# Prevalence and Clinical Determinants of Valvular Regurgitation

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## INTRODUCTION

In the wake of controversy surrounding anorectic drugs and valvular regurgitation (1,2) there has been a sudden surge of interest in the prevalence and predictors of valvular regurgitation. Little information however, is available on the prevalence and determinants of regurgitant valvular lesions in the general population. Color Doppler echocardiography, a sensitive technique for detecting valvular regurgitation, provides a semiquantitative method for estimating the severity of regurgitation (3). Previous color Doppler echocardiography studies reporting prevalence of valvular regurgitation have been limited to small subsets of individuals (4-6), athletes (7), children (8) and to subjects with structurally normal hearts (4,6,9). There is limited information available regarding the prevalence rates of mitral, tricuspid or aortic regurgitation in a large unselected sample of middle-aged men and women. The purpose of this study was 2 fold; 1) to use color Doppler echocardiography to establish the prevalence and distribution of mitral (MR), tricuspid (TR) and aortic regurgitation (AR) in a population-based cohort and 2) to study the clinical determinants of these regurgitant valvular lesions.

## METHODS

### Study Sample

The Framingham Heart Study is a prospective epidemiological study established in 1948 to evaluate potential risk factors for coronary heart disease. The original study cohort included 5209 men and women, aged 28 to 62 years. In 1971, 5124 additional subjects were entered into the Framingham Offspring Study. Study design and selection criteria have been published (10-12)

Subjects for the present investigation were Framingham Offspring Study subjects who had color Doppler echocardiographic examinations performed between 1991 and 1995 during their routine fifth examination cycle at the Framingham Heart Study clinic. Subjects were excluded if they met any of the following criteria: 1) technically poor echocardiogram (i.e. color Doppler of insufficient quality to accurately assess the severity of regurgitation), 2) mitral stenosis, 3) more than mild aortic stenosis or 4) prosthetic or bioprosthetic heart valve.

The clinical variables included in this investigation were age, sex, hypertension, body mass index, smoking, total cholesterol level, diabetes mellitus and history of myocardial infarction or congestive heart failure. The association between tricuspid regurgitation and percent predicted $FEV_1$ (a measure of airflow obstruction) was also examined. The diagnoses of myocardial infarction and congestive heart failure were confirmed by a committee of three physicians who evaluated records from the Framingham Heart Study clinic examinations, interim hospitalizations, and visits to personal physicians in accordance with published criteria (13). Diabetes was defined as a fasting blood glucose level ≥ 140 mg/dL (> 7.7 mmol/liter) or the use of insulin or an oral hypoglycemic agent. Body height and weight measurements, medical history, physical examination, blood pressure measurements and pulmonary function tests were performed routinely at the same examination.

### Color Doppler Echocardiography

Color Doppler examinations were performed with a commercially available system (Hewlett Packard, Sonos 1000) using a 2.5 Mhz transducer. All images were recorded on videotape using a Panasonic VCR system (AG 7350). Conventional pulsed Doppler echocardiography was performed routinely in apical 4-and 5-chamber views by selective placement of the sample volume on the color Doppler echocardiographic regurgitation signals when present.

Color Doppler variations were represented by different groups of brightness and color intensity. Flow directed toward the transducer was conventionally coded in red and flow away from the transducer in blue. Valvular regurgitation was diagnosed using color-coded Doppler imaging proximal to the valve plane during its closure and extended into the chamber proximal to the valve. For color Doppler studies, gain settings were adjusted to eliminate background speckling and to maximize the extent of intracavitary velocity coding. Mitral regurgitation was sought from the parasternal long axis, apical 4-and 2-chamber, apical long axis and subcostal views. Tricuspid regurgitation was sought from the parasternal right ventricular inflow, parasternal short axis, apical 4 chamber and subcostal views. Aortic regurgitation was sought using the parasternal long axis, parasternal short axis, apical 5-chamber and apical long axis view.

Mitral regurgitation was considered to be present if blue, green or mosaic signals were seen originating from the mitral valve and spreading into the left atrium during systole. Tricuspid regurgitation was considered to be present if blue, green or mosaic signals were seen originating from the tricuspid valve and spreading into the right atrium during systole. Aortic regurgitation was considered to be present if red, yellow or mosaic signals (blue in parasternal long axis) were seen originating from the aortic valve and spreading into the left ventricle during diastole. Valvular regurgitation was assessed qualitatively using semi-quantitative guidelines and graded none, trace, mild, moderate or severe (Table 1).

**Table I Definitions of Grades of Regurgitation**

| Grades | Mitral Regurgitation | Tricuspid Regurgitation | Aortic Regurgitation |
|---|---|---|---|
| Absent | - | - | - |
| Trace | w/in 1cm of valve | w/in 1cm of valve | JH/LVOH < 10% |
| Mild | RJA/LAA< 19% | RJA/RAA< 19% | 10-24% |
| Moderate | 20-40% | 20-40% | 25-49% |
| Severe | > 41% | > 41% | > 50% |

RJA = regurgitant jet area; LAA = left atrial area; RAA = right atrial area; JH = jet height; LVOH = left ventricular outflow height; w/in = within. Valvular regurgitation was assessed qualitatively using these semi-quantitative categories as guidelines

### Statistical Analysis

All statistical analyses were valve specific. Prevalence rates of MR, TR and AR were examined by grade of regurgitation in different age groups. Age- and sex-adjusted Spearman rank correlations were used to examine associations between clinical variables and each regurgitant lesion. The clinical variables included body mass index, hypertension, cholesterol, diabetes, smoking, history of myocardial infarction or congestive heart failure.

Multivariable regression analyses (14) were performed to assess the strength and independence of the clinical variables with MR and TR (≥ mild severity) and AR (≥ trace severity). This analysis was performed after excluding subjects with a history of myocardial infarction or congestive heart failure, since these disease states are known to be associated with valve regurgitation. Results are expressed as odds ratios

(OR) and 95% confidence intervals (CI). Odds ratios are expressed for 1 standard deviation of the continuous variables. Statistically significant values were defined as a two-tailed $p < 0.05$. All analyses were done on a Sparcstation 2 (SUN Microsystems) using the Statistical Analysis System (SAS) (15).

## RESULTS

### Subjects

Of 3589 subjects (1696 men and 1893 women) who attended the baseline examination and underwent color Doppler echocardiographic examination, 21 subjects were excluded for mitral stenosis or more than mild aortic stenosis and 9 for prosthetic heart valves. Subjects with technically poor color Doppler echocardiograms were also excluded (344 men and 334 women for MR, 354 men and 340 women for AR, and 668 men and 639 women for TR). A total of 2881 subjects (1336 men and 1545 women) were eligible for assessing MR, 2252 (1012 men and 1240 women) were eligible for assessing TR and 2865 (1326 men and 1539 women) were eligible for assessing AR. Subjects selected for analyses (mean age, 54 ± 10 years) had a lower body mass index (men, 27.6 ± 3.6 and women, 26.0 ± 4.7 $kg/m^2$) compared to subjects excluded from analysis for technically poor echocardiograms (men, 30.1 ± 4.7 and women, 29.8 ± 6.9 $kg/m^2$, $p<0.0001$).

### Prevalence of valvular regurgitation

Mitral regurgitation was detectable in 87.7% men and 91.5% of women, whereas TR was detectable in 82.0% men and 85.7% women. Aortic regurgitation was less prevalent and was observed in 13.0% men and 8.5% women. The prevalence of ≥ mild severity MR was 19.0% in men and 19.1% in women and of TR was 14.8% in men and 18.4% in women. The prevalence of regurgitation of ≥ moderate severity was much lower for all 3 valves in both sexes (range 0.4 -2.0%). When examined across different age groups the prevalence of MR and TR ≥ mild severity, and AR ≥ trace severity, increased with advancing age in both sexes (Table 2a and 2b).

**Table IIa. Prevalence of Valvular Regurgitation Stratified by Age and Severity in Men**

| Age (years) | 26 - 39 | 40 - 49 | 50 - 59 | 60 - 69 | 70 - 83 |
|---|---|---|---|---|---|
| **Mitral Regurgitation** | (n=91) | (n=351) | (n= 432) | (n=372) | (n=90) |
| None (%) | 14.4 | 13.3 | 11.3 | 12.7 | 9.0 |
| Trace (%) | 76.7 | 72.9 | 74.6 | 60.3 | 51.7 |
| Mild (%) | 8.9 | 13.5 | 12.5 | 24.6 | 28.1 |
| ≥ Moderate (%) | 0.0 | 0.3 | 1.6 | 2.4 | 11.2 |
| **Tricuspid Regurgitation** | (n=77) | (n=289) | (n=320) | (n=260) | (n=66) |
| None (%) | 14.3 | 17.8 | 19.0 | 18.3 | 16.7 |
| Trace (%) | 72.7 | 72.5 | 71.5 | 59.8 | 47.0 |
| Mild (%) | 13.0 | 9.4 | 9.2 | 21.9 | 25.8 |
| ≥ Moderate (%) | 0.0 | 0.3 | 0.3 | 0.0 | 1.5 |
| **Aortic Regurgitation** | (n=91) | (n=352) | (n=433) | (n=359) | (n=91) |
| None (%) | 96.7 | 95.4 | 91.1 | 74.3 | 75.6 |
| Trace (%) | 3.3 | 2.9 | 4.7 | 13.0 | 10.0 |
| Mild (%) | 0.0 | 1.4 | 3.7 | 12.1 | 12.2 |
| ≥ Moderate (%) | 0.0 | 0.3 | 0.5 | 0.6 | 2.2 |

**Table IIb Prevalence of Valvular Regurgitation Stratified by Age and Severity in Women**

| Age (years) | 26 - 39 | 40 - 49 | 50 - 59 | 60 -69 | 70 - 83 |
|---|---|---|---|---|---|
| **Mitral Regurgitation** | (n=93) | (n=452) | (n=515) | (n=395) | (n=90) |
| None (%) | 14.0 | 8.6 | 9.0 | 7.2 | 5.6 |
| Trace (%) | 76.3 | 75.0 | 74.0 | 66.5 | 70.8 |
| Mild (%) | 9.7 | 15.5 | 16.0 | 24.0 | 23.6 |
| ≥ Moderate (%) | 0.0 | 0.9 | 1.0 | 2.3 | 0.0 |
| **Tricuspid Regurgitation** | (n=84) | (n=371) | (n=414) | (n=300) | (n=71) |
| None (%) | 20.5 | 16.0 | 14.5 | 10.4 | 14.1 |
| Trace (%) | 65.1 | 70.0 | 70.7 | 62.2 | 56.4 |
| Mild (%) | 13.2 | 13.5 | 14.1 | 25.7 | 23.9 |
| ≥ Moderate (%) | 1.2 | 0.5 | 0.7 | 1.7 | 5.6 |
| **Aortic Regurgitation** | (n=93) | (n=451) | (n=515) | (n=390) | (n=90) |
| None (%) | 98.9 | 96.6 | 92.4 | 86.9 | 73.0 |
| Trace (%) | 1.1 | 2.7 | 5.5 | 6.3 | 10.1 |
| Mild (%) | 0.0 | 0.7 | 1.9 | 6.0 | 14.6 |
| ≥ Moderate (%) | 0.0 | 0.0 | 0.2 | 0.8 | 2.3 |

Data are presented as percent of subjects.

A total of 944 men and 1225 women had color Doppler echocardiograms technically adequate for all three valves. Regurgitation (MR or TR ≥ mild severity or AR ≥ trace severity) involving a single valve was more common than regurgitation of two or more valves (Figure 1).

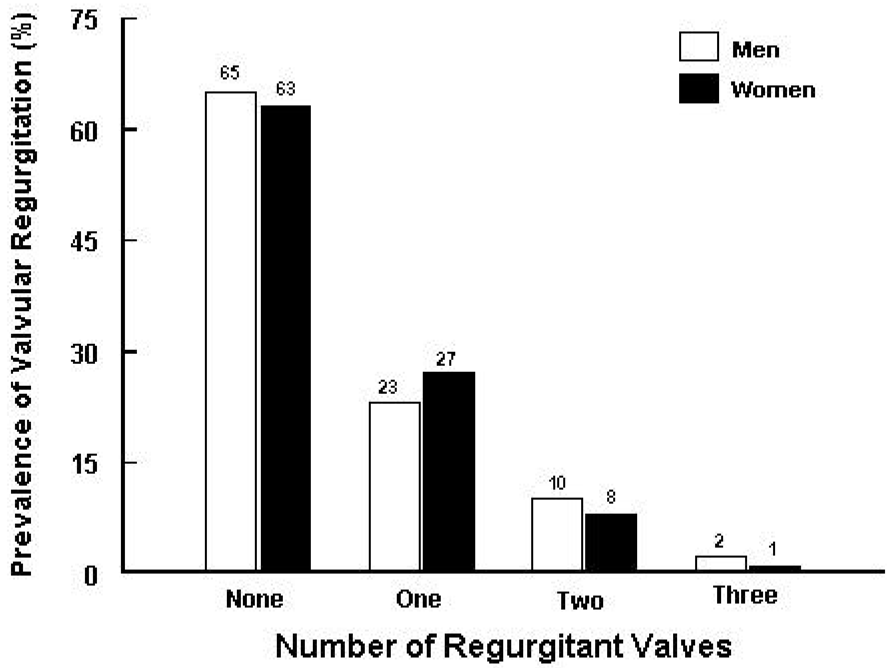


Figure 1: Histogram showing prevalence of valvular regurgitation by number of regurgitant valves. One indicates any single regurgitant valve; Two, any two regurgitant valves; Three, combined aortic, mitral and tricuspid regurgitation. Regurgitation was defined as ≥ mild severity for mitral and tricuspid regurgitation and ≥ trace severity for aortic regurgitation.

### Determinants of valvular regurgitation

Age was related positively to the severity of MR, TR and AR ($p<0.0001$, Tables 3a, b & c). The prevalence of AR was greater in men, whereas tricuspid regurgitation was more common in women. In models that adjusted for age and sex, the severity of MR and TR correlated with lower body mass index, and history of congestive heart failure and myocardial infarction. Mitral regurgitation was also related to presence of systemic hypertension.

**Table IIIa**
**Clinical Characteristics and Severity of Mitral Regurgitation**

| Clinical Characteristics | Degree of Regurgitation | | | | r | p value |
|---|---|---|---|---|---|---|
| | None | Trace | Mild | ≥ Moderate | | |
| Male / Female (%) | 55/45 | 45/55 | 45/55 | 60/40 | 0.03 | 0.09 |
| Age (years) | 54±10 | 54±10 | 57±10 | 62±9 | 0.13 | 0.0001 |
| BMI (kg/m$^2$) | 26.9±0.2 | 26.8±0.1 | 26.1±0.2 | 26.3±0.6 | -0.06 | 0.0006 |
| Systemic HTN (%) | 29 | 30 | 35 | 43 | 0.05 | 0.004 |
| Total CHOL (mg/dl) | 210±2 | 204±1 | 204±2 | 200±5 | -0.04 | 0.052 |
| Diabetes Mellitus (%) | 6 | 5 | 7 | 4 | 0.02 | 0.30 |
| Smoking (pack years) | 17 | 16 | 15 | 22 | -0.02 | 0.23 |
| CHF or MI (%) | 2 | 3 | 5 | 10 | 0.09 | 0.0001 |

**Table IIIb**
**Clinical Characteristics and Severity of Tricuspid Regurgitation**

| Clinical Characteristics | Degree of Regurgitation | | | | r | p value |
|---|---|---|---|---|---|---|
| | None | Trace | Mild | ≥ Moderate | | |
| Male / Female (%) | 50/50 | 45/55 | 39/61 | 38/62 | 0.06 | 0.003 |
| Age (years) | 53.0±9.9 | 53.1±9.7 | 57.0±10.5 | 62.2±12.8 | 0.12 | 0.0001 |
| BMI (kg/m$^2$) | 27.2±0.2 | 26.2±0.1 | 25.3±0.2 | 23.9±0.8 | -0.15 | 0.0001 |
| Systemic HTN (%) | 33 | 28 | 28 | 13 | -0.03 | 0.11 |
| Diabetes Mellitus (%) | 6 | 5 | 3 | 2 | -0.03 | 0.20 |
| Smoking (pack years) | 15±1 | 16±1 | 14±1 | 19±4 | -0.01 | 0.60 |
| CHF or MI (%) | 2 | 3 | 4 | 4 | 0.04 | 0.04 |
| Airflow Obstruction (%) | 12 | 9 | 10 | 9 | -0.14 | 0.50 |

**Table IIIc**
**Clinical Characteristics and Severity of Aortic Regurgitation**

| Clinical Characteristics | Degree of Regurgitation | | | | r | p value |
|---|---|---|---|---|---|---|
| | None | Trace | Mild | ≥ Moderate | | |
| Male / Female (%) | 45 /55 | 54/46 | 60/40 | 54/46 | -0.07 | 0.0001 |
| Age (years) | 53±10 | 60±10 | 63±8 | 63±10 | 0.24 | 0.0001 |
| BMI (kg/m$^2$) | 26.7±0.8 | 26.5±0.3 | 26.5±0.4 | 25.6±1.2 | -0.009 | 0.62 |
| Systemic HTN (%) | 30 | 34 | 32 | 12 | 0.029 | 0.12 |
| Total CHOL (mg/dl) | 205±1 | 201±3 | 207±3 | 195±10 | -0.01 | 0.54 |
| Diabetes Mellitus (%) | 5 | 6 | 10 | 0 | 0.03 | 0.18 |
| Smoking (pack years) | 16±1 | 15±2 | 16±2 | 11±6 | -0.24 | 0.19 |
| CHF or MI (%) | 3 | 4 | 6 | 0 | 0.006 | 0.76 |

r= Spearman rank correlations; BMI = body mass index; CHF or MI = history of congestive heart failure or myocardial infarction; CHOL = cholesterol; HTN = hypertension

Multiple logistic regression analyses were performed after excluding subjects with a history of myocardial infarction or congestive heart failure (Table 4). The clinical determinants of MR (≥ mild severity) were age, lower body mass index and systemic hypertension; the determinants of TR (≥ mild severity) were age, lower body mass index and female sex and the determinants of AR (≥ trace severity) were age and male sex.

**Table IV. Results of Multivariable Regression Analyses**

| | | Mitral Regurgitation | Tricuspid Regurgitation | Aortic Regurgitation |
|---|---|---|---|---|
| Clinical Determinants | Unit | OR (95% CI) | OR (95% CI) | OR (95% CI) |
| Age (years) | 9.9 | 1.3 (1.2, 1.5) | 1.5 (1.3, 1.7) | 2.3 (2.0, 2.7) |
| Sex | M/F | 1.1 (0.9, 1.3) | 1.2 (1.0, 1.6) | 0.6 (0.5, 0.8) |
| BMI ($kg/m^2$) | 4.3 | 0.8 (0.7, 0.9) | 0.7 (0.6, 0.8) | 1.0 (0.8, 1.1) |
| HTN | Y/N | 1.6 (1.2, 2.0) | 1.1 (0.8, 1.4) | 1.2 (0.9, 1.5) |

Data expressed as odds ratio (95 % confidence intervals). BMI = body mass index; HTN = hypertension; OR = odds ratio; CI = confidence interval; M/F = male/female; Y/N = yes/no. Odds ratios for continuous variables expressed for 1 standard deviation of age and BMI.

## DISCUSSION

The results of our study show that valvular regurgitation detectable by color Doppler echocardiography was highly prevalent in the general population. Mitral and tricuspid regurgitation were most common, followed by AR. Obesity was associated with a lower prevalence of TR and MR. These data provide population-based estimates for comparison with patients taking anorectic drugs.

### Prevalence of valvular regurgitation

Previous studies using conventional pulsed Doppler methodology have varied widely in their estimates of the prevalence of valvular regurgitation. In normal subjects, prevalence rates of TR have ranged from 24 to 96%, MR from 10 to 80% and AR from 0 to 33% (16-20). Color Doppler flow imaging, which superimposes color-coded flow patterns on the real-time 2-dimensional image, is a more comprehensive and sensitive, yet less tedious method compared to conventional pulsed wave Doppler echocardiography (4,21). Consequently, color Doppler echocardiography has become the procedure of choice to detect and measure valvular regurgitation. The reported prevalence has varied widely ranging from 15 to 100% for TR, 38 to 58% for MR and 0 to 18% for AR (4-6,9). The discrepancies in prevalence rates can be explained by the fact that the earlier studies have been limited to small numbers of subjects (4-6) and have varied in their definitions of regurgitation (4-6,9). Also, in contrast to previous reports, our study is not limited by selection bias (by virtue of echocardiography laboratory referral patterns) (4-6,9) or by interpretation of echocardiograms unblinded to the clinical status of patients (4-9).

Prevalence rates in the Framingham Heart Study sample differed markedly according to threshold definitions (i.e. trace versus mild severity). The high prevalence of trace regurgitation suggests that this, may be an artifact of valve closure (17) or may be, a feature related to closure of anatomically normal valves (16).

### Clinical determinants

Age was observed to exert a profound influence on the prevalence of valve regurgitation in the population. Our findings that the prevalence of mitral, tricuspid and aortic regurgitation increased with age are consistent with earlier Doppler studies (6,9,16). Long-standing mechanical stress may play a role in the wear and tear of the valve resulting in valvular regurgitation (22). Although left-sided valves (aortic and mitral) are exposed to high pressures and are likely to undergo degenerative changes earlier than right sided valves, the prevalence rates of MR and TR were comparable at all ages.

Systemic hypertension was associated with MR but not with AR. Increased afterload may play an important role in the genesis of minor degrees of MR. Earlier reports have suggested that hypertension predisposes to aortic root enlargement and, consequently, to AR (23). Our observation of a lack of association between hypertension and aortic regurgitation is supported by a recent study demonstrating the lack of an association between blood pressure and dilatation of the aortic root at the site of commissural attachment and AR (24). The present investigation and previous studies (24, 25) have shown a strong association between aortic regurgitation and age, which in turn may explain the lack of association between hypertension and AR after adjusting for age in the multivariable model.

### Obesity and Regurgitation

The severity and prevalence of MR and TR decreased as a function of increasing body mass index. This may be because ultrasonic penetration becomes poorer in individuals with obesity and that the ultrasound may be too attenuated to permit adequate detection of Doppler signals from distally located areas. To minimize this bias we purposefully excluded subjects with technically poor Doppler echocardiograms. The inverse relation between body mass index and MR and TR persisted despite exclusion of technically limited studies. Since obesity is associated with changes in cardiac structure, hemodynamics and altered ventricular inflow patterns (26,27) it might be speculated that mechanisms other than technical factors may be involved in the inverse association between body mass index and valvular regurgitation. Further studies are needed to examine this association.

## REFERENCES


1. Connolly HM, Crary JL, McGoon MD et al. Valvular heart disease associated with fenfluramine-phenteramine. N Engl J Med 1997;337:581-588.

2. Abenhaim L, Moride Y, Brenot F et al. Appetite-suppressant drugs and the risk of primary pulmonary hypertension. N Engl J Med 1996;335:609-616.

3. Helmcke F, Nanda NC, Hsiung MC et al. Color Doppler assessment of mitral regurgitation with orthogonal planes. Circulation 1987;75:175-183.

4. Yoshida K, Yoshikawa J, Shakudo M et al. Color Doppler evaluation of valvular regurgitation in normal subjects. Circulation 1988;78:840-847.

5. Jobic Y, Slama M, Tribouilloy C et al. Doppler echocardiographic evaluation of valve regurgitation in healthy volunteers. Br Heart J 1993;69:109-113.

6. Klein AL, Burstow DJ, Tajik AJ et al. Age-related prevalence of valvular regurgitation in normal subjects: a comprehensive color flow examination of 118 volunteers. J Am Soc Echocardiogr 1990;3:54-63.

7. Douglas PS, Berman GO, O'Toole ML, Hiller WD, Reicheck N. Prevalence of multivalvular regurgitation in athletes. Am J Cardiol 1989;64:209-212.

8. Brand A, Dollberg S, Keren A. The prevalence of valvular regurgitation in children with structurally normal hearts: a color Doppler echocardiographic study. Am Heart J 1992;123:177-180.

9. Biava G, Delfino M, Lagana B et al. Prevalence of valvular regurgitation in structurally normal hearts: a colour-Doppler study. Coronary Artery Dis 1997;8:559-563.

10. Dawber TR, Meadors GF, Moore FE. Epidemiologic approaches to heart disease: the Framingham study. Am J Public Health 1951;41:279-286.

11. Dawber TR, Kannel WB, Lyell LP. An approach to longitudnal studies in a community: the Framingham study. Ann N Y Acad Sci 1963;107:539-556.

12. Kannel WB, Feinleib M, McNamara PM, Garrison RJ, Castelli WP. An investigation of coronary heart disease in families: the Framingham Offspring study. Am J Epidemiol 1979;110:281-290.

13. Sorlie P. Cardiovascular disease and death following myocardial infarction and angina pectoris: Framingham Study, 20 year follow-up. Washington,DC, US Government Printing Office, 1977.

14. Kleinbaum DG, Kupper LK, Muller KE. Applied regression analysis and other multivariable methods. PWS-KENT, Boston, 1988;102-162.

15. SAS/STAT User's Guide, Version 6. Cary, NC, SAS Institute Inc. 1989;1071-1126, 1351-1456.

16. Akasaka T, Yoshikawa J, Yoshida K et al. Age-related valvular regurgitation: a study by pulsed Doppler echocardiography. Circulation 1987;76:262-265.

17. Kostucki W, Vandenbossche J, Friart A, Englert M. Pulsed Doppler regurgitant flow patterns of normal

valves. Am J Cardiol 1986;58:309-313.

18. Berger M, Hecht SR, Van Tosh A, Lingam U. Pulsed and continous wave Doppler echocardiographic assessment of valvular regurgitation in normal subjects. J Am Coll Cardiol 1989;13:1540-1545.

19. Choong CY, Abascal VM, Weyman J et al. Prevalence of valvular regurgitation by Doppler echocardiography in patients with structurally normal hearts by two-dimensional echocardiography. Am Heart J 1989;117:636-642.

20. Aronow WS, Ahn C, Kronzon I. Prevalence of echocardiographic findings in 554 men and 1243 women aged > 60 years in a long-term health care facility. Am J Cardiol 1997;79:379-380.

21. Rivera JM, Vandervoort PM, Morris E, Weyman AE, Thomas JD. Visual assessment of valvular regurgitation: comparison with quantitative Doppler measurements. J Am Soc Echocardiogr 1994;7:480-487.

22. Braunwald E. Valvular heart disease. In: Braunwald E (ed): Heart disease. W.B. Saunders Company, Philadelphia, 1992; 1007-1077.

23. Ionati L, Cuspidi C, Sampieri L et al. Prevalence of physiological valvular regurgitation in hypertensive patients: echocardiographic and color Doppler study. Cardiology 1992;81:365-370.

24. Kim M, Roman MJ, Cavallini MC, Schwartz JE, Pickering TG, Devereux RB. Effect of hypertension on aortic root size and prevalence of aortic regurgitation. Hypertension 1996;28:47-52.

25. Vasan RS, Larson MG, Levy D. Determinants of echocardiographic aortic root size. Circulation 1995;91:734-740.

26. de Divitiis O, Fazio S, Petitto M, Maddalena G, Contaldo F, Mancini M. Obesity and cardiac function. Circulation 1981;64:477-482.

27. Gottdiener JS, Reda DJ, Materson BJ et al. Importance of obesity, race and age to the cardiac structural and functional effects of hypertension. The Department of Veterans Affairs Cooperative Study Group on Antihypertensive Agents. J Am Coll Cardiol 1994;24:1492-1498.

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