Association of Fibroblast Growth Factor 23 With Risk of Incident Coronary Heart Disease in Community-Living Adults

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IMPORTANCE Higher circulating fibroblast growth factor 23 (FGF23) concentrations are associated with cardiovascular disease events linked to heart failure, but associations of FGF23 with coronary heart disease (CHD) have been less consistent.

OBJECTIVE To determine the association of plasma FGF23 concentrations with incident CHD and whether this association differs by race, sex, or chronic kidney disease status.

DESIGN, SETTING, AND PARTICIPANTS We examined the association of FGF23 concentrations with incident CHD risk within the Reasons for Geographic and Racial Differences in Stroke study, a prospective cohort of black and white adults 45 years and older enrolled between January 2003 and October 2007 with follow-up through December 31, 2011. Using a case-cohort design, we measured FGF23 concentrations in 829 participants who developed incident CHD and in 812 participants randomly selected from the Reasons for Geographic and Racial Differences in Stroke study cohort (cohort random sample). To account for the stratified sampling design, the cohort random sample was weighted back to the original cohort overall (n = 22 127). Cox proportional hazards models were used to examine the association of FGF23 concentration with incident CHD, adjusting for CHD risk factors and kidney function. In prespecified analyses, we examined whether race, sex, or chronic kidney disease modified the association of FGF23 concentration with incident CHD.

EXPOSURES Plasma C-terminal FGF23 concentrations.

MAIN OUTCOMES AND MEASURES Investigator-adjudicated incident CHD events.

RESULTS Of the 22 127 participants in the weighted cohort random sample, 13 059 (58.9%) were female and 9435 (42.6%) were black, and the mean age was 64.3 (95% CI, 63.7-64.9) years. Greater age, lower estimated glomerular filtration rate, higher urine albumin to creatinine ratio, and female sex were associated with higher FGF23 concentration at baseline. In multivariable models adjusted for established CHD risk factors and kidney function, higher FGF23 concentrations were associated with greater risk of CHD (hazard ratio [HR] comparing fourth with first quartile, 2.15; 95% CI, 1.35-3.42). The magnitude and strength of these associations differed by sex. However, these differences were no longer observed when adjusting for hormone therapy in women (men: HR comparing fourth with first quartile, 2.40; 95% CI, 1.30-4.42; women: HR comparing fourth with first quartile, 2.34; 95% CI, 1.04-5.27) or when using sex-specific FGF23 quartiles (men: HR comparing fourth with first quartile, 2.65; 95% CI, 1.43-4.90; women: HR comparing fourth with first quartile, 2.26; 95% CI, 1.02-5.03).

CONCLUSIONS AND RELEVANCE Higher FGF23 concentrations were associated with greater risk of CHD. Heterogeneity in the association by sex may be caused by differences in the distribution of plasma FGF23 concentrations or the use of hormone therapy in men vs women.

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Fibroblast growth factor 23 (FGF23) is a hormone secreted by osteocytes that regulates phosphorus and vitamin D metabolism. Multiple studies have shown that FGF23 concentration is associated with increased risk of cardiovascular disease (CVD) events and death, but the magnitude and direction of these associations appear to differ by CVD outcome. Fibroblast growth factor 23 concentration has most consistently been linked to increased risk of heart failure-related events, possibly through direct effects promoting cardiomyocyte hypertrophy. However, evidence linking FGF23 concentration with atherosclerotic events, such as coronary heart disease (CHD), is conflicting. Some studies have shown an independent association of higher FGF23 concentrations with CHD events, whereas other studies showed no associations after accounting for traditional risk factors. The reasons for these discrepancies are unclear but may be related to the relatively small number of events in several of the studies or differences in study cohort characteristics. In addition, few studies examined whether the association of FGF23 concentration with CHD was modified by demographic and clinical factors. This is important given evidence of heterogeneity in the association of markers of phosphorus excess (such as FGF23 concentration) with CVD by race, sex, and the presence or absence of chronic kidney disease (CKD). Therefore, in the current study, we examined the association of FGF23 concentration with incident CHD, and in a prespecified analysis, we further examined whether this association was modified by race, sex, or CKD status in participants of the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study.

**Methods**

The REGARDS study is a population-based investigation of stroke incidence in black and white US adults 45 years and older. Details of the study design have been reviewed elsewhere. Briefly, the study was designed to provide approximately equal representation of men and women and oversampled individuals who were black as well as individuals living in the southeastern region of the United States. Trained interviewers conducted computer-assisted telephone interviews to obtain information, including participants’ sociodemographic characteristics, cardiovascular risk factors, and use of antihypertensive, antilipidemic, and cholesterol-lowering medications. Following this call, health care professionals conducted an in-home study visit that included an electrocardiography (ECG) recording, a blood pressure reading, height and weight measurements, an inventory of medications, and collection of blood and urine samples. Overall, 30,239 individuals were enrolled between January 2003 and October 2007 (12,700 [41.9%] were black and 16,631 [54.9%] were women). Follow-up was conducted by computer-assisted telephone interviews every 6 months for suspected medical events (or proxy-reported events if participants were unable to respond). The REGARDS study protocol was approved by the institutional review boards governing research in human subjects at the participating centers, and all participants provided informed consent. This study was approved by the University of Alabama at Birmingham Institutional Review Board for Human Use. Written informed consent was obtained from all participants prior to study entry.

**Outcome of Interest**

The outcome of interest was incident CHD events, defined as a composite of definite or probable myocardial infarction or definite or probable CHD death. Medical records were retrieved for suspected CHD events and were reviewed by 2 expert adjudicators to validate potential events using published guidelines as detailed previously. Briefly, for suspected myocardial infarctions, medical records were examined for signs or symptoms of ischemia; a rising and/or falling pattern in cardiac troponin or creatine phosphokinase-MB concentration over 6 or more hours, with a peak concentration greater than twice the upper limit of normal; and ECG changes consistent with ischemia. Definite myocardial infarctions were defined as those with diagnostic enzymes or ECG, and probable myocardial infarctions were defined as those with equivocal diagnostic enzymes with a positive but not diagnostic ECG or, if enzymes were missing, a positive ECG in the presence of ischemic signs or symptoms. Only definite or probable myocardial infarctions were included as CHD events in this study. For fatal events, the medical history, hospital records, interviews with next of kin or proxies, and death certificates or National Death Index data were reviewed to adjudicate the cause of death, with definite or probable CHD death used in this analysis.

**Covariates of Interest**

Age, sex, race, body mass index, waist circumference, smoking history, annual family income, educational attainment, and
use of hormone therapy in women were determined by self-report. Systolic and diastolic blood pressure were defined as the average of 2 seated measures taken after a 5-minute rest. Waist circumference (in centimeters) was measured during the in-home visit using a tape measure positioned midway between the lowest rib and the iliac crest with the participant standing. History of CHD was defined as having evidence of myocardial infarction on the baseline ECG, self-report of a history of a cardiac procedure (eg, coronary artery bypass surgery or percutaneous coronary intervention), or self-reported history of myocardial infarction. Diabetes was defined as self-reported use of insulin or oral hypoglycemic agents, a fasting blood glucose concentration of 126 mg/dL or higher, or a nonfasting blood glucose concentration of 200 mg/dL or higher. Physical activity was assessed through a single question—“How many times per week do you engage in intense physical activity, enough to work up a sweat”—with response options of “none,” “1-3 times per week,” or “4 or more times per week.” Neighborhood socioeconomic characteristics of the census tract where participants lived were defined using a summary score based on 6 variables representing wealth/income, education, and occupation, as previously described:23-24: (1) log of median household income; (2) log of median value of owner-occupied housing units; (3) proportion of households receiving interest, dividend, or net rental income; (4) proportion of adults 25 years and older with a high school diploma; (5) proportion of adults 25 years and older with a college degree; and (6) proportion of people employed in executive, managerial, or professional occupations. Left ventricular hypertrophy was classified using ECG criteria.25 High-sensitivity C-reactive protein concentration was measured by particle-enhanced immunonephelometry (BNII nephelometer; Dade-Behring). Total cholesterol, high-density lipoprotein cholesterol, and triglyceride levels were measured by colorimetric reflectance spectrophotometry. Serum intact parathyroid hormone concentrations were measured using a commercially available enzyme-linked immunosorbent assay (Roche Elecsys 2010; Roche Diagnostics). N-terminal pro-B-type natriuretic peptide (NT-proBNP) level was measured in a subset of participants using an electrochemiluminescence immunoassay (Roche Elecsys 2010). Estimated glomerular filtration rate (eGFR) was determined from isotope dilution mass spectrometry–traceable serum creatinine measurements using the CKD Epidemiology Collaboration equation.26 Urine albumin level measured by the BNII ProSpec nephelometer (Siemens AG) and urine creatinine level measured by the rate Jaffé method (Roche/Hitachi) were used to calculate urine albumin to creatinine ratio (ACR). Chronic kidney disease was defined as an eGFR less than 60 mL/min/1.73 m² or an ACR of 30 mg/g or greater.

**Derivation of Case Cohort**

We used a case-cohort study design.27,28 We included all participants who developed an incident CHD during follow-up through December 31, 2011. The cohort random sample (comparison group) was selected using stratified sampling to ensure sufficient representation of high-risk groups, as described previously.29

**Statistical Analysis**

Descriptive statistics were used to compare participant characteristics within the cohort random sample overall and across quartiles of FGF23 concentration using appropriate weights to account for the stratified sampling design. After confirming the proportionality of hazards, Cox regression models for case-cohort studies were used to estimate the hazard ratio (HR) of incident CHD as a function of baseline FGF23 concentration, adjusting for sociodemographic, clinical, and laboratory factors in sequential models. In all models, FGF23 concentration was analyzed in quartiles, with the lowest quartile serving as the referent group and on a continuous scale after log₂ transformation (interpreted as “per doubling” of FGF23 concentration).

In sensitivity analyses, we examined the association of FGF23 concentration with fatal CHD events and with death from cardiovascular causes (defined as death from definite, probable, or possible myocardial infarction; stroke; sudden death; heart failure; other cardiac; noncardiac but other cardiovascular; or pulmonary embolism) in participants within the random subcohort. In addition, we examined the association of FGF23 concentration with incident CHD after adjusting for NT-proBNP level in the subset of individuals with available data and after adjusting for self-reported use of hormone therapy in women. Further, we compared C statistics of multivariable models without and with FGF23 concentration using the methods described by Pencina and D’Agostino.30 Because prior studies have shown differences in the associations of markers of excess phosphorus levels with CVD outcomes by race, sex, and CKD status,14–18 we examined for effect modification by these variables by testing the statistical significance of a multiplicative interaction term in the models (modeling FGF23 concentration as a categorical variable in quartiles). All P values were 2-tailed, and significance was set at P < .05, except for analyses in which interaction terms were tested where a P value < .10 was considered statistically significant.

**Results**

**Baseline Characteristics of Study Participants**

After excluding 125 participants who had missing FGF23 concentrations and 224 participants who had a history of CHD at the baseline visit, we included a total of 829 participants who developed CHD during follow-up and 812 participants randomly selected from the REGARDS study cohort in the study.

The median (interquartile range) FGF23 concentration in the cohort random sample was 67.9 (51.9-95.8) relative units/mL, similar to what was reported in other US population-based cohorts.2,13 Table 1 depicts the baseline characteristics of participants in the cohort random sample overall and by quartiles of FGF23 concentration. Individuals in higher quartiles of FGF23 concentrations were more likely to be older, female, current smokers, and receiving renin-angiotensin-aldosterone system inhibitors; had lower diastolic blood pressure and eGFR levels; and had higher urine ACR, parathy-

Table 1
Associations of FGF23 Concentration With Incident CHD
Table 2 depicts the HRs of incident CHD by baseline FGF23 concentrations. In models adjusted for race, age, and sex, higher quartiles of FGF23 concentration were associated with higher risk of incident CHD (quartile 1: HR, 1 [reference]; quartile 2: HR, 1.67; 95% CI, 1.19-2.34; quartile 3: HR, 1.90; 95% CI, 1.36-2.67; and quartile 4: HR, 3.79; 95% CI, 2.67-5.39). After additional adjustment for body mass index, systolic blood pressure level, diastolic blood pressure level, diabetes, income, education, physical activity, neighborhood socioeconomic characteristics, cigarette smoking, left ventricular hypertrophy, and use of aspirin, statins, and renin-angiotensin-aldosterone system inhibitors, the magnitude and strength of the associations were modestly attenuated (HR comparing fourth with first quartile, 2.85; 95% CI, 1.89-4.30). After further adjustment for eGFR, log-transformed ACR, high-sensitivity C-reactive protein, parathyroid hormone, triglycerides, high-density lipoprotein cholesterol, and total cholesterol levels, the association was further attenuated but remained statistically significant (HR comparing fourth with first quartile, 2.15; 95% CI, 1.35-3.42). Similarly, when examined on a continuous scale, higher FGF23 concentrations were associated with higher risk of incident CHD (fully adjusted model: HR per doubling of FGF23 concentration, 1.48; 95% CI, 1.20-1.81).

In sensitivity analyses in the subset of participants who had NT-proBNP data available, higher FGF23 concentrations remained associated with higher risk of incident CHD in the fully adjusted model including natural log–transformed NT-proBNP concentrations (HR per doubling of FGF23 concentration, 1.50; 95% CI, 1.21-1.86). The addition of FGF23 concentration to the

<table>
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<tr>
<th>Characteristic</th>
<th>Mean (95% CI) Overall</th>
<th>FGF23 Concentration Quartile 1 (&lt;53 RU/mL)</th>
<th>Quartile 2 (53-70 RU/mL)</th>
<th>Quartile 3 (70-100 RU/mL)</th>
<th>Quartile 4 (&gt;100 RU/mL)</th>
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<td>Participants, weighted No.</td>
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<td>Female, %</td>
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<td>Body mass index*</td>
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<td>28.5 (27.7-29.4)</td>
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<td>Waist circumference, cm</td>
<td>95.2 (93.9-96.4)</td>
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<td>95.1 (92.5-97.6)</td>
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<td>Systolic blood pressure level, mm Hg</td>
<td>126.9 (125.6-128.1)</td>
<td>128.4 (125.4-131.3)</td>
<td>125.6 (123.6-127.7)</td>
<td>126.6 (123.8-129.4)</td>
<td>126.8 (124.4-129.1)</td>
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<td>Diastolic blood pressure level, mm Hg</td>
<td>76.7 (75.9-77.4)</td>
<td>78.1 (76.7-79.5)</td>
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<td>Less than high school education, %</td>
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<td>Current smoking</td>
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<td>Left ventricular hypertrophy</td>
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<td>5.2</td>
<td>5.8</td>
<td>9.6</td>
<td>8.9</td>
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<td>Aspirin</td>
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<td>35.4</td>
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<td>Hormone therapyb</td>
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<td>51.0</td>
<td>56.3</td>
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<td>61.2</td>
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<tr>
<td>eGFR, mL/min/1.73 m²</td>
<td>87.3 (85.8-88.7)</td>
<td>93.8 (91.3-96.3)</td>
<td>89.8 (87.4-92.3)</td>
<td>86.8 (84.0-89.5)</td>
<td>77.4 (74.2-80.6)</td>
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<td>UACR, mg/g</td>
<td>6.9 (4.4-13.8)</td>
<td>6.4 (4.0-12.6)</td>
<td>6.6 (4.2-11.1)</td>
<td>7.3 (5.1-14.8)</td>
<td>8.9 (4.5-20.6)</td>
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<td>HDL-C level, mg/dL</td>
<td>52.6 (51.3-53.9)</td>
<td>53.7 (51.2-56.3)</td>
<td>51.8 (49.3-54.3)</td>
<td>51.6 (48.4-54.8)</td>
<td>53.4 (50.8-55.9)</td>
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<td>Triglyceride concentration, mg/dL</td>
<td>131.1 (125.0-131.7)</td>
<td>116.4 (106.6-126.4)</td>
<td>125.9 (115.7-136.2)</td>
<td>139.9 (126.3-153.6)</td>
<td>144.0 (130.1-157.9)</td>
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<td>Total cholesterol level, mg/dL</td>
<td>192.9 (189.8-196.2)</td>
<td>192.2 (186.1-198.4)</td>
<td>196.1 (190.2-202.1)</td>
<td>193.9 (186.4-201.4)</td>
<td>189.2 (183.1-195.3)</td>
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<td>Serum parathyroid hormone level, pg/mL</td>
<td>45.7 (43.9-47.4)</td>
<td>40.3 (37.9-42.8)</td>
<td>45.5 (42.7-48.3)</td>
<td>49.9 (46.2-53.7)</td>
<td>47.2 (42.4-52.1)</td>
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<td>C-reactive protein level, mg/L</td>
<td>2.1 (0.9-4.7)</td>
<td>1.7 (0.7-3.8)</td>
<td>1.8 (0.9-3.7)</td>
<td>2.6 (1.1-5.4)</td>
<td>2.7 (1.1-5.5)</td>
</tr>
</tbody>
</table>

Abbreviations: eGFR, estimated glomerular filtration rate; HDL-C, high-density lipoprotein cholesterol; RAAS, renin-angiotensin-aldosterone system; RU, relative unit; UACR, urine albumin to creatinine ratio.

* Body mass index calculated as weight in kilograms divided by height in meters squared.

b Only in women in the random cohort with available data (weighted n = 12 941).
The association of FGF23 concentration with risk of incident CHD became apparent when further adjusting for hormone therapy use (model 4; HR comparing fourth with first quartile, 2.40; 95% CI, 1.30-4.42). However, among women with available data on hormone therapy, an association between higher FGF23 concentration and incident CHD became apparent when further adjusting for hormone therapy use (model 4; HR comparing fourth with first quartile, 2.48; 95% CI, 1.96-3.16). To further explore this, we stratified by hormone therapy use in women (eTable 3 in the Supplement) and found a significant association between baseline FGF23 concentration and risk of incident CHD in the fully adjusted model in women who did not report hormone therapy use (HR comparing fourth with first quartile, 1.25; 95% CI, 1.04-1.50). However, among women with available data on hormone therapy, adjusting the association between higher FGF23 concentration and incident CHD became apparent when further adjusting for hormone therapy use (model 4; HR comparing fourth with first quartile, 1.44; 95% CI, 1.08-1.91). To further explore this, we stratified by hormone therapy use in women (eTable 3 in the Supplement) and found a significant association between baseline FGF23 concentration and risk of incident CHD in the fully adjusted model in women who did not report hormone therapy use (HR comparing fourth with first quartile, 1.48; 95% CI, 1.11-1.97).

The magnitude and strength of the association between FGF23 concentration and incident CHD was greater in men than in women (men: HR comparing fourth with first quartile, 2.40; 95% CI, 1.30-4.42; women: HR, 1.51; 95% CI, 0.79-2.86). However, among women with available data on hormone therapy, an association between higher FGF23 concentration and incident CHD became apparent when further adjusting for hormone therapy use (model 4; HR comparing fourth with first quartile, 2.48; 95% CI, 1.96-3.16). To further explore this, we stratified by hormone therapy use in women (eTable 3 in the Supplement) and found a significant association between baseline FGF23 concentration and risk of incident CHD in the fully adjusted model in women who did not report hormone therapy use (HR comparing fourth with first quartile, 1.48; 95% CI, 1.11-1.97).

Because the distribution of FGF23 concentration differed by sex (eFigures 1 and 2 in the Supplement), we also examined the association of FGF23 concentration with incident CHD using sex-specific quartiles (Table 4). When using sex-specific quartiles, the association between FGF23 concentration and incident CHD became apparent when further adjusting for hormone therapy use (model 4; HR comparing fourth with first quartile, 2.48; 95% CI, 1.96-3.16). To further explore this, we stratified by hormone therapy use in women (eTable 3 in the Supplement) and found a significant association between baseline FGF23 concentration and risk of incident CHD in the fully adjusted model in women who did not report hormone therapy use (HR comparing fourth with first quartile, 1.48; 95% CI, 1.11-1.97).
specific quartiles, baseline FGF23 concentrations were associated with increased risk of CHD events in both men (HR comparing fourth with first quartile, 2.65; 95% CI, 1.43-4.90) and women (HR comparing fourth with first quartile, 2.26; 95% CI, 1.02-5.03) in fully adjusted models.

In sensitivity analyses, sex modified the association of FGF23 concentration with fatal CHD events and the association of FGF23 concentration with cardiovascular deaths (eTables 4 and 5 in the Supplement). However, similar to our main observation with CHD events, when the main models were further adjusted for self-reported use of hormone therapy in women, the sex-related differences in outcomes between men and women were largely attenuated.

**Discussion**

In participants of the REGARDS study, higher concentrations of FGF23 were associated with a greater risk of developing CHD independently of established risk factors. We also observed differences in this association by sex, which were attenuated when using sex-specific quartiles of FGF23 concentration or after adjusting for hormone therapy use in women.

The relationship between higher FGF23 concentration and risk of mortality among individuals with kidney disease and community-living adults is well established. Fibroblast growth factor 23 concentration has also been independently associated with increased risk of CVD events related to heart failure in both CKD and non-CKD populations. Evidence supporting an association between FGF23 concentration and atherosclerotic CVD, such as ischemic heart disease, has been less consistent, with some studies showing no association and others showing one. The inconsistency in these findings may be caused by differences in the study cohorts. The studies that did not find an association between FGF23 concentration and CHD had key limitations, such as exclusively studying older adults, studying recurrent as opposed to incident CHD events, and/or having limited representation of nonwhite populations. In contrast, the Atherosclerosis Risk in Communities and the Multiethnic Study of Atherosclerosis cohorts, like the REGARDS study cohort, included community-dwelling adults who were relatively similar in age at the time of the baseline visit, had a large proportion of black individuals, and had equal representation of men and women.

We observed that sex heterogeneity in the association of FGF23 concentration with incident CHD events was no longer observed following adjustment for hormone therapy in women. The association of higher serum phosphorus concentrations with increased risk of CVD and death has also been shown to differ by sex, being stronger and more consistent in men than in women.

These findings have been attributed to the rise in serum phosphorus concentrations because of declining estrogen concentrations among postmenopausal women, blunting the ability to detect an association of serum phosphorus concentration with CVD events in older women. Notably, the association of serum phosphorus concentration with left ventricular mass differed by hormone therapy use in female participants of the Heart and Soul Study—an inverse association was noted in women who were not receiving hormone therapy but not in those who were. Similarly, in the current study, higher FGF23 concentration was associated with incident CHD in women who did not report using hormone therapy but not those who did. Collectively, these data suggest that accounting for hormone therapy use is critical for interpreting the association.
of biomarkers of phosphorus metabolism with heart disease in older women.

We also found that using sex-specific quartiles of FGF23 concentration reduced heterogeneity in the association of FGF23 concentration with incident CHD by sex. To our knowledge, only 2 other studies2,11 using general population-based cohorts have examined the association of FGF23 concentration with incident CHD using the same assay (C-terminal FGF23 assay) as used in the current study. Ix et al3 found no association of FGF23 concentration with incident CHD in multivariable-adjusted models in the Cardiovascular Health Study but did not report whether effect modification by sex was examined. In contrast, di Giuseppe et al11 found an independent association of FGF23 concentration with incident CHD, which was not modified by sex in the European Prospective Investigation of Cancer–Germany cohort. Importantly, neither of these studies used sex-specific quartiles of FGF23 concentration. It is also worth noting that neither the Atherosclerosis Risk in Communities4 nor Multiethnic Study of Atherosclerosis5 cohorts (which more closely mirror the cohort characteristics of the REGARDS study) observed differences in the association of FGF23 concentration with incident CHD by sex.3,4 Interestingly, however, these latter studies used an FGF23 assay that exclusively measured the intact peptide concentration in contrast to the current study, which used an assay that detects both the intact peptide concentration and C-terminal fragments. The intact FGF23 peptide concentration is the biologically active compound and is cleaved into N-terminal and C-terminal circulating fragments of unclear physiological significance. This is important because although our study and others2,11,35 showed that C-terminal FGF23 concentrations are higher in women than men, intact FGF23 concentrations do not differ substantially by sex.1,4 The reasons for this are unclear but may be caused by sex differences in the posttranslational handling of FGF23. A number of processes have been shown to influence the proteolytic cleavage of the intact FGF23 peptide, including iron deficiency and hypoxia, which upregulate the proteolysis of intact FGF23 into N-terminal and C-terminal fragments.16 Because iron deficiency is more prevalent in women than in men, another potential explanation for the observed sex heterogeneity is that higher C-terminal FGF23 concentrations in women reflect physiological processes more strongly related to iron deficiency than cardiovascular risk, blunting potential associations of C-terminal FGF23 concentrations with CHD risk in women compared with men when using nonsex-specific quartiles.

Limitations

Our study has limitations. Because of the observational nature of our study, we cannot draw causal inferences with respect to the relationship between FGF23 concentration and CHD events. Serum phosphorus and calcium levels were not available in patients with CHD, so we could not adjust for these covariates. Nonetheless, prior studies3,4 showed that the association of FGF23 concentration with incident CHD was robust to adjustment for phosphorus and calcium levels. Moreover, because data were not available on contemporary cardiovascular markers, such as high-sensitivity troponins, we could not account for these in our analysis. Finally, results from our study may not be applicable to other racial or ethnic groups, such as Asian, Hispanic, and other minority populations.

Conclusions

The results of this study support an association of FGF23 concentration with incident CHD among community-living adults and suggest that sex hormone use and differences in the distribution of FGF23 by sex may be important to consider when assessing the relationship between FGF23 concentration and CHD in older adults.
Fibroblast Growth Factor 23 and Risk of Coronary Heart Disease in Community-Living Adults

Original Investigation Research

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