred after a stroke. West Indian Med J 2004; **53 (Suppl 2):** 69–70.