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Chest Pain, Atherosclerotic Cardiovascular Disease Risk, and Cardiology Referral in Primary Care

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Abstract

Background: The atherosclerotic cardiovascular disease (ASCVD) 10-year risk estimate is recommended by cardiologists for determining risk of a cardiac event. However, the majority of patients presenting to primary care with chest pain have noncardiac etiologies. Therefore, we determined if high versus low ASCVD risk was associated with primary care physicians' referral to cardiology in patients with and without chest pain. **Methods:** Deidentified electronic health record (EHR) data was obtained from 5795 patients treated in academic primary care clinics from 2008 to 2015. Referral to cardiology was defined by an EHR code, chest pain was defined by ICD-9-CM code (786.5) and ASCVD was modeled as high versus low risk. Separate logistic regression models were computed to estimate the association between chest pain and referral to cardiology, ASCVD risk and referral, and both chest pain and ASCVD risk and referral with adjustment for potential confounding factors. **Results:** More patients with (n = 95, 7.8%) versus without (n = 75, 2.0%) chest pain were referred to cardiology ($P < .0001$). Separate unadjusted models revealed chest pain and high versus low ASCVD risk were significantly associated with referral (odds ratio [OR] = 4.20; 95% confidence interval [CI] 3.07-5.73 and OR = 1.41; 95% CI 1.04-1.91, respectively). After adjusting for ASCVD risk and confounders, chest pain but not high ASCVD risk remained significantly associated with referral (OR = 1.75; 95% CI 1.24-2.47 and OR = 1.15; 95% CI 0.72-1.82, respectively). **Conclusions:** In primary care patients presenting with chest pain, ASCVD risk scores are not associated with referral to cardiology. Overall, less than 8% of patients with chest pain were referred. While there is no evidence to indicate excessive referral to cardiology, we posit that implementing ASCVD risk tools in decision aids could contribute to referring those most in need of cardiology care.

Keywords

cardiology, chest pain, retrospective cohort, epidemiology

Introduction

Chest pain accounts for 1% of all primary care visits[1] and for the majority (>97%) of patients these presentations are for noncardiac chest pain (NCCP) etiologies.[2] Chest pain in primary care is often due to gastroesophageal reflux,[1] anxiety, depression, musculoskeletal pain, and other noncardiac etiologies.[2,3]

Although per patient costs of NCCP are lower than those of patients with ischemic heart disease, costs of diagnostic testing (occurring in 83% of patients with chest pain),[4] the high prevalence of NCCP, and absenteeism associated with the diagnosis contribute to costs that exceed those associated with cardiac chest pain.[5] Health care burden could be reduced by limiting testing for cardiovascular disease to those patients at greatest risk. The American College of Cardiology/American Heart Association (ACC/AHA) guideline on assessment of cardiovascular risk advocates for the use of the ASCVD (atherosclerotic cardiovascular disease) 10-year risk estimate to determine which individuals are at a quantifiable risk of a cardiac event. A risk percentage greater than 7.5% is considered high risk.[6,7] Whether to implement the ASCVD risk tool or use other clinical prediction rules in primary care continues to be debated.[2,8]

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It is not known if the elements of the ASCVD risk tool contribute to primary care physician decisions to refer patients with chest pain to cardiology specialists in real-world academic primary care practice. Therefore, we used a retrospective cohort design to determine if this risk, chest pain or both were associated with likelihood of cardiology referral before and after adjusting for covariates in a large sample of patients seen in academic family medicine and general internal medicine settings.

Methods

Subjects

Data were obtained from the Primary Care Patient Data (PCPD) Registry from a medical school located in the Midwest. The PCPD captures electronic health record (EHR) data generated from patient visits between July 1, 2008 and June 30, 2015 to any 1 of 3 family medicine and 3 general internal medicine clinics located in urban and suburban areas of eastern Missouri. The PCPD Registry contains deidentified medical data on 33 661 patients, including International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes, laboratory results, referral codes, medication orders, vital signs and limited demographics, and has been used in several prior studies of cardiovascular disease.[9-11] The creation of the PCPD for primary care research was approved by the medical school's institutional review board.

Eligibility

Eligibility criteria were designed to calculate 10-year ASCVD risk per the 2013 ACC/AHA guidelines,[6] for patients 40 to 79 years of age, free of ASCVD, and with an low-density lipoprotein (LDL) <190 mg/dL. The sample was restricted to age 40 to 79 years (n = 17 381) and limited to patients with complete demographic data, leaving 16 977 eligible patients (Figure 1). To permit measurement of comorbidities and laboratory results prior to a cardiology referral, we limited the cohort to patients with 2 or more visits during the observation period (n = 13 906). Patients with a cardiology referral on their first encounter in primary care were excluded (n = 132). Patients had to be free of ASCVD diagnosis (ICD-9-CM codes: 410.x, 412.x, 413.x, 414.x, 433.x, 435.x, 436.x, 440.x, 441.x, 437.0, 437.1, 443.9) prior to cardiology referral date or last visit date, if not referred. (n = 12 464). Patients were excluded if they had no metabolic laboratory results (n = 6398) or had an LDL ≥190 mg/dL in the follow-up period (n = 147). Patients without body mass index (BMI) data at time of referral or before end of follow-up were also excluded (n = 124) resulting in a final sample size of 5795 patients.

Outcome Variable

Referral to cardiology was defined by an EHR-specific referral code.

Predictor Variables

Chest pain was defined by ICD-9-CM code 786.5.

The ASCVD pooled cohort risk equations (PCRE),[6] developed by the ACC/AHA Task Force on Practice Guidelines, were used to calculate 10-year ASCVD risk.[6] The 10-year ASCVD risk is applicable to patients without known coronary disease, documented LDL <190 mg/dL and ages 40 to 79 years. The PCRE are race- and gender-specific equations using: age (years), total cholesterol (mg/dL), high-density lipoprotein cholesterol (HDL; mg/dL), systolic blood pressure (mm Hg), hypertension treatment (yes/no indicated by a prescription for an antihypertensive), diabetes (type 1 or type 2 diagnosis), and self-reported smoking status (yes/no). Total cholesterol, HDL, and systolic blood pressure were the last available laboratory values before cardiology referral date or last visit date if there was no referral in the observation period. Diabetes and hypertension treatment had to occur before end of observation. A 10-year ASCVD score of ≥ 7.5 is high risk and < 7.5 is low risk.[7]

Covariates

We selected covariates that occurred before the end of follow-up if they were theoretically potential confounders of the association between ASCVD risk, chest pain and cardiology referral. Covariates included ICD-9-CM codes for hypertension, diabetes (type 1 or 2), hyperlipidemia, BMI on or closest to before follow-up end date, last available diastolic blood pressure and LDL before end date (the latter 2 variables were used only in descriptive analysis), statin medications, either prescribed by a primary care provider or on the medication history list (the latter indicating they were prescribed elsewhere), and an order for cardiac testing from the primary care physician. Cardiac testing orders included Current Procedural Terminology (CPT) codes for electrocardiography, cardiac monitoring, stress tests, arterial and venous Doppler studies, or cardiac echocardiography.

Demographics included gender, race (African American vs other), marital status (married/partnered vs other) and neighborhood socioeconomic status (nSES). The nSES variable links patient zip code to United States census information on poverty, public assistance, unemployment, household income, and similar data elements[12] and is associated with type of treatments received in this primary care database.[13] The score was quartiled into lower, lower middle, upper middle, and high nSES.

We adjusted for volume of clinic utilization to control for detection bias by computing the distribution of the average number of clinic visits per month. We created quartiles from the distribution and modeled the top 25th percentile as high health care utilization versus the bottom 75th percentile.

Analytic Approach

All analyses were conducted using SAS v9.4 (SAS Institute, Cary, NC). Patients were followed from their first visit in the observation period to the end date defined as either date of

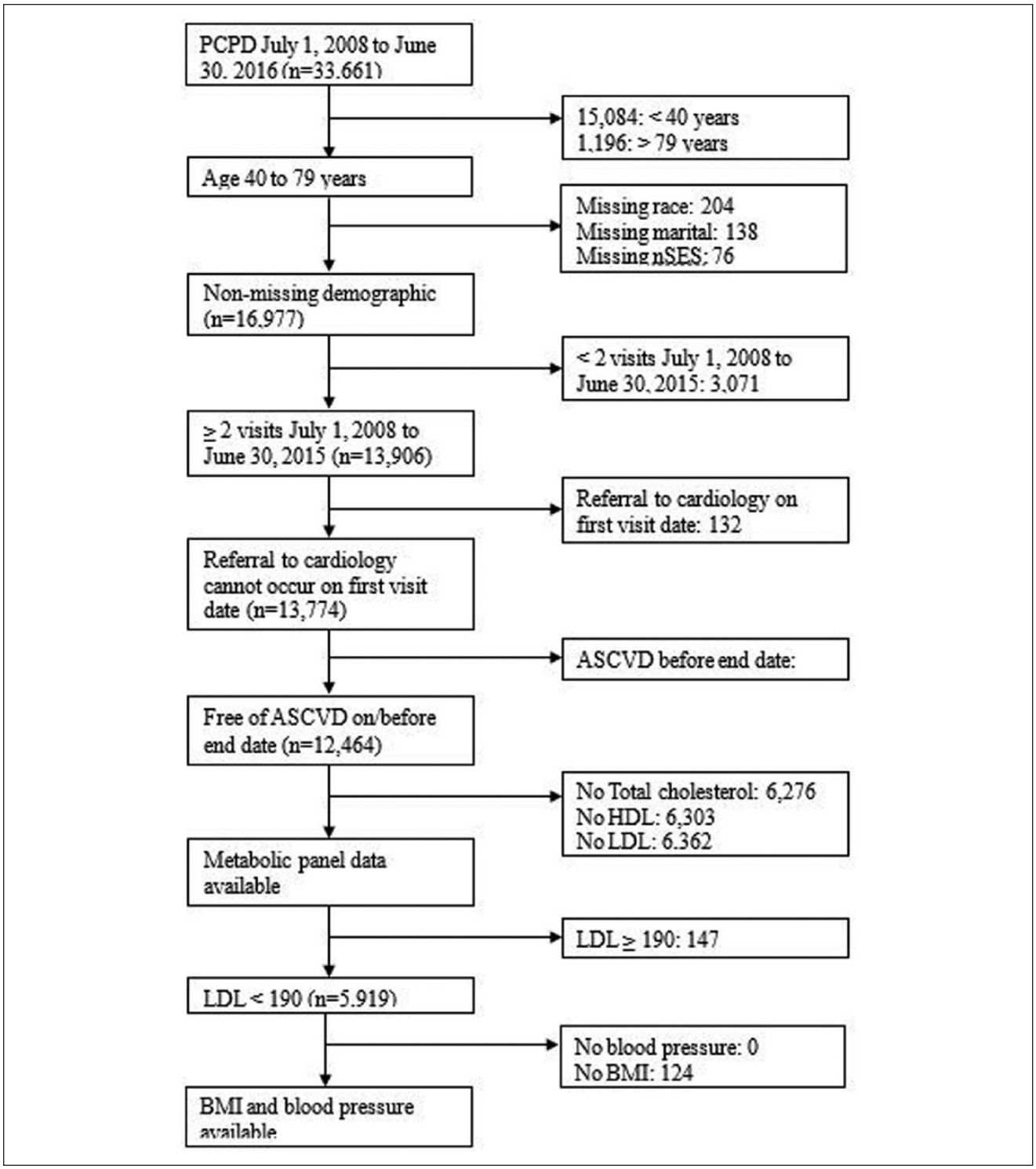

Figure 1. Eligibility criteria.

cardiology referral or, if not referred, the last recorded visit date. The distribution of sociodemographics, comorbidities, laboratory values, and referral to cardiology were assessed separately by chest pain and high versus low ASCVD risk. The distribution of chest pain, ASCVD risk and covariates was also assessed by referral to cardiology. Measures of association were computed using chi-square tests for categorical variables and independent-samples *t* tests for continuous variables. Separate bivariate logistic regression models first evaluated the unadjusted associations (odds ratios [ORs] and

95% confidence intervals [CIs]) of chest pain and ASCVD risk on cardiology referral. A third model calculated the independent contributions of chest pain and ASCVD risk on cardiology referral. A final, fully adjusted model included chest pain, ASCVD risk, sociodemographics, BMI, hypertension, hyperlipidemia, and statin treatment.

Sensitivity Analysis

Because the ASCVD risk tool was published in 2013, it was not available to physicians during the first half of our observation period. Therefore, we conducted sensitivity analysis by replacing ASCVD with the Framingham risk score.[14] We defined Framingham risk score as low (≤10%), medium (>10% to ≤20%), and high (>20%). The reference group was low risk. Regression models estimated the association of Framingham risk and chest pain with cardiology referral before and after adjusting for all covariates.

Results

As shown in Table 1, the sample was 40.8% African American, 38.6% male, and relatively young (mean age 56.7 years, SD 9.7 years). Less than 2.0% (n = 966) had an encounter for chest pain, and among these patients, 7.8% were referred to cardiology versus 2.0% of patients without chest pain ($P < .0001$). Older age ($P = .026$) and African American race ($P = .007$) were positively associated with chest pain. Males were less likely to have chest pain encounters ($P < .001$). Patients with high clinic utilization ($P < .0001$), higher BMI ($P < .0004$), hypertension ($P = .0004$), hyperlipidemia ($P < .0001$), lower mean HDL ($P < .0001$), statin prescriptions ($P < .019$), antihypertensive prescriptions ($P < .0001$), cardiac testing orders ($P < .0001$), and high ASCVD risk ($P = .025$) were more prevalent in patients with chest pain.

As shown in Table 2, referral to cardiology was significantly more common among patients with high ASCVD risk (3.5% vs 2.5%, $P = .028$). Older age, African American race, and male gender were significantly more common among patients with high ASCVD risk while being married and having a higher nSES were significantly less common among patients with high ASCVD risk. High clinic utilization, higher mean BMI, hypertension, hyperlipidemia, statin treatment, and receipt of cardiac testing orders were significantly more prevalent among patients with high ASCVD risk ($P < .0001$).

Figure 2 shows the percent referred to cardiology by chest pain and ASCVD risk group. Patients with chest pain versus without were significantly more likely to be referred ($P < .0001$). ASCVD risk was not significantly associated with referral in patients with and without chest pain.

Bivariate associations between patient characteristics and referral to cardiology are shown in Table 3. Older average age was positively associated with referral ($P = .029$) and male gender was less prevalent among referrals ($P = .019$). High clinic utilization ($P < .0001$), greater mean BMI ($P < .0001$), diabetes ($P = .009$), hypertension ($P = .11$), greater mean diastolic blood pressure ($P = .022$), antihypertensive medication ($P < .0001$), cardiac testing orders from the primary care physician ($P < .0001$) and high ASCVD risk ($P = .013$) were significantly more prevalent in patients referred.

Results from logistic regression models are shown in Table 4. Chest pain alone was markedly associated with cardiology referral (OR = 4.20; 95%CI 3.07-5.73) and remained significant when controlling for ASCVD risk. High versus low ASCVD risk alone was significantly associated with referral (OR = 1.41; 95% CI 1.04-1.91), but this association was not significant when chest pain and ASCVD risk were modeled together (see model 3). In the full model (model 4), chest pain remained significantly associated with cardiology referral (OR = 1.75; 95% CI 1.24-2.47) but not ASCVD risk (OR = 1.15; 95% CI 0.72-1.82).

Logistic regression models computed for sensitivity analysis revealed chest pain alone and high Framingham risk versus low risk score alone were significantly associated with referral (OR = 4.22; 95% CI 3.09-5.77 and OR = 1.56; 95% CI 1.07-2.30, respectively). Medium Framingham risk score was not significant. In the fully adjusted model, chest pain remained significantly associated with referral to cardiology and Framingham high risk was no longer significant (OR = 1.34; 95% CI, 0.75-2.40).

Discussion

In a cohort of nearly 6000 primary care patients, results from fully adjusted models revealed that chest pain, but not high ASCVD risk, was significantly associated with referral to cardiology. Results from fully adjusted models revealed orders for cardiac testing, BMI and high clinic utilization were significantly associated with referral. For patients presenting with chest pain in primary care, there was no statistically significant association between ASCVD risk and referral to cardiology (OR = 1.15; 95% CI 0.72-1.82) after adjusting for all covariates.

Our results suggest the presence of chest pain drives decisions about referral, but this may be attributed to patient behavior. Patients may ask for referral even when the provider believes there is little evidence to support this decision. Another possibility is that the 15-minute primary care visit limits time for thoughtful shared decision making about the source of chest pain symptoms. Last, low-risk patients may be referred as a means of ruling out a cardiac event.

Our findings are partly consistent with previous studies on referral to cardiology. In a large claims database, only a quarter of patients referred were confirmed to have ischemic chest pain,[15] which suggests most referrals for chest pain are not for patients at risk for near-term cardiac events. In a sample of

Table 1. Sociodemographic, ASCVD PCRE Risk Factors, and Other Health-Related Characteristics of 5795 Primary Care Patients Aged 40 to 79 Years Free of ASCVD and LDL<190 mg/dL, Overall and by Presence or Absence of Chest Pain (July 1, 2008 to June 30, 2015).

	Overall (n = 5795)	No Chest Pain (n = 4829)	Chest Pain (n = 966)	*P*
Referral to cardiology, n (%)	170 (2.9)	95 (2.0)	75 (7.8)	<.0001
Sociodemographics				
Age, years, mean (SD)[a]	56.7 (9.7)	56.6 (9.8)	57.3 (9.4)	.026
African American race,[a] n (%)	2365 (40.8)	1933 (40.0)	432 (44.7)	.007
Male gender,[a] n (%)	2239 (38.6)	1912 (39.6)	327 (33.9)	.001
Married, n (%)	3064 (52.9)	2567 (53.2)	497 (51.4)	.331
nSES, n (%)				
Lowest	1551 (26.7)	1281 (26.5)	270 (27.9)	
Lower middle	1251 (21.6)	1038 (21.5)	213 (22.1)	.721
Upper middle	1465 (25.3)	1229 (25.5)	236 (24.4)	
Highest	1528 (26.4)	1281 (26.5)	247 (25.6)	
Health-related characteristics				
High clinic utilization, n (%)	2366 (40.8)	1808 (37.4)	558 (57.8)	<.0001
BMI, kg/m^2, mean (SD)	31.5 (7.8)	31.3 (7.8)	32.3 (7.8)	.0004
Smoker,[a] n (%)	1215 (21.0)	996 (20.6)	219 (22.7)	.154
Diabetes (type 1 or 2),[a] n (%)	1147 (19.8)	935 (19.4)	212 (21.9)	.066
Hypertension, n (%)	3195 (55.1)	2612 (54.1)	583 (60.4)	.0004
Hyperlipidemia, n (%)	2711 (46.8)	2204 (45.6)	507 (52.5)	<.0001
Total cholesterol, mg/dL,[a] mean (SD)	191.5 (34.9)	191.5 (34.7)	191.6 (189.4)	.966
HDL, mg/dL,[a] mean (SD)	54.5 (15.8)	54.9 (15.9)	52.7 (15.0)	.0001
LDL, mg/dL, mean (SD)	112.08 (31.0)	111.9 (30.9)	113.2 (31.2)	.228
Systolic BP, mm Hg,[a] mean (SD)	126.5 (15.5)	126.5 (15.6)	126.4 (15.3)	.963
Diastolic BP, mm Hg, mean (SD)	78.2 (9.9)	78.2 (9.9)	78.2 (10.0)	.825
Antihypertensives,[a] n (%)	3382 (58.4)	2744 (56.8)	638 (66.1)	<.0001
Statin treatment, n (%)	1691 (29.2)	1379 (28.6)	312 (32.3)	.019
Cardiac testing order, n (%)	1693 (29.2)	989 (20.5)	704 (72.9)	<.0001
ASCVD 10-year risk, mean (SD)	10.3 (10.6)	10.2 (10.6)	10.8 (10.7)	.098
ASCVD 10-year risk ≥7.5% (high), n (%)	2725 (47.0)	2239 (46.4)	486 (50.3)	.025

Abbreviations: ASCVD, atherosclerotic vascular disease; nSES, neighborhood socioeconomic status (lowest, 25th percentile; lower middle, 26th to 50th percentile; upper middle, 51st to 75th percentile; highest, >75th percentile; PCRE, pooled cohort risk equation; BMI, body mass index; BP, blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein.
[a] Risk factors for ASCVD PCRE.

807 primary care patients presenting with non-specific chest pain in German primary care practices, 14.5% eventually had a cardiology encounter, though not necessarily following a primary care referral.[16] In comparison to these prior studies, the percent referred to cardiology in our sample is low (2.5% for patients with low ASCVD risk and 3.5% among patients with high ASCVD risk). Although the ASCVD tool may not influence referral to cardiology for patients with chest pain in primary care, in a previous study of the risk tool in our primary care patient data registry, ASCVD risk score was associated with an increase in the appropriate use of statins and a reduction of undertreatment of high-risk patients.[10]

Limitations

We did not have information on referrals to the emergency department (ED) and our results do not apply to patients with chest pain referred to the ED. The database is limited to one geographic region and academic primary care clinics; therefore, results may not generalize to other parts of the country or to private practice settings. We lacked measures of other symptoms such as shortness of breath but most are unlikely to reliably distinguish cardiac vs. non-cardiac chest pain.[17] Missing metabolic laboratory results could lead to misclassification of ASCVD risk and would confound our results if missing was associated with cardiology referral; however, we found no significant association between missing metabolic panels and referral to cardiology ($P = .30$; data not shown). Additionally, our observation period was 2008-2015 and therefore our analysis included years prior to the 2013 publication of the ASCVD risk tool. However, sensitivity analysis revealed the Framingham risk score, available throughout the observation period, was also not associated with referral after adjusting for chest pain

Table 2. Sociodemographic, ASCVD PCRE Risk Factors, and Other Health-Related Characteristics of 5795 Primary Care Patients Aged 40 to 79 Years Free of ASCVD and LDL <190 mg/dL, by ASCVD Risk (July 1, 2008 to June 30, 2015).

	ASCVD Risk <7.5% (n = 3070)	ASCVD Risk ≥7.5% (n = 2725)	*P*
Referral to cardiology, n (%)	76 (2.5)	94 (3.5)	.028
Sociodemographics			
Age, years, mean (SD)[a]	50.9 (7.1)	63.2 (8.1)	<.0001
African American race,[a] n (%)	972 (31.7)	1393 (51.1)	<.0001
Male gender,[a] n (%)	852 (27.8)	1387 (50.9)	<.0001
Married, n (%)	1772 (57.7)	1292 (47.4)	<.0001
nSES, n (%)			
Lowest	635 (20.7)	916 (33.6)	
Lower middle	599 (19.5)	652 (23.9)	<.0001
Upper middle	842 (27.4)	623 (22.9)	
Highest	994 (32.4)	534 (19.6)	
Health-related characteristics			
High clinic utilization, n (%)	976 (31.8)	1390 (51.0)	<.0001
BMI, kg/m^2, mean (SD)	31.1 (8.1)	31.9 (7.5)	<.0001
Smoker,[a] n (%)	362 (11.8)	853 (31.3)	<.0001
Diabetes (type 1 or 2),[a] n (%)	187 (6.1)	960 (35.2)	<.0001
Hypertension, n (%)	1084 (35.3)	2111 (77.5)	<.0001
Hyperlipidemia, n (%)	998 (32.5)	1713 (62.9)	<.0001
Total cholesterol, mg/dL,[a] mean (SD)	192.1 (34.1)	191.0 (35.7)	.167
HDL, mg/dL,[a] mean (SD)	57.6 (15.8)	51.0 (15.1)	<.0001
LDL, mg/dL, mean (SD)	111.5 (30.1)	112.7 (31.9)	.135
Systolic BP, mm Hg,[a] mean (SD)	121.0 (13.0)	132.6 (15.9)	<.0001
Diastolic BP, mm Hg, mean (SD)	77.3 (9.4)	79.3 (10.3)	<.0001
Antihypertensives,[a] n (%)	1188 (38.7)	2194 (80.5)	<.0001
Statin treatment, n (%)	477 (15.5)	1214 (44.6)	<.0001
Cardiac testing order, n (%)	778 (25.3)	915 (33.6)	<.0001
ASCVD 10-year risk, mean (SD)	3.1 (2.1)	18.4 (10.4)	<.0001

Abbreviations: ASCVD, atherosclerotic vascular disease; nSES, neighborhood socioeconomic status (lowest, 25th percentile; lower middle, 26th to 50th percentile; upper middle, 51st to 75th percentile; highest, >75th percentile; PCRE, pooled cohort risk equation; BMI, body mass index; BP, blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein.
[a] Risk factors for ASCVD PCRE.

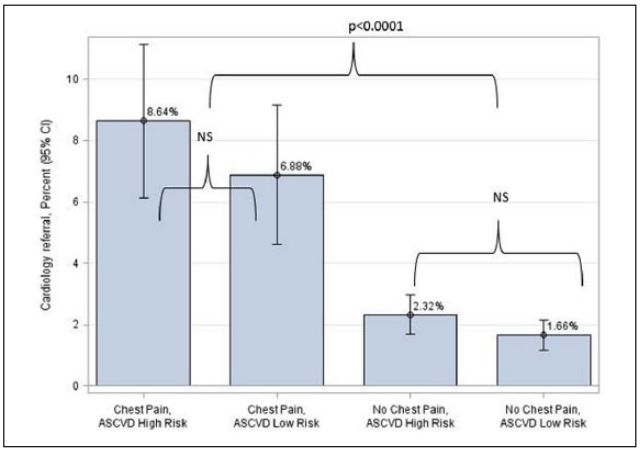

Figure 2. Percent referred to cardiology by atherosclerotic vascular disease (ASCVD) risk and presence of chest pain (n = 5795).

and covariates. The binary high versus low 10-year ASCVD score may be too broad and very high risk scores could have contributed to referral. Therefore, we conducted post hoc analysis and computed the percent referred to cardiology among the following ASCVD categories: (A) <2.5, (B) 2.5 to <5, (C) 5 to <7.5, (D) 7.5 to <10, (E) 10 to <15, (F) 15 to <20, and (G) >20. The percent referred from each category was (A) 13.3%, (B) 14.7%, (C) 16.0%, (D) 21.3%, (E) 14.7%, (F) 5.3%, and (G) 14.7%. This suggests similar referral rates at the lowest and highest ASCVD risk and further supports the conclusion that decisions to refer patients to cardiology are not associated with ASCVD score. In addition, among the subset of 143 patients referred to cardiology with available follow-up time after referral, we observed 16.7% of patients at high ASCVD risk with chest pain had an ASCVD event and 12.5% of those with high ASCVD risk without chest pain had an event. No events

Table 3. Sociodemographic, ASCVD PCRE Risk Factors, and Other Health-Related Characteristics of 5795 Primary Care Patients Aged 40 to 79 Years Free of ASCVD and LDL<190 mg/dL, by Cardiology Referral (July 1, 2008 to June 30, 2015).

	No Cardiology Referral (n = 5625)	Cardio Referral (n = 170)	*P*
Sociodemographics			
Age, years, mean (SD)[a]	56.6 (9.7)	58.3 (9.1)	.029
African American race,[a] n (%)	2286 (40.6)	79 (46.5)	.128
Male gender,[a] n (%)	2188 (38.9)	51 (30.0)	.019
Married, n (%)	2982 (53.0)	82 (48.2)	.219
nSES, n (%)			
Lowest	1502 (26.7)	49 (28.8)	
Lower middle	1217 (21.6)	34 (20.0)	.900
Upper middle	1421 (25.3)	44 (25.9)	
Highest	1485 (26.4)	43 (25.3)	
Health-related characteristics			
High clinic utilization, n (%)	2256 (40.1)	110 (64.7)	<.0001
BMI, kg/m^2, mean (SD)	31.4 (7.7)	34.7 (9.7)	<.0001
Smoker,[a] n (%)	1174 (20.9)	41 (24.1)	.306
Diabetes (type 1 or 2),[a] n (%)	1100 (19.6)	47 (27.7)	.009
Hypertension, n (%)	3085 (54.8)	110 (64.7)	.011
Hyperlipidemia, n (%)	2620 (46.6)	91 (53.5)	.074
Total cholesterol, mg/dL,[a] mean (SD)	191.6 (34.8)	191.3 (37.5)	.932
HDL, mg/dL,[a] mean (SD)	54.5 (15.8)	53.5 (16.1)	.422
LDL, mg/dL, mean (SD)	112.1 (30.9)	111.9 (34.3)	.955
Systolic BP, mm Hg,[a] mean (SD)	126.4 (15.4)	128.7 (19.1)	.060
Diastolic BP, mm Hg, mean (SD)	78.2 (9.9)	79.9 (10.3)	.022
Antihypertensives,[a] n (%)	3254 (57.8)	128 (75.3)	<.0001
Statin treatment, n (%)	1632 (29.0)	59 (34.7)	.108
Cardiac testing order, n (%)	1566 (27.8)	127 (74.7)	<.0001
ASCVD 10-year risk, mean (SD)	10.2 (10.6)	12.3 (12.2)	.013

Abbreviations: ASCVD, atherosclerotic vascular disease; nSES, neighborhood socioeconomic status (lowest, 25th percentile; lower middle, 26th to 50th percentile; upper middle, 51st to 75th percentile; highest, >75th percentile; PCRE, pooled cohort risk equation; BMI, body mass index; BP, blood pressure; LDL, low-density lipoprotein; HDL, high-density lipoprotein.
[a] Risk factors for ASCVD PCRE.

Table 4. Logistic Regression Models[a] Estimating the Association of Chest Pain and ASCVD Risk With Referral to Cardiology in 5795 Primary Care Patients Aged 40 to 79 Years Free of ASCVD and LDL <190 mg/dL (July 1, 2008 to June 30, 2015).

	Model 1; OR (95% CI)	Model 2; OR (95% CI)	Model 3; OR (95% CI)	Model 4; OR (95% CI)
Chest pain	4.20 (3.07-5.73)		4.15 (3.4-5.67)	1.75 (1.24-2.47)
ASCVD 10-year risk ≥7.5% (high)		1.41 (1.04-1.91)	1.35 (0.99-1.84)	1.15 (0.72-1.82)
Age				1.01 (0.98-1.03)
African American race				0.98 (0.66-1.45)
Male gender				0.81 (0.56-1.17)
Married				0.98 (0.69-1.37)
nSES				
Lowest				1.00
Lower middle				0.96 (0.60-1.53)
Upper middle				1.13 (0.71-1.80)
Highest				1.10 (0.66-1.83)

(continued)

Table 4. (continued)

	Model 1; OR (95% CI)	Model 2; OR (95% CI)	Model 3; OR (95% CI)	Model 4; OR (95% CI)
High clinic utilization				1.72 (1.22-2.44)
BMI				1.04 (1.02-1.06)
Hypertension				0.81 (0.55-1.19)
Hyperlipidemia				1.03 (0.69-1.52)
Statin treatment				0.98 (0.65-1.48)
Cardiac testing order				5.18 (3.51-7.65)

Abbreviations: ASCVD, atherosclerotic vascular disease; nSES, neighborhood socioeconomic status (lowest, 25th percentile; lower middle, 26th to 50th percentile; upper middle, 51st to 75th percentile; highest, >75th percentile; PCRE, pooled cohort risk equation; BMI, body mass index; BP, blood pressure; LDL, low-density lipoprotein.

[a] Models do not include conditions/variables that go into calculation of ASCVD risk score. However, per prior literature, age, gender, and race are included.

were observed for patients with low ASCVD risk with and without chest pain. These results provide further rationale for following ASCVD risk scores when referring to specialty care.

Conclusions

We found that patients with both high and low ASCVD risk scores were referred to cardiology at similar rates when they endorsed chest pain. Without chest pain, a similarly low percent of high and low ASCVD risk patients were referred. Whether ASCVD risk scores should be adopted as the gold standard predictive tool for evaluating patients in primary care presenting with chest pain remains uncertain. Our study fills a gap in the literature in primary care management of NCCP, and to our knowledge is the first study on this topic that used data from primary care encounters in the United States. The majority of existing research in this field has been done with European patient cohorts.[16,18,19] Further research is warranted to determine if dissemination over time results in more primary care providers using the ASCVD risk tool when making referrals to cardiology. Replication in practice-based research networks is warranted and primary data collection is needed to measure whether and how primary care physicians use ASCVD risk score in making clinical decisions.

Declaration of Conflicting Interests

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