



Racial and ethnic differences in severity of coronary calcification among patients undergoing PCI: Results from a single-center multiethnic PCI registry

Solomon W. Bienstock^{a,1,2}, Rajeev Samtani^{a,1,2}, Ashton C. Lai^{a,1}, Usman Baber^{b,1}, Dylan Sperling^{a,1}, Anton Camaj^{a,1}, Jason Feinman^{a,1}, Peter Ting^{a,1}, Nikola Kocovic^{a,1}, Emily Li^{a,1}, Martin E. Goldman^{a,1,*}

^a Zena and Michael A. Wiener Cardiovascular Institute, Icahn School of Medicine at Mount Sinai, New York, NY, United States

^b Division of Cardiovascular Disease, Oklahoma University Medical Center, Oklahoma City, OK, United States

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ABSTRACT

Background: Although population-based studies have demonstrated racial heterogeneity in coronary artery calcium (CAC) burden, the degree to which such associations extend to percutaneous coronary intervention (PCI) cohorts remains poorly characterized. We sought to evaluate the associations between race/ethnicity and CAC in a PCI population.

Methods: This single center retrospective study analyzed 1025 patients with prior CAC who underwent PCI between January 1, 2012 and May 15, 2020. Patients were grouped as non-Hispanic White (NHW, N = 779), non-Hispanic Black (NHB, N = 81) and Hispanic (H, N = 165). Associations between race and CAC (Agatston units) were examined using negative binomial regression while adjusting for baseline parameters.

Results: Among the 1025 patients (mean age 65.8, 70% male) who underwent PCI, NHW, NHB, and H populations had median CAC scores of 760, 500, and 462 Agatston units, respectively ($p < 0.0001$). Hispanic patients displayed a higher burden of diabetes mellitus, hypertension and hyperlipidemia compared with other groups. After adjusting for baseline differences and compared with NHW, the inverse association between Hispanic and CAC persisted ($\beta = -324.1$, $p < 0.0001$) whereas differences were not significant for NHB ($\beta = -51.5$, $p = 0.67$).

Conclusions: Despite a higher risk clinical phenotype, Hispanic patients who underwent PCI had significantly lower CAC compared with non-Hispanic patients. Thus, current risk stratification models using universalized CAC scores may underestimate the risk for the Hispanic population. Race/ethnicity-informed CAC thresholds may better guide clinical decisions.

1. Introduction

Coronary artery calcification (CAC) is a well-established marker of subclinical coronary artery disease (CAD) as the progression of CAC has been shown to correlate with the progression of CAD [1,2]. CAC score is strongly predictive of coronary heart disease, cardiovascular disease, and all-cause mortality, independent of traditional risk factors [3]. The CAC score, calculated using computed tomography (CT) scan of the heart, has been validated across ethnicities; however, previous

population-based studies have demonstrated significant racial differences in CAC score severity [4–9]. Despite known racial differences in CAC score severity, current clinical guidelines do not incorporate these parameters into risk assessment with CAC scoring. This risk stratification is especially important when evaluating the need for percutaneous coronary intervention (PCI). Data thus far is limited for whether these ethnic differences in CAC score are seen amongst patients requiring PCI. Through a retrospective review of all patients requiring PCI at our institution, we sought to identify whether associations between race/

* Corresponding author at: Zena and Michael A. Wiener Cardiovascular Institute, Icahn School of Medicine at Mount Sinai, One Gustave L. Levy Place, Box 1030, New York, NY 10029, United States.

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² Authors contributed equally to the preparation of this manuscript.

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ethnicity and CAC score extend to a PCI cohort.

2. Methods

Upon approval from the Institutional Review Board, this single center retrospective study analyzed 1025 patients in The Mount Sinai Hospital institutional PCI registry with prior CAC score who underwent PCI from January 1, 2012 to May 15, 2020. The Mount Sinai Hospital maintains an institutional PCI registry that collects clinical, procedural and PCI-related data points at baseline and follow-up over one year. Baseline characteristics of patients were collected including demographics, comorbidities, medications, laboratory data, and presenting symptoms prior to PCI. Self-reported race was grouped as Black or White, while ethnicity was grouped as Hispanic or non-Hispanic. Based on these classifications, three separate populations were studied: non-Hispanic White (NHW, N = 779), non-Hispanic Black (NHB, N = 81) and Hispanic (H, N = 165). Patients who underwent CAC scoring and PCI were included in the study. Patients with indeterminate CAC scores and those who did not have demographic information available were excluded from analysis. Demographics and comorbidities were compared between the study groups. Categorical variables were compared using a chi-squared test. Continuous variables were compared using a *t*-test. Associations between race/ethnicity and CAC score (in Agatston units) were examined using negative binomial regression while adjusting for baseline parameters. In these models, race/ethnicity was modelled as a categorical variable with NHW serving as referent group. Associations between independent variables and CAC score are expressed using a beta coefficient (β), with larger absolute values indicating a stronger effect.

3. Results

The baseline characteristics of the 1,025 patients are presented in Table 1. The average age of our study population was 65.8 years. Male patients comprised a greater proportion of NHW compared to NHB and H (74.1% versus 54.3% and 58.2%, respectively). H had a significantly higher prevalence of hyperlipidemia (HLD), hypertension (HTN), peripheral artery disease (PAD), anemia, and presentation of stable angina amongst the groups. NHW had the lowest prevalence of diabetes mellitus (DM) and smoking while the prevalence of DM was similar between H and NHB. There was no significant difference between the groups with regards to rates of prior myocardial infarction (MI) and coronary artery bypass grafting (CABG). Use of statins was similar between H and NHW, and lowest amongst NHB.

With regard to PCI data, NHW had more left anterior descending (LAD) intervention (62.0%), followed by H (57.6%) and NHB (45.7%); ($p = 0.013$). H had less left main (LM) intervention compared to NHW and NHB (0.6%, 2.6%, and 2.5%, respectively; $p = 0.300$). Mean Syntax, B2C scores, stent length, use of rotational atherectomy, and the percentage of thrombotic lesions were all significantly lower in NHB and H than NHW.

NHW, NHB, and H populations had a median CAC (interquartile range 25th-75th percentile) of 760 (273–1433), 500 (80–1235), and 462 (173–918) Agatston units, respectively. When analyzing the data with negative binomial regression without adjusting for baseline parameters, the β coefficient for NHB was not statistically significant ($\beta = -92.3$, $p = 0.461$); whereas for H, the β coefficient was statistically significant ($\beta = -412.5$, $p < 0.001$). Similarly, when adjusting for baseline parameters, the β coefficient for NHB was not statistically significant ($\beta = -51.1$, 95% CI -282.9 to 180.8 ; $p = 0.667$), whereas for H, β remained statistically significant ($\beta = -324.1$, 95% CI -492.5 to -155.7 ; $p < 0.001$). Other parameters with statistically significant β coefficients were age ($\beta = 22.9$, $p < 0.001$), syntax score ($\beta = 33.9$, $p < 0.001$), sex ($\beta = -223.6$, $p < 0.002$), DM ($\beta = 201.0$, $p < 0.011$), prior revascularization ($\beta = 188.1$, $p < 0.020$), statin use ($\beta = 200.5$, $p < 0.010$), CKD stage III ($\beta = 974.6$, $p < 0.008$), and dialysis ($\beta = 2423.2$, $p < 0.001$) (Fig. 1).

Table 1

Baseline characteristics of the study population.

	NHW (N = 779)	NHB (N = 81)	H (N = 165)	Overall (N = 1025)	p-value
Age	66.8	62.2	66.2	65.8	0.0003
Gender (%)	74.1	54.3	58.2	70.0	<0.0001
M)					
BMI	28.6	30.7	28.8	28.8	0.005
HLD %	86.9	79.0.5	94.6	87.5	0.001
HTN %	80.0	91.4	93.3	83.0	<0.0001
DM %	25.8	40.7	39.4	29.2	<0.0001
CKD (GFR < 60) %	17.2	19.2	21.1	18.0	0.472
LVEF %	58.5	57.3	57.8	58.3	0.144
Smoking %	6.8	14.8	10.9	8.1	0.015
Lung Disease %	6.4	12.4	4.2	6.5	0.052
Anemia %	7.1	9.9	13.9	8.4	0.013
Ischemic History					
MI %	4.2	1.2	6.1	4.3	0.212
CABG %	0.6	0.0	0.0	0.5	0.452
PAD %	5.0	3.7	13.3	6.24	<0.0001
CeVD %	7.7	13.6	12.1	8.9	0.058
Presentation					
Stable	82.7	71.2	75.3	80.5	–
Angina %					
NSTEMI %	15.6	26.3	21.6	17.5	–
STEMI %	1.7	2.5	3.1	2.0	–
Overall	–	–	–	–	0.045
Medications at Admission					
Statin %	79.7	62.96	78.79	78.24	0.002
Baseline Labs					
LDL, mg/dL	84.0	94.6	83.4	84.7	0.371
CrCl	91.5	88.7	85.8	90.3	0.142
Hgb, g/dl	13.7	13.0	13.2	13.6	<0.0001
CRP, mg/L	2.0	3.0	2.5	2.2	0.0002

BMI, Body Mass Index; HLD, Hyperlipidemia; HTN, Hypertension; DM, Diabetes Mellitus; CKD, Chronic Kidney Disease; LVEF, Left Ventricular Ejection Fraction; MI, Myocardial Infarction; CABG, Coronary Artery Bypass Graft; PAD, Peripheral Artery Disease; CeVD, Cerebrovascular Disease; NSTEMI, Non-ST Elevation MI; STEMI, ST Elevation MI; LDL, Low-density Lipoprotein; CrCl, Creatinine Clearance; Hgb, Hemoglobin; CRP, C-Reactive Protein.

4. Discussion

Previous studies, such as the Multi-Ethnic Study of Atherosclerosis (MESA) study [8], have found that the amount of CAC was significantly lower for Hispanic and Black patients than for White patients, however without prior cardiovascular disease (CVD) and in a non-PCI cohort. Autopsy studies have exhibited a similar relationship, showing that Blacks exhibited less CAC after death than Whites [10]. More recently, it has been found that Blacks and Hispanics had a significantly increased risk of CVD and all-cause mortality as compared to whites across all CAC stratifications, such that Blacks and Hispanics with a CAC of 0 had a greater risk of CVD than whites with a CAC of 0 [11]. Thus, race/ethnicity-specific risk stratification appears warranted.

In our study, Hispanics had significantly lower CAC compared with non-Hispanics in a cohort of patients who underwent PCI. Of note, the Hispanic population in our cohort had a higher prevalence of traditional cardiovascular risk factor such as diabetes, hypertension and hyperlipidemia as compared to non-Hispanic patients. Thus, generalized CAC scoring may underestimate the extent and severity of significant CAD in the H population with less calcific plaque matrix whether due to race specific atherosclerotic process or more rapid plaque progression. Hispanic patients may have a higher burden of “high-risk” or “vulnerable” plaques, consisting of large lipid cores, thin fibrous caps, and increased macrophages. High-risk vulnerable plaques are thought to put patients at higher risk for rupture and cardiac events than fully calcified plaque [12]. CAC scoring generally identifies stable plaque upon which more vulnerable plaque can develop. Thus, Hispanics may have less calcium but higher soft or “vulnerable” plaque burden, as supported by the

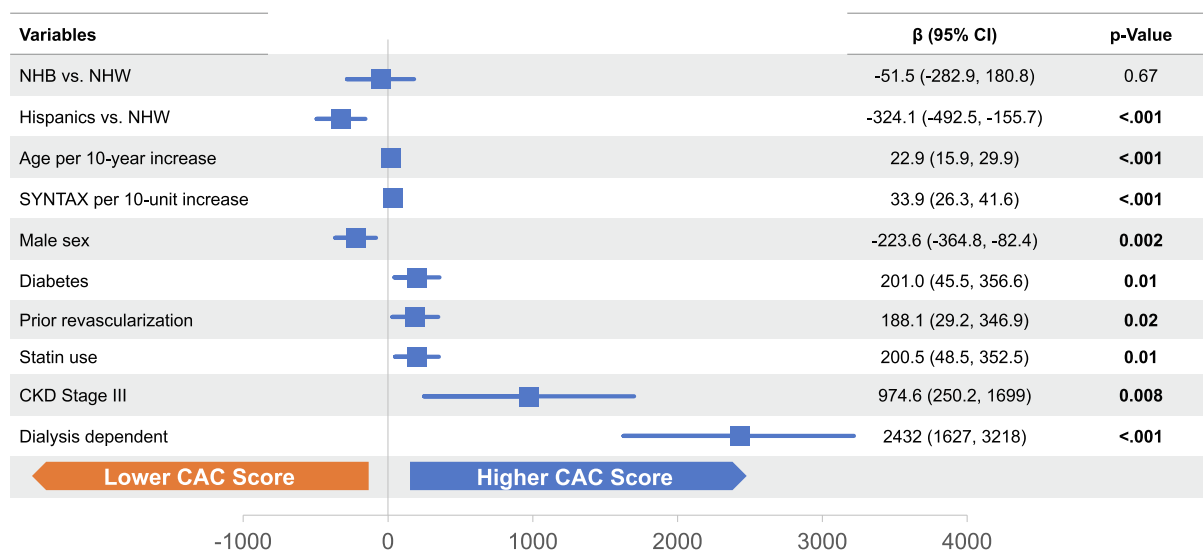


Fig. 1. Forest plot of β coefficients on coronary artery calcium scores for several variables. Hispanics had lower CAC scoring as compared to NHW. Chronic kidney disease, CKD; Coronary artery calcium, CAC; Non-Hispanic Blacks, NHB; Non-Hispanic Whites, NHW.

increased rates of prior peripheral arterial disease compared to other ethnicities. Furthermore, there is evidence that the Hispanic population tends to have worse outcomes after PCI, suggesting that there may exist a biological difference in plaque composition [13]. This is also supported by data from Desai and colleagues, who evaluated racial and gender disparities in multi-vessel PCI outcomes. Among all demographic groups, they found that Hispanic females had the largest increase in in-hospital mortality over the five-year study period [14].

Our findings suggest that predictive models might consider taking race/ethnicity into account when determining the risk associated with calcium scores in each group. Additionally, while race informed cut-offs for CAC score could also be considered, it is possible that if Hispanics have a larger amount of “vulnerable” plaque, combinational imaging of separate vascular beds, such as imaging of femoral and carotid arteries, may be better suited for risk stratification [12]. Such an approach would incorporate total plaque burden rather than coronary artery calcification alone. Further investigations should assess coronary catheterization outcome data and the degree of atherosclerotic plaque burden by femoral and carotid ultrasound as compared to CAC scoring. One might also consider wider incorporation of the Coronary Artery Calcium Data and Reporting System (CAC-DRS), which takes into account the Agatston score as well as the number of calcified vessels. The prognostic significance of this newer scoring system was recently validated by Dzaye and colleagues. They found that, compared to CAC score or number of calcified vessels alone, the CAC-DRS is a better predictor for risk of all-cause mortality, coronary heart disease mortality, and cardiovascular disease mortality. The investigators confirmed that this scoring system also has predictive value independent of traditional cardiovascular risk factors [15]. These more inclusive scoring systems may also be better risk stratifying models when used across different races/ethnicities.

4.1. Limitations

Of note, our work had mild discrepancies with the previously discussed MESA study; we were unable to recapitulate the finding that Black patients had lower CAC than White patients, which could be attributed to the low number of Black patients in our registry. Further work in a larger patient population would be prudent to elucidate this discordant finding. Additionally, most patients in The Mount Sinai Hospital institutional registry who presented for PCI had stable heart

disease rather than acute coronary syndrome (ACS). One area of interest would be to evaluate whether the same results are seen in patients who present with ACS who have different coronary plaque composition. Lastly, Hispanic ethnicity is a large ethnic group composed of diverse individuals from several different countries, regions and backgrounds. There are likely differences in socio-economic status, genetics, and lifestyle between these subgroups that are not accounted for in our current analysis. Further investigations should focus on these differences.

Conclusions

Our study illustrates that Hispanic patients who underwent PCI had significantly lower CAC compared with non-Hispanic patients. This suggests race/ethnic-specific CAC thresholds may better guide clinical decisions for therapeutic interventions (medications and invasive). Ultimately, we hope this will further help in determining how racial differences in CAC impact cardiac risk prediction.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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