# Usefulness of Left Ventricular Mass and Geometry for Determining 10-Year Prediction of Cardiovascular Disease in Adults Aged >65 Years (from the Cardiovascular Health Study)

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**Left ventricular (LV) mass and geometry are associated with risk of cardiovascular disease (CVD). We sought to determine whether LV mass and geometry contribute to risk prediction for CVD in adults aged ≥65 years of the Cardiovascular Health Study. We indexed LV mass to body size, denoted as LV mass index (echo-LVMI), and we defined LV geometry as normal, concentric remodeling, and eccentric or concentric LV hypertrophy. We added echo-LVMI and LV geometry to separate 10-year risk prediction models containing traditional risk factors and determined the net reclassification improvement (NRI) for incident coronary heart disease (CHD), CVD (CHD, heart failure [HF], and stroke), and HF alone. Over 10 years of follow-up in 2,577 participants (64% women, 15% black, mean age 72 years) for CHD and CVD, the adjusted hazards ratios for a 1-SD higher echo-LVMI were 1.25 (95% CI 1.14 to 1.37), 1.24 (1.15 to 1.33), and 1.51 (1.40 to 1.62), respectively. Addition of echo-LVMI to the standard model for CHD resulted in an event NRI of −0.011 (95% CI −0.037 to 0.028) and nonevent NRI of 0.034 (95% CI 0.008 to 0.076). Addition of echo-LVMI and LV geometry to the standard model for CVD resulted in an event NRI of 0.013 (95% CI −0.0335 to 0.0311) and a nonevent NRI of 0.043 (95% CI 0.011 to 0.09). The nonevent NRI was also significant with addition of echo-LVMI for HF risk prediction (0.10, 95% CI 0.057 to 0.16). In conclusion, in adults aged ≥65 years, echo-LVMI improved risk prediction for CHD, CVD, and HF, driven primarily by improved reclassification of nonevents.**  **(Am J Cardiol 2016;118:684−690)**

Left ventricular (LV) hypertrophy is an independent predictor and potentially modifiable risk factor for incident cardiovascular disease (CVD).[1−4] Although previous data demonstrate a strong association between LV mass (LVM)/hypertrophy and increased cardiovascular risk, other statistical methods may be more useful in determining the utility of a biomarker to aid in clinical decision making. Net reclassification improvement (NRI) determines the number of subjects who are appropriately reclassified into higher or lower risk with addition of a new biomarker to an existing risk algorithm.[5,6] LVM tends to increase, and LV hypertrophy becomes more prevalent with increasing age,[7] so these measurements may be particularly important for risk assessment. We sought to determine the extent to which LVM and geometry determined by echocardiography and electrocardiography improves risk prediction for coronary heart disease (CHD), heart failure (HF), stroke, and global CVD outcomes, beyond models based on traditional risk factors.

## Methods

The Cardiovascular Health Study (CHS) is a prospective study sponsored by the National Institutes of Health; details of the study design have been previously published.[8] Participants were recruited from the following 4 communities: Washington County, Maryland; Pittsburgh, Pennsylvania; Forsyth County, North Carolina; and Sacramento County, California. CHS includes 5,201 community-dwelling men and women aged ≥65 years, recruited in 1989 to 1990; an additional cohort of 687 African-Americans was recruited from 1992 to 1993. Echocardiograms were recorded in 1989 to 1990 for the original cohort and 1994 to 1995 for the African-American cohort. In the present analysis, "baseline" refers to the 1989 to 1990 examination for the initial cohort and the 1994 to 1995 examination for the second cohort. Figure 1 shows the exclusion criteria for the CHD and CVD

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See page 689 for disclosure information.

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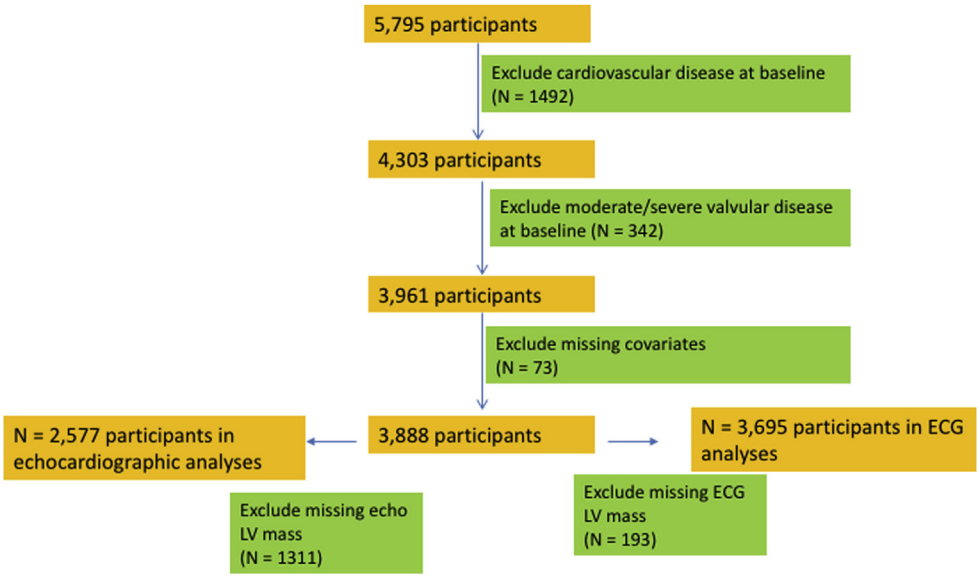


Figure 1. CONSORT diagram for CHS cohort A (CHD and CVD outcomes).

analyses, which we refer to as cohort A. For the CHD and CVD analyses, we excluded participants who had a previous diagnosis of CHD, HF, stroke, or atrial fibrillation (total with clinical CVD = 1,529), missing indexed echo LVM (n = 1,486), missing key covariates at the baseline examination (n = 51), and moderate or severe valvular stenosis or regurgitation (n = 245). After exclusions, 2,577 participants were available for analyses.

Figure 2 shows the exclusion criteria for the HF analyses, which we refer to as cohort B. In cohort B, we used inclusion criteria that are similar to those previously described by Butler et al[9] in the Health ABC Study. We excluded participants with HF at baseline (n = 297), missing indexed echo-LVM (n = 1,958), and other missing key covariates or baseline data (n = 82). The final cohort B included 3,551 participants. We then conducted a sensitivity analysis for the HF outcome after additionally excluding participants with LV ejection fraction <45% (n = 75). Of note, unlike cohort A, cohort B does not exclude participants with a history of CHD and stroke.

Electrocardiographic left ventricular hypertrophy (ECG-LVH) was considered present if the following Minnesota Codes[10] were present: 3-1, 3-3, 4-1 to 4-3, and 5-1 to 5-3. ECG-LVM was calculated according to the race- and sex-specific formulas and adjusted for body size, as described by Rautaharju et al[11] previously in CHS. Echo-LVM was calculated from 2-dimensionally guided M-mode echocardiograms using a method that has been described in detail previously.[12] We used the following formula described by Devereux[13] to calculate the unadjusted LV mass: LV mass (grams) = $0.80 \times 1.04 \times ([\text{VSTd} + \text{LVIDd} + \text{PWTd}]^3 - [\text{LVIDd}]^3) + 0.6$; where VSTd refers to the ventricular septal thickness in end diastole, LVIDd refers to LV internal diameter in end diastole, and PWTd refers to the posterior wall thickness in end diastole.

The echo-LVM value obtained from the Devereux equation was adjusted for height, weight, and gender based on a method previously described from the Multi-Ethnic Study of Atherosclerosis.[14] A healthy subgroup (without a history of coronary disease, HF, stroke, hypertension, diabetes, obesity, or significant subclinical disease by carotid ultrasound and ankle-brachial index) within CHS was used to define reference equations for LVM and wall thickness, adjusted for height, weight, and gender. We used a linear regression model with log-transformed LVM as the outcome

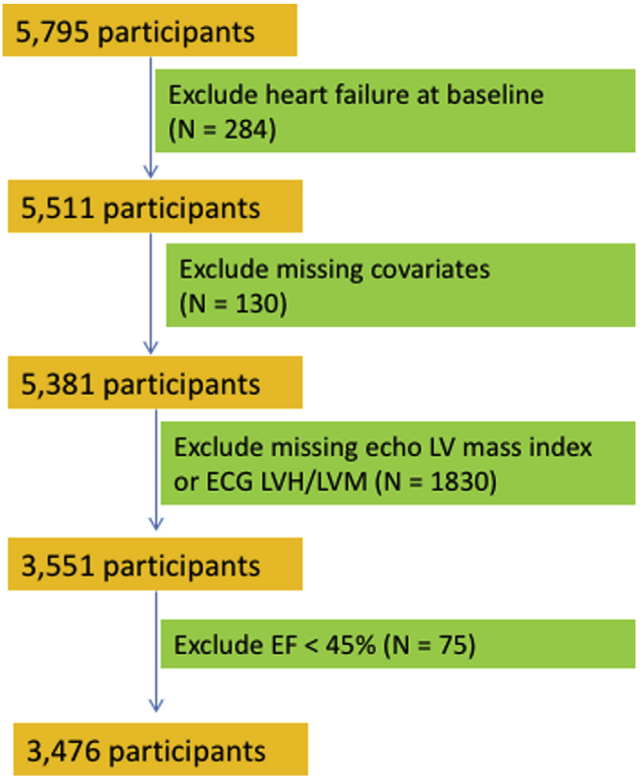


Figure 2. CONSORT diagram for CHS cohort B (HF outcome). EF = ejection fraction.