

Supplementary Table 2. Comparison of CKM staging definitions between the American Heart Association (AHA) framework and the modified criteria used in the present study

CKM stage	Original AHA definition	Definition used in the present study	Rationale for modification
Stage 1	Overweight, abdominal obesity, dysfunctional adiposity based on BMI, waist-to-hip ratio, or adiposity imaging	BMI ≥ 23 kg/m ² , WC ≥ 85 cm (women), ≥ 90 cm (men), or fasting glucose 100–125 mg/dL	NHIS dataset lacks waist-to-hip ratio and adiposity imaging data. Thus, limited to BMI, WC, and fasting glucose
Stage 2	Metabolic risk factors including insulin resistance biomarkers, advanced metabolic profiling, hypertension, dyslipidemia, diabetes, or CKD (eGFR 30–59 mL/min/1.73 m ²)	Metabolic risk factors based on clinical parameters readily available: triglycerides ≥ 135 mg/dL, hypertension, metabolic syndrome, diabetes (fasting glucose ≥ 126 mg/dL or medication use), dyslipidemia (statin use or cholesterol ≥ 240 mg/dL), or CKD (eGFR 30–60 mL/min/1.73 m ²)	NHIS dataset does not include advanced insulin resistance biomarkers or metabolic profiling, thus modified to available clinical and laboratory data
Stage 3	Subclinical cardiovascular disease identified by cardiac imaging findings (e.g., LVH, coronary calcium scoring, carotid IMT), biomarkers (NT-proBNP, troponin), or high-risk CKD (eGFR < 30 mL/min/1.73 m ²)	High 10-year cardiovascular risk defined by PREVENT score $\geq 20\%$ or very high-risk CKD (eGFR < 30 mL/min/1.73 m ²)	NHIS lacks cardiac imaging and cardiac biomarkers, so imaging/biomarkers replaced with validated risk scores (PREVENT) and severe CKD as proxies for subclinical CVD
Stage 4	Clinical cardiovascular disease (CAD, HF, stroke, PAD, AF) defined by standard clinical definitions	Clinical cardiovascular disease similarly defined based on ICD-10 codes and validated procedure codes from hospitalizations (CAD, HF, stroke, PAD, AF)	Similar criteria, closely following AHA definition using validated NHIS ICD-10 codes

CKM, cardiovascular-kidney-metabolic; BMI, body mass index; WC, waist circumference; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; NHIS, National Health Insurance Service; LVH, left ventricular hypertrophy; IMT, intima-media thickness; NT-proBNP, N-terminal pro-B-type natriuretic peptide; CAD, coronary artery disease; HF, heart failure; PAD, peripheral artery disease; AF, atrial fibrillation; ICD-10, International Classification of Diseases, 10th Revision.